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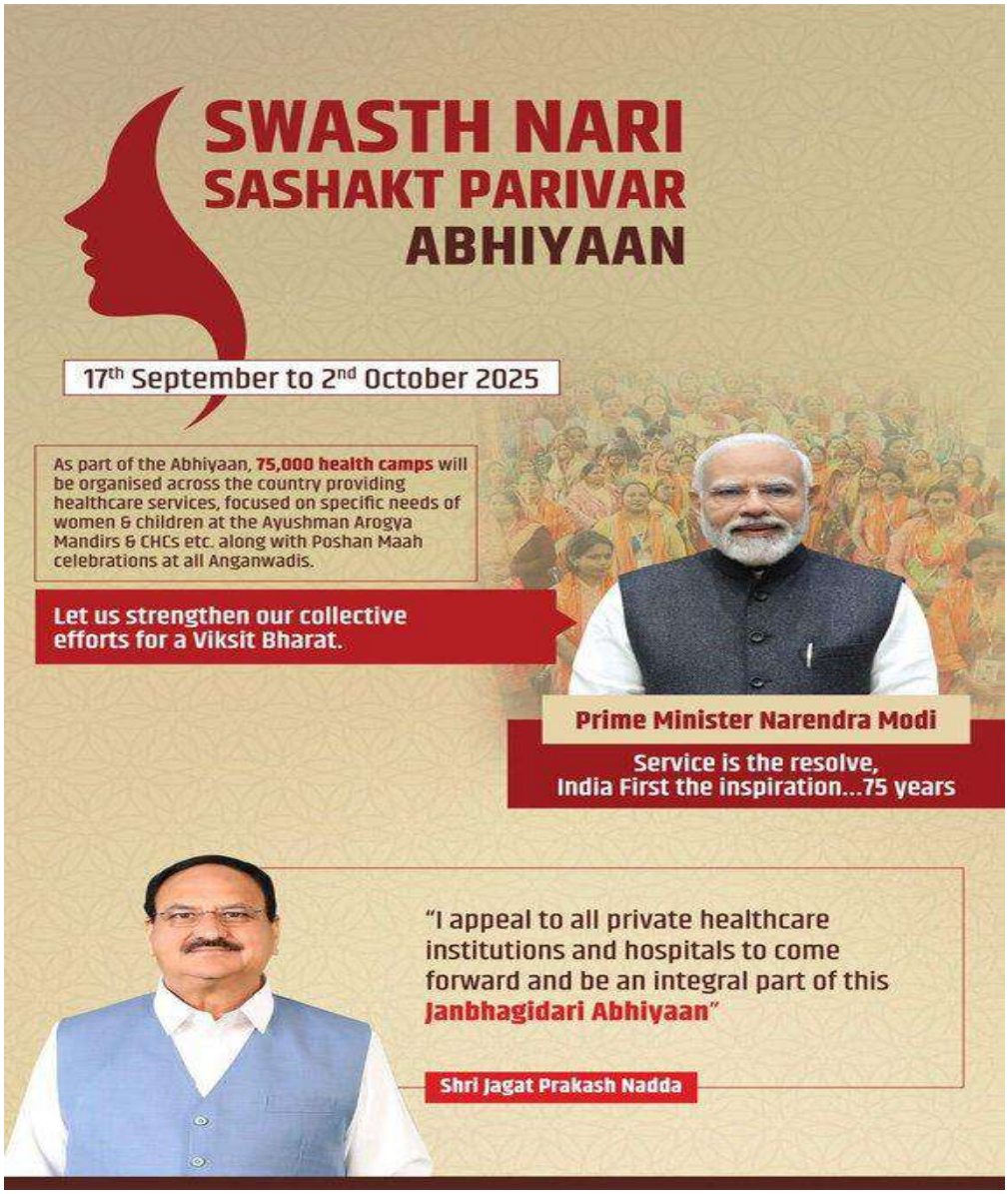

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EDITORIAL

Government Efforts in Improving Women's Healthcare Outcomes in India & The Swasth Nari, Sashakt Parivar Pakhwara

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The Government of India has undertaken sustained and multipronged efforts to improve healthcare outcomes for women, with a strong focus on reproductive, maternal, and adolescent health. Under the umbrella of the National Health Mission (NHM), the RMNCH+A strategy addresses reproductive, maternal, newborn, child, and adolescent health in an integrated manner.

Programs such as the Janani Suraksha Yojana (JSY) and the Janani Shishu Suraksha Karyakram (JSSK) have been instrumental in increasing institutional deliveries and ensuring that women receive free maternity services, including transport, diagnostics, and essential drugs. The Pradhan Mantri Surakshit Matritva Abhiyan (PMSMA) further guarantees free antenatal checkups on designated days, improving early detection of high-risk pregnancies.

Nutritional security has been advanced through the POSHAN Abhiyaan and Anemia Mukt Bharat, aiming to tackle the persistently high burden of malnutrition and anemia among women. Simultaneously, adolescent health and reproductive choices are being strengthened through the Rashtriya Kishor Swasthya Karyakram (RKSK) and Mission Parivar Vikas, which expand access to family planning services, menstrual hygiene education, and contraceptive options.

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With the launch of Ayushman Bharat, a paradigm shift has occurred in women's health access: Health and Wellness Centres are now providing comprehensive primary care, including reproductive and cancer screening services, while PM-JAY insurance coverage ensures financial protection for secondary and tertiary care needs, including obstetric emergencies and cancers. The National Programme for Prevention and Control of Cancer, Diabetes, CVDs, and Stroke (NPCDCS) has brought cervical and breast cancer screening to the forefront of women's health interventions.

Digital innovations such as the Mother and Child Tracking System (MCTS) and eSanjeevani telemedicine platform are enabling more efficient follow-up and expanding specialist access in underserved areas. These initiatives align with India's commitment to the Sustainable Development Goals (SDGs), especially SDG 3 (health) and SDG 5 (gender equality).

The Swasth Nari, Sashakt Parivar Abhiyaan

The Swasth Nari, Sashakt Parivar Abhiyaan is a fortnight-long health campaign that ran from September 17 to October 2, 2025. Launched by the *Ministry of Health and Family Welfare (MoHFW)*, the campaign was designed to address the healthcare needs of women and children by organizing health camps and providing specialist services across the country. It was held in convergence with the *8th Rashtriya Poshan Maah*, focusing on healthy women and empowered families (Figure 1).

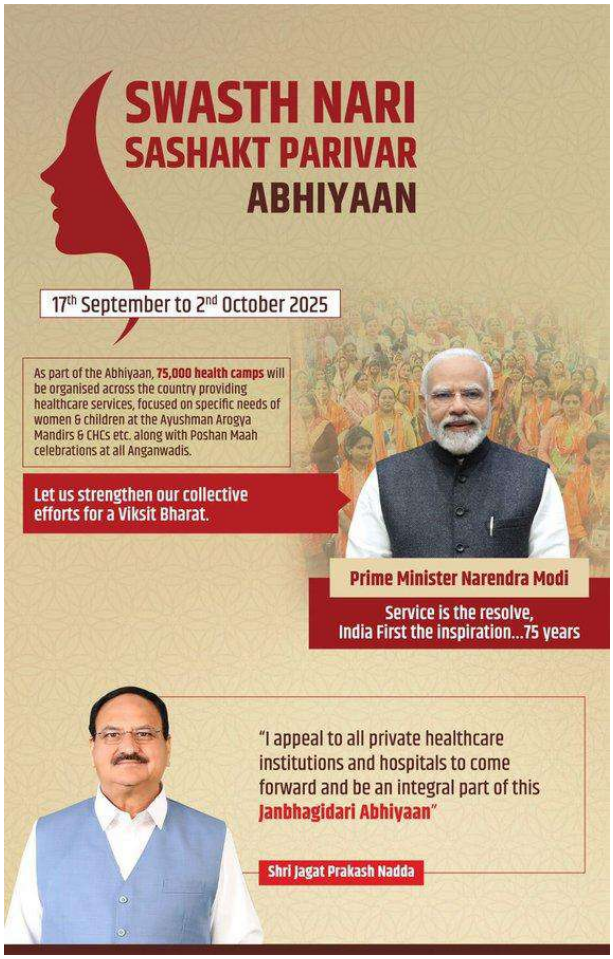

Figure 1. Swasth Nari, Sashakt Parivar Pakhwara

The campaign activities are aimed to

- Improve health outcomes for women, adolescent girls, and children.
- Provide screening for communicable and non-communicable diseases.
- Conduct health counselling and awareness sessions on nutrition and hygiene.
- Strengthen immunization and child health coverage.
- Ensure access to comprehensive health services nationwide.

Key Objectives & Activities

- **Focus on Women and Children:** To address the specific healthcare needs of women and children.
- **Nationwide Health Camps:** Daily health camps were organized at government health facilities, including Ayushman Arogya Mandirs, Community Health Centres, and District Hospitals.
- **Specialist Services:** Mobilization of specialists from gynaecology, paediatrics, eye care, ENT, dental, dermatology, and psychiatry.
- **Community Mobilisation:** Active participation from ASHAs, ANMs, Anganwadi workers, community self-help groups, and youth volunteers.
- **Integration with Poshan Maah:** The campaign was held alongside the 8th Rashtriya Poshan Maah, a national nutrition campaign.

The campaign brings together communities, healthcare providers, and policymakers to reaffirm the vision: Healthy Women, Empowered Families, Stronger India.

Strategic Approach

1. Community Convergence: Mobilizing local communities, self-help groups, and frontline workers (ASHA, ANM, Anganwadi).
2. Health System Integration: Linking primary care centers, district hospitals, and national programs.
3. Policy Synergy: Working in alignment with Ayushman Bharat, Poshan Abhiyaan, and Mission Shakti.
4. Awareness & Behaviour Change: Targeted IEC campaigns for nutrition, menstrual hygiene, breastfeeding, and lifestyle diseases.

Expected Impact

- Reduction in maternal and child mortality rates.
- Improved nutritional status of women and children.
- Increased adolescent health literacy and empowerment.
- Stronger family health resilience and productivity.

Vision

The Abhiyaan reaffirms India's commitment to:

👉 Healthy Women → Empowered Families → Stronger Nation

The National Board of Examinations in Medical Sciences runs 111 courses. These are:

Broad Specialty (03 years)	**29 Courses**
Super Specialty (03 years)	32 Courses
Fellowship (02 years)	41 Courses
Post MBBS Diploma Courses (02 years)	09 Courses
Total	**111**

Of these, courses that are specific to women's health are:

- Broad specialty DNB in Obstetrics and Gynaecology
- Super Specialty DrNB in Gynaeco Oncology
- Skill enhancement Fellowships (FNB) in Breast imaging, Maternal & Foetal medicine, Minimally Invasive Gynaecologic Surgery & Reproductive medicine and
- Post MBBS Diploma in Obstetrics and Gyaecology

As a result of these collective efforts, India has achieved significant progress: the Maternal Mortality Ratio (MMR) has declined sharply to 97 per 100,000 live births, and institutional deliveries have crossed 89%. Nevertheless, challenges remain—particularly the high prevalence of anemia, gaps in quality of care across states, and inequitable access in rural and tribal regions. Addressing these will be critical to further strengthening women's health and achieving the vision of a healthier, empowered India.

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PERSPECTIVE ARTICLE

Redefining Global Medical Education Governance: Advocating for India's National Medical Commission as an Independent WFME Regional Entity

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Abstract

Background: The World Federation for Medical Education (WFME) governs global medical education through six regional associations, despite being home to the largest number of medical colleges and producing over 125,000 medical graduates annually. India, through its statutory regulator, the National Medical Commission (NMC), lacks direct representation in this structure. **Objective:** This article advocates for the formal recognition of the National Medical Commission (NMC) as an independent regional entity within the WFME framework, emphasizing that India's central role in shaping global health systems warrants direct and proportionate representation in global medical education governance. **Discussion:** The NMC has implemented wide-ranging reforms, including digital accreditation systems and a competency-based curriculum, establishing itself as a model for emerging regulators, particularly in low- and middle-income countries. However, current representation through SEARAME does not provide the regulatory authority or scope needed to engage meaningfully in global decision-making. International precedents exist where WFME has recognized national bodies with substantial influence, justifying similar recognition for the NMC. **Conclusion:** India's medical education scale, regulatory sophistication, and global outreach warrant a dedicated platform within WFME. The structural inclusion of India, either through NMC, AHPE, or a federation formed by all medical educators in India, would foster equitable governance, enhance collaboration, and support medical education reform across diverse regions.

Keywords: National Medical Commission, WFME, medical education governance, global health workforce, SEARAME, accreditation, India, NexT, competency-based education, regulatory reform, Pan-American Federation of Associations of Medical Schools

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Introduction

Global medical education is undergoing a transformative shift driven by increasing demands for quality assurance, standardization, and equitable representation in international regulatory frameworks. The World Federation for Medical Education (WFME) plays a pivotal role in shaping these developments by setting global standards and accrediting medical education authorities worldwide. The idea for an international medical education body began at the 1966 New Delhi Conference, led by Amador Neghme of the Pan-American Federation of Associations of Medical Schools (PAFAMS). In 1972, WFME was officially established in Copenhagen, with its Constitution signed by regional representatives, the World Health Organization (WHO), and the World Medical Association (WMA). The Constitution was deposited with WHO, recognizing WFME as the global authority for medical education [1].

WFME brings together a broad coalition of stakeholders committed to enhancing the quality of medical education globally. Its governance includes six regional associations: the Association for Medical Education in the Eastern Mediterranean Region (AMEEMR), the Association of Medical Schools in Africa (AMSA), the Association of Medical Schools in Europe (AMSE), the PAFAMS, the South East Asian Regional Association for Medical Education (SEARAME), and the Western Pacific Association of Medical Education (WPAME). In addition, WFME is supported by global partner organizations, including the Association for Medical Education in Europe (AMEE), Intealth™, the World Medical Education Junior Doctors Network (WMA JDN), and the World Medical Association (WMA). Educational Commission for Foreign Medical Graduates (ECFMG®), which is also a member of Intealth™, Non-voting members include Health Care in Danger (HCID), the United Nations Educational, Scientific and Cultural Organization (UNESCO), the International Federation of Medical Students' Associations (IFMSA), the WHO, FAIMER®, another Intealth™ member. And other key global organizations. These non-voting members, while not holding voting rights, play a vital role in shaping WFME's initiatives through collaboration, insight, and global outreach.

FAIMER and WFME collaborate to oversee the World Directory of Medical Schools, a unified and comprehensive database of medical education institutions globally. This directory was established through a partnership involving the WHO and the University of Copenhagen, merging FAIMER's International Medical Education Directory (IMED) with WFME's Avicenna Directory to create a single authoritative resource on undergraduate medical education worldwide [2].

India stands as a major global force in medical education, both in terms of scale and impact. With over 770 operational medical colleges and an annual output exceeding 125,000 medical graduates, India leads the world in the number of trained physicians produced each year [3]. This vast infrastructure not only caters to the domestic healthcare system but also attracts thousands of international students, particularly from low- and middle-income countries (LMICs) in Asia and Africa [4].

As the host of the world's largest medical education ecosystem, India occupies a uniquely influential position in the global health workforce pipeline.

Despite this substantial contribution, India's role in global medical education governance remains underrepresented. The National Medical Commission (NMC), which succeeded the Medical Council of India (MCI) in 2020 as the country's primary regulatory authority for medical education and practice, does not hold a formal position within WFME's Executive Council or its committees responsible for setting global standards in medical education [5]. India's representation is currently channeled through SEARAME, a consortium that includes academic bodies from multiple nations but lacks statutory authority or regulatory influence over India's national policies [6]. Notably, the Academy of Health Professions Education (AHPE) represents India within SEARAME, but it functions more as an academic association than a policy-making or accrediting body [7]. WFME also lacks formal representation from several major medical regulatory bodies, including the Liaison Committee on Medical Education (LCME), the Accreditation Council for Graduate Medical Education (ACGME), the UK General Medical Council, and numerous other national medical councils. In some countries, the quality of medical education is overseen by private organizations, while in others, it is regulated more directly through government-appointed authorities.

This representational gap creates a mismatch between India's and other countries' actual influence on medical education and its role within global regulatory structures. The lack of direct participation in WFME's decision-making processes undermines equitable governance and limits India's and other countries' ability to contribute meaningfully to global educational standards. The NMC has undertaken major reforms streamlining undergraduate and postgraduate regulations, digitizing compliance monitoring, and mandating transparent accreditation processes, placing it among the most progressive medical education regulators globally [8].

In light of India's unparalleled capacity, regulatory maturity, and increasing global influence, it is imperative to reassess its position within the WFME structure. This article advocates for the formal recognition of NMC as an independent WFME regional entity along with other countries. Such recognition would not only reflect India's rightful status in the global medical education hierarchy but also enable more inclusive, representative, and context-sensitive governance of medical education worldwide. Reimagining India's place within WFME is a necessary step toward a more balanced and globally relevant educational ecosystem.

India's Dominant Position in Global Medical Education

India has emerged as a global epicenter for undergraduate and postgraduate medical training, not merely by scale but through strategic reforms, cross-border influence, and sustained investment in medical education infrastructure. With over 770 operational medical colleges and approximately 118,148 medical admissions annually, India is home to the world's largest medical education system [9]. The magnitude of this

output surpasses any other country, positioning India as a critical supplier of trained physicians for both domestic and international healthcare systems.

Scale and Institutional Footprint

As of 2025, NMC oversees 706 recognized government and private medical colleges with an annual undergraduate intake capacity exceeding 108,000 students [10]. Including new approvals under the NMC's dynamic expansion plan, the number of operational colleges has surpassed 770 institutions, supported by a network of teaching hospitals and affiliated research centers [11]. In contrast, Brazil, the second-largest contributor, hosts approximately 357 medical schools, followed by the United States with 173 and China with around 164 [12].

The centralized admission process through the National Eligibility cum Entrance Test (NEET) has further streamlined access to medical education in India and ensured standardized academic entry criteria across all institutions [13]. Simultaneously, India is also planning to transition to a National Exit Test (NExT) model, which will serve as a uniform licensure and postgraduate entrance examination, adding transparency and accountability to the quality assurance process [14].

Global Reach and Support to LMICs

India's influence extends beyond its borders through the education of thousands of international medical students annually, predominantly from low- and middle-income countries (LMICs) in Africa, Central Asia, and Southeast Asia. Estimates suggest that more than 25,000 international students are currently enrolled in Indian medical institutions, many of whom are recipients of bilateral scholarships or self-financed education seekers [15]. These students often return to serve in their home countries, thereby contributing to global health workforce capacity building.

Comparative Standing Among WFME Regions

When comparing across WFME-recognized regional associations, India's medical education system outpaces most in terms of infrastructure and output. The African continent, though vast, collectively operates around 444 medical schools, while Europe hosts approximately 479 [12]. The Western Pacific Region, including countries such as China, Australia, and Malaysia, has about 408 institutions, and the PAFAMS covers roughly 650 affiliated schools [12]. India's centralized governance through the NMC enables consistent standards across its vast network, unlike in many other regions where regulatory control is fragmented or decentralized [14].

This unparalleled scale, coupled with a harmonized regulatory framework, distinguishes India as a standalone educational force rather than just another regional contributor. Given India's scale and significance in global medical education, there is a need for fair representation of India, NMC, within WFME's governance structure. Currently, India is represented through SEARAME [17].

The WFME Representation Gap

The WFME operates through a decentralized structure involving six regional associations that support WFME's mission of improving the quality of medical

education globally. These associations include: PAFAMS, AMEE, AMEEMR, AMEWPR, AFREhealth, and SEARAME [2]. Each regional body serves as a liaison between WFME and its member countries, contributing to policy formulation, accreditation advocacy, and quality enhancement. However, in the case of India, this structure presents several representational inadequacies that merit critical review.

SEARAME's Composition and Limitations

SEARAME, the designated WFME regional association for the South-East Asia region, comprises academic bodies from multiple countries, including the Association for Medical Education (Bangladesh), the Myanmar Academy of Medical Science, the Association of Health Professions Educationists of Nepal (AHPEN), the Indonesian Association for the Study of Health Professions Education (IASHE), the Forum of Sri Lankan Medical Educationists (FOSME), the Consortium of Thai Medical Schools (COTMES), and the Academy of Health Professions Education (AHPE) from India [6]. While the intention behind such a consortium is to foster regional cooperation in educational innovation and standards alignment, its composition remains largely academic and advisory in nature.

Most of SEARAME's constituent organizations lack statutory authority over their respective national medical education systems, like in the USA. In India's case, the AHPE is an academic association that plays no role in regulatory oversight, licensing, or accreditation. It operates independently of the NMC, which is the sole legal and statutory authority governing medical education and practice in India under the National Medical Commission Act, 2019 [5].

This structural disconnect severely limits SEARAME's capacity to represent India's regulatory interests at the global level. Unlike regions where regulatory bodies themselves have direct participation in WFME discussions, India is effectively represented by a non-statutory academic organization without decision-making authority, rendering its engagement superficial and misaligned with national priorities.

Inadequacy of Current Representation for India's Regulatory Authority

India's representation through AHPE within SEARAME does not reflect the scale or strategic priorities of the NMC, which oversees 770+ medical colleges and licenses over 125,000 doctors annually, far exceeding most SEARAME region countries [9]. Despite this immense scale and regulatory responsibility, NMC does not have a formal seat at the WFME decision-making table.

The absence of the NMC in WFME's regional or global governance processes results in a fundamental misalignment between India's contributions to global medical education and its ability to influence the policies and standards that affect it. Given the NMC's recent implementation of transformative reforms such as the Undergraduate and Postgraduate Regulations of 2023, and a centralized accreditation portal with live compliance monitoring, the exclusion of this high-capacity regulator from WFME representation appears increasingly anachronistic [14].

Disproportionate Influence Versus Contributions

India trains more medical graduates annually than any other nation and hosts more medical institutions than the entire African continent or the European region individually [18]. It serves as a critical node in global health workforce development, especially for low- and middle-income countries. Yet, in the WFME governance structure, smaller nations with minimal medical education output are granted equal or greater influence through their regional representatives.

This disproportionate model not only marginalizes India's role but also limits the broader global health community's ability to learn from and integrate India's scalable, cost-effective, and outcomes-focused innovations in medical training. The lack of appropriate representation stifles opportunities for equitable leadership and prevents WFME from leveraging India's regulatory best practices to strengthen medical education in similar contexts.

It is within this context that a reassessment of India's position becomes necessary. A formal restructuring that recognizes the NMC as a standalone regional entity within WFME would rectify these asymmetries, create space for substantive policy input, and foster a more inclusive and proportionally representative governance framework in global medical education.

The Case for NMC as a Separate WFME Regional Association

For equitable representation within global medical education governance is not solely a matter of scale but also one of institutional capability, innovation, and relevance. The National Medical Commission (NMC), established under the National Medical Commission Act, 2019, has not only inherited the statutory authority of its predecessor (the Medical Council of India) but also introduced sweeping reforms aligned with modern regulatory standards. These transformations distinguish the NMC from academic bodies within SEARAME and position it as a suitable and necessary candidate for recognition as an independent regional association under the World Federation for Medical Education (WFME).

Institutional Capacity: NMC's Structure, Digitization, and Transparency

The NMC functions as a statutory autonomous regulatory authority under the Ministry of Health and Family Welfare, Government of India. It comprises four vertical autonomous boards - Undergraduate Medical Education Board (UGMEB), like LCME in the USA, Postgraduate Medical Education Board (PGMEB), similar to ACGME, Medical Assessment and Rating Board (MARB), and Ethics and Medical Registration Board (EMRB), equal to FSMB in the USA. Each is tasked with specific mandates to ensure streamlined governance [5].

One of the NMC's hallmark advancements is the integration of digital governance platforms for institution recognition, faculty tracking, student admissions, and compliance monitoring. The Medical College and Institution Information Management System (MCIIMS) enables real-time tracking of infrastructure, faculty qualifications, and hospital patient load - significantly enhancing transparency and regulatory

oversight [19]. These systems reduce bureaucratic delays and ensure public accountability, placing India at the forefront of regulatory modernization among LMICs and comparable economies.

Furthermore, the NMC mandates public disclosure of institutional data, decisions on recognitions, and faculty qualifications, thereby promoting a culture of transparency rarely matched by similar bodies in the region [20].

Regulatory Innovation: UG NEET, PG NEET, and National Standards

The NMC has initiated several policy-level innovations that reflect a commitment to outcome-based, standardized medical education. The National Eligibility cum Entrance Test (UG NEET) ensures a merit-based, uniform admissions process across all government and private medical institutions in India. This has significantly improved equity and standardization in medical education access [13].

In parallel, as per NMC Gazette, NMC is planning to implement the National Exit Test (NExT) - a unified licensure and postgraduate entrance exam - which represents a landmark regulatory shift. It eliminates multiple assessments across states and universities, thereby ensuring that all graduating medical students meet a national benchmark of competency before entering clinical practice [14].

The NMC has also revised the Undergraduate and Postgraduate Medical Education Regulations, focusing on competency-based medical education (CBME), integrated curricula, early clinical exposure, and formative assessment strategies that align with global best practices [21]. These developments underscore India's ability to not only regulate but also lead in pedagogical innovation.

Global Relevance: Emulation by LMICs and Education Export

India’s medical education system plays a pivotal role in training international medical students, especially from LMICs across Africa, Central Asia, and Southeast Asia. With over 25,000 foreign medical students currently enrolled in Indian institutions, the country functions as a global hub for affordable, English-medium medical education [15].

Moreover, several LMICs have shown interest in adopting regulatory frameworks modeled on India's experience with centralized examinations (NEET/NExT), digital accreditation platforms, and structured curricula. This diffusion of regulatory practices signals India's soft power in medical education governance - an aspect of global relevance that further justifies its need for independent recognition at the WFME level [16].

International Precedents and Comparative Models

WFME has long espoused principles of inclusivity, adaptability, and regional engagement in its mission to improve the quality of medical education globally. Although the formal structure of WFME operates through six recognized regional associations, it has historically demonstrated flexibility in engaging with diverse regional models and adapting to unique geopolitical or educational circumstances. These precedents support the argument that the current regional framework is not rigid and can evolve to

accommodate emerging needs and powerhouses in global medical education, such as India.

WFME's Flexible Engagement with Regions

WFME has adopted a region-based approach primarily to foster regional collaboration, context-specific standard-setting, and decentralized quality assurance. However, this structure has not been uniformly applied or enforced with exclusivity. In several instances, WFME has established working relationships with national regulatory bodies, accreditation agencies, and regional consortia, even outside the six formal regional associations.

For example, AMEE, although named as a regional body, maintains active collaborations beyond Europe and includes members from Asia, Africa, and the Americas [23]. Similarly, WFME has acknowledged PAFAMS as a broad regional entity, while also working closely with national bodies like the ECFMG in the United States on accreditation standards and recognition protocols [24].

Moreover, the Middle East and North Africa (MENA) region does not constitute a formal WFME-defined zone. Nonetheless, entities such as the AMEEMR were granted regional recognition despite overlapping significantly with other WFME regions [25]. This adaptability demonstrates WFME's capacity and precedent to accommodate new or hybrid regional configurations, especially when driven by national regulatory maturity and scale.

Examples of Custom Regional Groupings or Special Recognitions

Several custom arrangements highlight WFME's precedent for asymmetric or specialized recognition of regional actors in response to evolving educational landscapes. Africa's fragmented representation is a case in point. While AFREhealth is broadly recognized as a collaborative platform for African medical educators and researchers, there is no single continent-wide accreditation body under WFME. Instead, individual countries such as South Africa and Egypt have developed independent accreditation agencies that engage directly with WFME for recognition [26, 27]. The ECFMG and the LCME in the United States have also received individual recognition or maintained bilateral roles in WFME initiatives, despite being part of a broader Pan-American grouping [28].

These precedents reflect the WFME's pragmatic and functionalist approach - granting recognition or entering into strategic partnerships when national agencies demonstrate substantial infrastructure, accountability, and global influence. Given India's NMC meets and arguably exceeds such thresholds, there is no structural barrier within WFME's policy tradition that would preclude recognizing NMC (India) as an independent regional association.

Furthermore, in light of growing calls for greater diversity, inclusion, and equity in global health governance, acknowledging large-scale, high-capacity regulators like the NMC (India) would not only align with WFME's mission but also enhance the effectiveness and legitimacy of its global educational framework.

Strategic Benefits of Independent Representation

Recognizing India's NMC as a separate regional association within the WFME would not only address representational imbalances but also provide several strategic benefits for global medical education governance. These advantages include the expansion of international collaborations, the alignment of global standards with India's national health education goals, and the promotion of equity in shaping policy discourse for medical education reform. As global health education frameworks become increasingly decentralized and collaborative, the inclusion of high-capacity national regulators such as NMC in leadership positions is essential for achieving shared objectives.

Enhanced Global Collaborations

India is already deeply engaged in transnational educational cooperation. Each year, it trains thousands of international medical students, particularly from LMICs, and actively partners with nations in Africa, Central Asia, and Southeast Asia for academic exchange and capacity building [15]. However, India's participation in shaping global accreditation and curricular frameworks remains limited by its indirect representation within the WFME via SEARAME, a body with limited regulatory authority and narrow geographic influence [5,6].

Independent regional recognition for NMC would enable direct participation in WFME-led policy development, accreditation guideline formation, and international quality assurance benchmarks. This structural inclusion would empower India to establish bilateral and multilateral partnerships with other national regulators, facilitate mutual recognition agreements, and lead initiatives focused on cost-effective, scalable medical education solutions, especially relevant for LMIC contexts [16].

Furthermore, India's digital infrastructure in medical education regulation, such as real-time institutional dashboards, centralized licensure examination (NExT), and uniform admission systems (NEET), serves as a replicable model for emerging regulatory ecosystems worldwide. A standalone regional status would offer a platform for India to export regulatory innovations, contribute to global capacity building, and extend its influence in collaborative research, training, and health systems strengthening initiatives [19].

Better Alignment with India's National Education Goals

India's National Education Policy (NEP) 2020 and subsequent reforms under the NMC emphasize competency-based, interdisciplinary, and technology-driven medical training tailored to national healthcare needs [29]. The policy's objectives include increased autonomy for educational institutions, greater integration of health education with national development goals, and creation of a globally competent yet locally responsive healthcare workforce.

Currently, the disconnect between WFME's regional representation and India's statutory regulator means that India's medical education strategies are underrepresented in global forums. Independent recognition of NMC would bridge this gap, allowing Indian priorities,

such as rural health training, cost containment, and primary care strengthening, to influence international policy discourse.

It would also create opportunities for India to align its accreditation systems with WFME standards without compromising on the contextual relevance of its curriculum, assessment methods, and public health orientation. Such alignment is crucial for Indian medical graduates seeking international mobility and for institutional credibility in global rankings and partnerships [14].

Equity in Decision-Making for Global Medical Education Reform

India's contributions to the global medical education landscape are unmatched in scale. It trains more physicians annually than any other country, serves as a key training destination for students from underserved regions, and pioneers innovative models in regulation and pedagogy. Yet, its voice in global governance structures remains diluted due to indirect representation through academic associations with no regulatory mandate [5,6].

Recognizing NMC as a standalone WFME regional body would rectify this inequity by granting India a proportional and policy-relevant seat at the table. This would not only reflect India's actual contribution to the global health workforce but also promote more balanced decision-making in the evolution of medical education standards, accreditation benchmarks, and ethical governance.

Moreover, equitable inclusion of regulators from high-burden, high-output countries like India is essential to diversifying the epistemic foundation of global medical education - moving away from Euro-American-centric models toward more inclusive, pluralistic frameworks that reflect the realities of LMICs [30].

Recommendations

Given India's unparalleled contribution to the global medical education ecosystem, its institutional regulatory maturity, and its expanding influence on education models across low- and middle-income countries (LMICs), it is both logical and timely that the World Federation for Medical Education (WFME) reconsider its regional representation framework. The following recommendations provide a structured path forward to promote equity, effectiveness, and global inclusivity in medical education governance.

WFME to Formally Recognize the (India) National Medical Commission as a Separate Region

Granting this recognition would not require dismantling SEARAME or undermining existing regional bodies; rather, it would expand WFME's regional architecture to reflect proportional representation and accommodate the growing influence of nations that operate at a supranational scale in education. Similar to how WFME has acknowledged national agencies like the ECFMG (USA), FAIMER, AMSE, WMA JDN of the World Medical Association, IFMSA, for their autonomous roles in accreditation, the NMC also merits equivalent recognition on account of its statutory authority, governance depth, and international engagement [24,27].

To promote global equity in medical education, an advisory council comprising accrediting agencies with WFME Recognition Status should be established, ensuring diverse regional perspectives inform WFME policy and international standards

Discussion

The global architecture of medical education governance is undergoing increasing scrutiny as stakeholders recognize the need for greater equity, contextual relevance, and representation in regulatory decision-making. The WFME, as the apex body for medical education standard-setting and accreditation, holds a pivotal role in ensuring that all regions and contributors to the global medical education ecosystem are adequately represented. While the current framework of regional representation is valuable, there remains a need to better reflect the scale, influence, and regulatory advancement of key contributors, most notably, India.

India, through its NMC, administers the largest medical education system in the world, both in terms of infrastructure and annual graduate output [8]. With over 770 medical colleges, a highly standardized national curriculum, centralized assessments (NEET and NExT), and a digital regulatory platform for institutional compliance, NMC exemplifies a modern, outcome-oriented, and transparent national medical regulator [13, 14, 31].

This disparity reflects a broader issue within global health governance - where historical regional divisions and academic associations continue to serve as gatekeepers, even when they no longer align with contemporary realities. As illustrated in earlier sections, SEARAME's composition is primarily academic and lacks statutory authority in most member countries, including India [17]. This raises important concerns about the effectiveness of regional representation under WFME, particularly when such arrangements result in the exclusion of high-capacity national regulators from critical decision-making processes.

There is precedent for reevaluating and reconfiguring WFME's regional frameworks. Entities such as the Educational Commission for Foreign Medical Graduates (ECFMG) in the United States and the have been recognized independently, based on their national capacity and global engagement, rather than their inclusion in a larger regional consortium [24,27]. This precedent supports the argument that structural flexibility is not only possible within WFME but has already been exercised in contexts of demonstrated regulatory maturity and global relevance.

India's unique position as a training ground for thousands of international students from low- and middle-income countries (LMICs) further amplifies its global significance. With many LMICs facing critical shortages of trained physicians, India has become an indirect contributor to the health workforce capacity in Africa, Southeast Asia, and Central Asia [16]. Furthermore, its regulatory reforms - especially the implementation of competency-based education, national exit testing, and transparent digital monitoring- are now being studied and adapted by emerging regulators in comparable settings [22]. Such policy diffusion strengthens the case for India to serve not only as a participant but as a leader in shaping global medical education frameworks.

An independent regional recognition body for India, separate from SEARAME, such as the NMC, AHPE, or a federation formed by all medical educators in India, could present an additional council within the WFME. would facilitate better integration of India's priorities, such as equity in access, public health alignment, rural workforce deployment, and affordability, into the global accreditation discourse. The International Liaison Committee on Resuscitation (ILCOR), another global association, has allotted India one council seat among its nine councils, with some councils representing multiple countries together [34].

It would also allow India to assume a proactive role in south-south collaboration, particularly in mentoring regulators in other LMICs, sharing scalable best practices, and promoting bilateral and multilateral educational exchanges [30]. These contributions would not only enhance WFME's global impact but also strengthen the collective mission of building a competent, ethical, and regionally responsive health workforce worldwide.

In addition, such a move would promote normative equity. India's current contribution to the global physician workforce and its educational infrastructure far exceeds that of many nations with equal or greater representation within WFME structures. Rectifying this imbalance is not merely a symbolic gesture; it is an operational imperative to ensure that global governance structures remain credible, inclusive, and responsive to evolving dynamics in medical education and healthcare delivery. This is allowed by the WFME Constitution.

"The World Federation for Medical Education (WFME) may include in its constitution regional organizations that are wholly or substantially devoted to the advancement of medical education, as designated by its Executive Council from time to time. In addition, the Executive Council may also recognize and include other global, regional, or national organizations that align with the WFME's mission and objectives" [32].

Conclusion

India has demonstrated the institutional capacity, regulatory innovation, and global relevance necessary to warrant recognition as a standalone regional entity within the WFME, with the world's largest network of medical colleges and a rapidly evolving framework for standardized, competency-based medical education. India is poised to lead, not just participate, in shaping global education standards. Current regional representation needs to reflect India's scale and contributions, underscoring the need for structural realignment.

WFME and its allied stakeholders must act decisively to ensure equitable representation by recognizing India as either NMC, AHPE or a Federation formed by all medical educators in India as an independent regional association. Such recognition will enhance global collaboration, foster south-south partnerships, and align medical education governance with contemporary realities. Now is the time to acknowledge India's leadership and integrate its voice meaningfully into the future of global medical education.

Statements and Declarations

Conflicts of interest

The authors declare that they do not have conflict of interest.

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ORIGINAL ARTICLE

Correlation Between Cord Blood TSH (CBTSH) and Maternal and Neonatal Factors: A Cross-sectional Study

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Abstract

Background: Fetal thyroid function significantly influences early growth and brain development. Cord blood thyroid stimulating hormone (CBTSH) measurement can help in early detection of congenital hypothyroidism (CH). This study examines the association between CBTSH levels, maternal characteristics, and neonatal outcomes. **Methods:** A cross-sectional study was performed in the Pediatrics Department of Muzaffarnagar Medical College and Hospital, including 200 inborn neonates. Maternal age, gestational age, birth weight, and delivery mode were recorded. CBTSH was measured at birth; elevated values were rechecked on day three. **Results:** Most mothers (91.5%) were aged 21–30 years. CBTSH was ≤20 mIU/L in 89.5% of neonates, while 5.5% showed ≥40 mIU/L; all normalized on repeat testing. Maternal age and gestational age were negatively correlated with CBTSH ($r = -0.315$, $p = 0.001$; $r = -0.284$, $p = 0.001$). Low birth weight and certain delivery modes were linked to transient TSH elevation. **Conclusion:** Maternal and gestational age influence CBTSH values. While most elevated readings were transient, early screening and follow-up are critical to exclude CH. Larger, multicenter studies with extended follow-up are recommended.

Keywords: Cord blood TSH, maternal age, birth weight, gestational age, congenital hypothyroidism, neonatal screening

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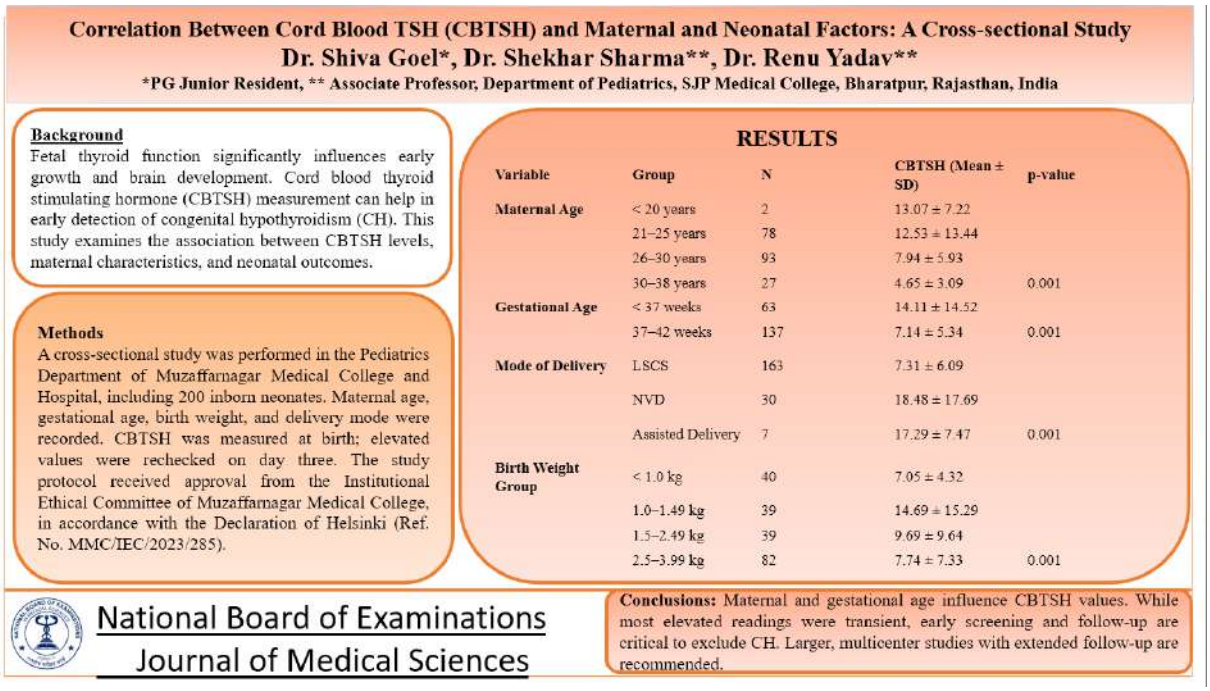
Graphical Abstract



Introduction

Thyroid hormones are vital for fetal neurodevelopment and overall growth. The pituitary gland produces thyroid-stimulating hormone (TSH), which stimulates the thyroid to release triiodothyronine (T3) and thyroxine (T4), while thyrotropin-releasing hormone (TRH) from the hypothalamus regulates TSH secretion. Cord blood TSH (CBTSH) reflects the newborn's thyroid status at birth [1].

Congenital hypothyroidism (CH) occurs when the neonatal thyroid cannot produce sufficient hormones. [2] It remains one of the most important preventable causes of intellectual disability in children. The condition occurs in approximately 1 in 2,500–2,800 live births in India and 1 in 3,000–4,000 worldwide. [3] Without systematic screening, CH often goes unnoticed, as most affected neonates appear asymptomatic at birth.

Screening for CH was first implemented widely in the 1970s, with Quebec among the pioneers, it is now standard in many high-income countries. The Indian Academy of Pediatrics recommends cord blood sampling as one viable method for neonatal CH screening. Although CBTSH testing is highly sensitive, its specificity is limited, resulting in more false positives.

Cord blood testing offers practical benefits: it is non-invasive, simple to perform immediately after birth, and minimizes the need for follow-up visits—particularly useful in early discharge settings. Studies have shown a strong correlation between cord blood and heel-prick TSH results obtained after 48 hours, reinforcing its clinical value despite the higher false-positive rate [4-6].

Measuring thyroid levels in cord blood, including TSH, T3, and T4, at birth may also help identify newborns at risk for adverse outcomes such as low birth weight, respiratory distress, or NICU admission. If strong associations are established between thyroid status and perinatal factors like

gestational age, delivery method, and maternal health, such testing could be integrated into routine neonatal screening to enable timely interventions and improve long-term outcomes.

Materials and Methods

This cross-sectional, descriptive, and analytical study was conducted in the Department of Pediatrics at Muzaffarnagar Medical College and Hospital, Uttar Pradesh, India. All neonates born in the institution during the study period were eligible for inclusion. The study was carried out over 18 months, comprising 12 months of data collection and 6 months for data processing and analysis.

Sample Size

The target sample size of 200 neonates was determined using the average institutional delivery rate from the preceding year. All eligible neonates born during the study period were enrolled consecutively.

Data Collection

After obtaining written informed consent from mothers, relevant maternal and neonatal information was recorded using a structured proforma. Maternal variables included age, parity, gravida, history of gestational diabetes mellitus (GDM), pregnancy-induced hypertension (PIH), pre-eclampsia, premature rupture of membranes (PROM), and socioeconomic status. Neonatal parameters included birth weight, gestational age, sex, Apgar score, resuscitation status at birth, anthropometric measurements, mode of delivery, and any neonatal morbidity or mortality.

Inclusion Criteria

- All inborn neonates delivered at MMC, Muzaffarnagar
- Mothers who provided informed written consent

Exclusion Criteria

- Outborn neonates
- Mothers declining participation
- Neonates with major congenital anomalies

Sample Collection and Testing

Immediately after delivery, 2 mL of cord blood was drawn from the maternal end of the umbilical cord following clamping and cutting. Samples were stored at approximately 25°C and transported to the laboratory within four hours. CBTSH concentrations were measured using an electrochemiluminescence immunoassay. For neonates with CBTSH values above the established cut-off, a repeat venous blood sample was taken on the third day of life to confirm results.

Ethical Approval

The study protocol received approval from the Institutional Ethical Committee of Muzaffarnagar Medical College, in accordance with the Declaration of Helsinki (Ref. No. MMC/IEC/2023/285).

Statistical Analysis:

Data entry was performed in Microsoft Excel and analysis was conducted using SPSS version 18. Depending on data distribution, appropriate statistical tests were applied, including the t-test, ANOVA, chi-square test, and regression analysis. Spearman’s rank correlation coefficient was used to assess

relationships between CBTSH and other variables. A p-value below 0.05 was considered statistically significant.

Results

A total of 200 neonates were included in the study. The largest proportion of mothers (48.5%, n=97) were aged 26–30 years, followed by 43.0% (n=86) in the 21–25-year age group. Only two mothers (1.0%) were younger than 20 years, and 15 (7.5%) were aged between 31 and 35 years. (Table 1)

List of Table

Table 1. Demographic and Clinical Characteristics of the Study Population (N = 200)

Variable	Category	No. of Cases	Percentage (%)
Maternal Age (years)	< 20	2	1.0%
	21–25	86	43.0%
	26–30	97	48.5%
	31–35	15	7.5%
	> 35	0	0.0%
Gender	Female	65	32.5%
	Male	135	67.5%
Birth weight	<1 kg	40	20%
	1-1.49 kg	39	19.5%
	1.5-2.49 kg	39	19.5%
	2.5-3.99 kg	82	41%
Gestational Age	Pre-term (≤ 37 weeks)	63	31.5%
	Term (37–41 weeks)	137	68.5%
	Post-term (≥ 42 weeks)	0	0.0%
Mode of Delivery	LSCS	163	81.5%
	NVD	30	15.0%

	Assisted Deliveries	7	3.5%
Parity	Primigravida	84	42.0%
	Multigravida	116	58.0%
TSH Levels	20-40m IU/L	10	5%
	>40 m IU/L	11	5.5%

Among the newborns, 67.5% (n=135) were male, while 32.5% (n=65) were female. Birth weight distribution showed that 20% (n=40) weighed less than 1.0 kg, 19.5% (n=39) were between 1.0 and 1.49 kg, another 19.5% (n=39) were between 1.5 and 2.49 kg, and the largest group (41%, n=82) weighed between 2.5 and 3.99 kg. No neonates weighed 4.0 kg or more.

Gestational age analysis indicated that 68.5% (n=137) were born at term (37–41 weeks), while 31.5% (n=63) were preterm (≤37 weeks). There were no post-term deliveries in the cohort.

Regarding delivery mode, the majority of births occurred via lower segment cesarean section (LSCS) (81.5%, n=163), followed by normal vaginal delivery (15.0%, n=30) and assisted deliveries (3.5%, n=7). Parity analysis showed that 42% (n=84) of mothers were primigravida and 58% (n=116) were multigravida.

When CBTSH levels were evaluated, most neonates (89.5%, n=179) had levels ≤20 mIU/L. Ten neonates (5.0%) had levels between 20 and 40 mIU/L, and 11 (5.5%) had levels above 40 mIU/L. On repeat testing on day three, none of the neonates showed persistent elevation of CBTSH.

Associations with Maternal and Neonatal Factors:

- Neonates born to mothers under 25 years of age had higher mean CBTSH levels compared to those born to older mothers.
- Preterm infants (<37 weeks) exhibited higher CBTSH concentrations than term infants.
- Babies delivered vaginally or by assisted methods had higher CBTSH levels than those born via cesarean section.
- Low birth weight infants, especially those weighing 1.0–1.49 kg, recorded the highest mean CBTSH values (Table 2).

Table 2. Association of Maternal and Neonatal Variables with Cord Blood TSH Levels

Variable	Group	N	Mean TSH (mIU/L)	SD	SE	Min	Max	Test	p-value
Maternal Age	< 20	2	13.07	7.22	7.96	18.17	15.85	F = 5.973	0.001
	21–25	78	12.53	13.44	0.70	48.90	47.59		
	26–30	93	7.94	5.93	0.25	27.28	48.90		
	30–38	27	4.65	3.09	2.51	17.59	17.59		
Gestational Age	< 37 weeks	63	14.11	14.52	1.83	3.85	48.90	F = 24.476	0.001
	37–42 weeks	137	7.14	5.34	0.46	0.25	27.09		
Mode of Delivery	LSCS	163	7.31	6.09	0.48	0.25	47.59	F = 23.098	0.001

	NVD	30	18.48	17.69	3.23	2.51	48.90		
	Assisted Deliveries	7	17.29	7.47	2.82	7.36	24.44		
Birth Weight Group	< 1 kg	40	7.05	4.32	0.68	0.25	18.17	F = 5.762	0.001
	1.0–1.49 kg	39	14.69	15.29	2.45	2.51	47.59		
	1.5–2.49 kg	39	9.69	9.64	1.54	1.09	48.90		
	2.5–3.99 kg	82	7.74	7.33	0.81	2.51	48.17		

Correlation Analysis

Spearman's rank correlation revealed a significant negative relationship between CBTSH and maternal age ($r = -0.315$, $p = 0.001$), as well as between CBTSH and gestational age ($r = -0.284$, $p = 0.001$). Birth weight showed a negative but non-significant correlation with CBTSH ($r = -0.127$, $p = 0.072$) (Table 3).

Table 3. Relationship between CBTSH level and various factors

Variable	Correlation Coefficient (r)	p-value	Statistical Significance
Maternal Age	–0.315	0.001	Significant
Gestational Age	–0.284	0.001	Significant
Birth Weight	–0.127	0.072	Not Significant

Discussion

This study assessed the relationship between cord blood TSH (CBTSH) levels and various maternal and neonatal factors, with a particular focus on perinatal outcomes. The majority of mothers in our cohort were in their 20s, which aligns with patterns observed in other Indian hospital-based studies.

Our birth weight distribution revealed that most neonates (41%) weighed between 2.5 and 3.99 kg, while 39% were between 1.0 and 2.49 kg, and 20% weighed below 1 kg. No neonates exceeded 4.0 kg. In contrast, Raj S. et al. [7] reported a larger proportion of infants within the healthy weight range (2.5–3.5 kg) and fewer low birth weight cases.Most neonates (89.5%) had CBTSH levels ≤20 mIU/L. A small proportion had transiently elevated CBTSH, all of which normalized by day three. This finding suggests that birth-related stress or physiological adaptation may explain initial high values.

Significant negative correlations were found between CBTSH and maternal age and between CBTSH and gestational age. Although birth weight showed a negative correlation, it was not statistically significant. These trends align with prior studies linking higher CBTSH levels to preterm birth, vaginal delivery, and lower birth weight.

Limitations

This was a single-center study with a short follow-up period and no routine T3/T4 testing. Maternal iodine status, medications, and intrapartum stressors were not accounted for.

Implications

CBTSH remains a valuable screening tool when interpreted alongside gestational age and maternal age. Repeat testing is essential to distinguish transient from persistent elevation.

Conclusion

Maternal age and gestational age significantly influence CBTSH levels in neonates. Transient elevations are relatively common in preterm, low birth weight, and vaginally delivered infants, but no persistent cases of congenital

hypothyroidism were identified. Routine CBTSH measurement, with follow-up testing for elevated results, can aid in early detection and intervention.

Statements and Declarations

Ethical Approval

Approved by Institutional Ethical Committee, Muzaffarnagar Medical College (Ref. No. MMC/IEC/2023/285)

Conflicts of interest

The authors declare that they do not have conflict of interest.

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ORIGINAL ARTICLE

Inguinal Hernia: The 'C S' way…!

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Abstract
The inguinal hernia is a common clinical condition in a General Surgeon's Practice. All aspects of current inguinal hernia practice, clinical, operative and common complications, have been described using the letters 'C and S', to give a novel way of reading again, and recollecting, the essentials of the inguinal hernia.

Keywords: Inguinal hernia, clinical aspects, operative management, complications, C and S

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Introduction

A simplified mnemonic has been developed for the postgraduate students and surgical trainees to remember the science of inguinal hernia in the ward. The idea of developing this mnemonic is to make the surgical trainees not miss any steps during the surgery and in the postoperative period.

Canal **S**tructure anatomy (from the front) vital for open surgery.
Concealed **S**equence anatomy (from inside / posterior aspect) important for Minimally invasive surgery (Laparoscopy).
Closing **S**hutter mechanism of local functional muscular physiology must be understood.

Clinical **S**tate of Inguinal Hernia, the findings would be either

1. **C**oming **S**traight through posterior wall (Direct), or
2. **C**ircle **S**ide entry into inguinal canal (Indirect)

Comparative **S**ize – complete (into scrotum), or incomplete (buboncoele)
Content **S**tatus – reducible / irreducible / obstructed / strangulated
Coats' **S**trength - local muscle tone to be noted
Causes (of) **S**usceptibility to inguinal hernia to be looked for
Consider **S**onics (Ultrasound) to confirm diagnosis (and for Insurance issues)

Classification **S**chedules

1. (Of) **C**hampion **S**eniors: Gilbert / Nyhus / Zollinger / Bendavid (TSD) – all outdated
2. **C**ontemporary **S**chemes: Aachen / European Hernia Society – most preferred today

Choice of **S**urgical options

1. **C**ircumspect **S**tandby option of '*watchful waiting*', no surgery for now, but kept on follow up.
2. **C**overing **S**trap, or the external truss, for the symptomatic patient, but unfit for surgery.
3. **C**ut & **S**uture (open surgical option).
   Cul de **S**ac Ligation (herniotomy) suffices in infants, and the young up to 18 years
   Containing **S**titches only (tissue repair, or herniorrhaphy)
   Constructed **S**upport (mesh repair or hernioplasty)
4. **C**losed **S**olution (Minimally Invasive Surgery, MIS) –
   Ideal for
   Coming **S**econd time (recurrence)
   Coupled **S**et (bilateral)
   Methods available
   Coelomic **S**ighting (trans peritoneal route, or the TAPP)
   Completely **S**uprapubic (extra peritoneal route, or the TEP / eTEP)

Consent **S**anction - Informed Consent explaining need for surgery, and of all options available.
Chronic **S**tates of pain persisting in some patients post operatively (inguinodynia and /or orchalgia) besides the chance of recurrence of the hernia, to be part of the informed consent

Core **S**tatuettes **-** Pre Operative general principles are **-**

Choice **S**pecific surgical approach to each case

Clean **S**urgery – hernias are best done as first case in OT list of the day

Confined (Local) or **S**ystemic anaesthesia (Regional / General) may be used.

A. **C**ut & **S**uture (open surgery)

Common **S**teps - Initial

Crease **S**tart – transverse inguinal crease incision, exposing external oblique

Canal **S**lit open- by cutting external oblique muscle in line of fibres

Conserve **S**ensation- nerves to be safeguarded

Cord **S**earch for sac – antero-lateral for indirect, and postero-medial for direct

Call (back) **S**ac - indirect sac, herniotomy; direct sac, invaginate

Cremaster **S**licing – debulking the hypertrophic cremaster muscle in canal

Common **S**teps – After the tissue / mesh repair of posterior wall

Close **S**ubcutaneous tissues

Cuticular **S**kin closure, either intradermal suture, staples or Steri Strips

a) **C**ontaining **S**titches repair - (herniorrhaphy)

Classical **S**houldice is the Gold standard operation

Create **S**leeves - divide posterior wall completely, create Transversalis fascia flaps

Close (in) **S**ix layers, starting with double breast of the Transversalis fascia

Circumvent **S**tress, with NO tension on suture lines

Cohesive, **S**trong layered repair obtained

Cut-out **S**trip of External Oblique Muscle as a 'live patch' repair, as the Desarda technique is an alternative form of tissue repair

b) **C**onstructed **S**upport (with a prosthetic mesh) – (hernioplasty)

Create **S**pace beneath the external oblique muscle

Comfortable **S**ize of mesh used, minimum adequate is 7.6 x 15 cm

Compact **S**utures, of smaller sizes preferred (2/0 or 3/0 non-absorbable, loose knots)

Commencing **S**titch of mesh fixation, 2.5cm medial to pubic tubercle, into rectus sheath

Configure **S**hield (mesh), with 'fish tail' across emerging cord at deep ring

Crumpled, (<u>not</u>) **S**tretched look on completion, no tension in placement

B. **C**losed **S**olution (**MIS**)

Common **S**teps

Chief **S**urgeon at head end of table

Cuboid **S**creen (monitor) at foot end of table

Coming (down) **S**houlders – the Trendelenburg position

Care (at) **S**pecific sites - Triangles of Doom & Pain

a). **C**ompletely **S**uprapubic (**TEP**)

Contrive **S**pherical area behind pubes in extra peritoneal space

Cephalad **S**triping of peritoneum and sac to expose all 3 potential defect spots

Copious **S**ize of mesh to cover all defects

Clip **S**tick mesh with tackers

b). **C**oelomic **S**ighting (**TAPP**)

Central **S**pot (umbilicus) for pneumoperitoneum, enter abdomen

Cut **S**hining peritoneum over groin area

Cephalad **S**triping of peritoneum and sac to expose all 3 potential defect spots

Copious **S**ize of mesh to cover all defects

Clip **S**tick mesh with tackers

Close **S**urface membrane (peritoneum) over mesh

c) **C**apacious **S**pread-out in the pre-peritoneal plane, (**eTEP* and eTEP-RS****)) is latest approach being advocated by **C**ontemporary **S**urgeons adept at **C**losed **S**olutions (**MIS**).

[*eTEP = Extended totally extraperitoneal, & **eTEP-RS = Extended Totally Extraperitoneal Rives-Stoppa]

Core **S**tatuettes **–** the post-operative general principles are

Check and **S**urvey for early SSO* – like Seroma, & SSIs (Surgical Site Infections)

[* SSO - Surgical site Occurrences]

Convalescence **S**hort – encourage early return to work

Continued **S**urveillance for recurrence

Cribriform **S**heets (Meshes / prosthesis used)

Are **C**omposed of **S**trands of woven non-absorbables, and are **C**heap and **S**trong

Less often **C**omposite **S**ynthetics are used to reduce visceral adhesions.

Constraining **S**taples (tackers) offer easy mesh fixation at MIS

Clinging **S**tickies (glue) have also been tried.

Today we have the **C**onsole **S**urgeon with his **C**omplaint **S**lave (Robotic Surgery) as a MIS Option!

Complications **S**een and their **C**ommended **S**olutions are

(for both, the open and the minimally invasive surgery options)

Common **S**eroma in wound / groin, best left alone to get absorbed
Congested **S**crotum – transient pain and/or swelling, use scrotal support
Cut's **S**ting - immediate post op pain, oral analgesics suffice
Curtain **S**epsis – mesh Infection / rejection, both are dreaded, with high morbidity, will ultimately need mesh explant
Continued **S**oreness – inguinodynia, delaying recovery, affecting Quality of Life scores, will need counselling and physiotherapy. Can try local **C**ortico-**S**teroid injections at specific pain trigger points in that groin. May need to **C**onsider **S**urgery again to explant mesh.

Circulation **S**ubtraction to gonad – Ischemic orchitis, (infarction leading to atrophy) with orchalgia, is also unpleasant, and may need surgical exploration / orchidectomy
Coital **S**ensitivity – Dysejaculatory syndromes in a few, settle with counselling and time
Crying **S**ymphysis denotes pain d/o osteitis pubis, also needs counselling, and analgesics
Comes **S**econd time, the unwelcome recurrence…!

- Cut & Suture (Anterior) repair recurrence – repair by Closed Solution (MIS) approach
- Closed Solution (MIS) repair recurrence – repair by Cut & Suture (Anterior) approach

Author's Contribution

KB: Literature review, data analysis, and critical revision of the manuscript for important intellectual content, Conceptualisation, study design, data acquisition, data interpretation; **CSR**: Conceptualisation, study design, data acquisition, data interpretation, and manuscript drafting, study design, data acquisition, data interpretation, and manuscript drafting; **KB CSR:** Supervision, final approval of the manuscript, and accountability for all aspects of the work.

Data Availability Statement

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

Conflicts of interest

The authors declare that they do not have conflict of interest.

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ORIGINAL ARTICLE

Awareness and Knowledge About Glaucoma Among Health Care Professionals in a Tertiary Care Hospital, Coimbatore

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Abstract

Introduction: Glaucoma is a leading cause of irreversible blindness worldwide and is often diagnosed late due to its asymptomatic progression. Healthcare professionals, being the first point of contact for at-risk individuals, play a crucial role in early detection and referral. Assessing their awareness and knowledge is essential for implementing preventive strategies and improving patient outcomes. **Materials and Methods:** A descriptive cross-sectional questionnaire-based survey was conducted from September to December 2024 at KMCH Institute of Health Sciences and Research, Coimbatore. The study included 218 healthcare professionals excluding ophthalmologists, selected through voluntary opt in method sampling. A structured online questionnaire comprising 15 questions (1 awareness and 14 knowledge questions) was used. Each correct response was scored as 1 and incorrect or unsure responses as 0. Total scores were categorized as poor (0–4), moderate (5–9), and good (10–14) knowledge **Results:** Out of 218 participants, 201 (92.2%) were aware of glaucoma. Knowledge assessment revealed that 4% had inadequate knowledge, 46.27% had moderate knowledge, and 49.75% had adequate knowledge. The highest correct responses were related to glaucoma's association with diabetes (88.6%) and blindness (92%), while misconceptions were common regarding mobile phone use (49.3%) and spectacle use (64.7%) as risk factors. **Conclusion:** Although awareness of glaucoma was high among healthcare professionals, considerable deficiencies in specific knowledge areas could be identified. Misconceptions and lack of understanding about asymptomatic progression and necessity for lifelong treatment underline the need for targeted educational initiatives.

Keywords: Glaucoma, Knowledge, Attitude, Practice

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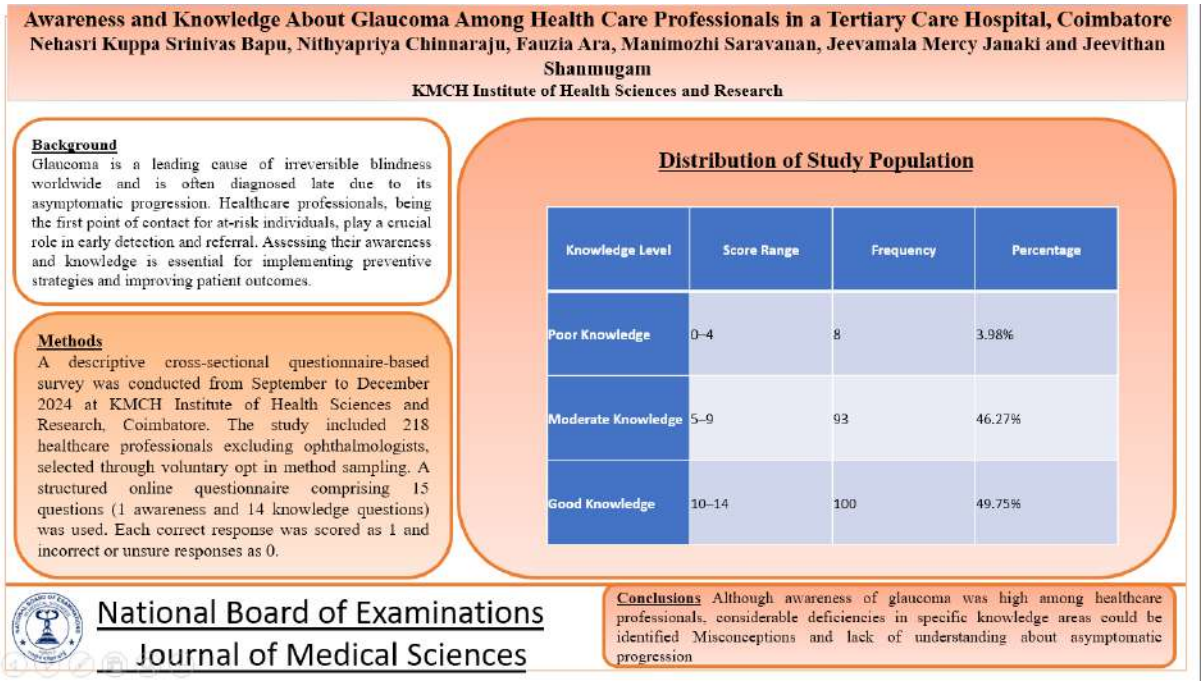
Graphical Abstract



Introduction

Glaucoma is the second leading cause of blindness globally, after cataract, and the leading cause of irreversible blindness worldwide [1]. It comprises a group of optic neuropathies characterized by progressive degeneration of the optic nerve head and associated visual field loss, often linked to raised intraocular pressure (IOP). However, glaucoma can also occur with normal or low IOP, emphasizing its complex multifactorial etiology [2]. The pathophysiology primarily involves damage to the retinal ganglion cells due to mechanical compression and impaired axonal transport at the lamina cribrosa [1].

Globally, the number of individuals aged 40–80 years living with glaucoma was estimated at 64.3 million in 2013, projected to rise to 111.8 million by 2040 [3]. In India alone, over 11 million people are estimated to be affected [4]. Despite this high prevalence, glaucoma is often diagnosed late because of its initially asymptomatic course [5,6]. A study from Nigeria found that more than half of patients were already blind in one or both eyes at the time of diagnosis, highlighting the consequence of poor early detection [5].

Numerous studies have shown that awareness does not always translate into accurate knowledge. Chakrabarty et al. [7] in Central India reported that even though healthcare professionals were largely aware of glaucoma, misconceptions were prevalent—such as beliefs that prolonged screen use or reading could cause glaucoma. In a South Indian study, although 76% of medical students had heard of glaucoma, only 52.2% knew about its familial predisposition and 70.7% were aware of its potential to cause blindness [4].

Healthcare professionals, particularly those outside ophthalmology, serve as vital links in early detection. Given that glaucoma shares risk factors such as diabetes, hypertension, and corticosteroid use, general physicians, nurses, and

paramedical staff play a crucial role in identifying high-risk individuals and referring them for ophthalmologic evaluation [2,6,8]. Moreover, they are important health educators who can reinforce knowledge, encourage screening, and enhance treatment adherence [9].

This study was conducted to assess the current levels of awareness and knowledge about glaucoma among healthcare professionals in a tertiary care hospital in Coimbatore. Understanding their knowledge profile will help identify educational gaps and improve referral pathways for early glaucoma detection and management.

Materials and Methods

This study was designed as a descriptive, cross-sectional, questionnaire-based survey to assess the awareness and knowledge regarding glaucoma among healthcare professionals. It was conducted in the KMCH Institute of Health Sciences and Research, Coimbatore, over a period of four months from September to December 2024. The study population comprised healthcare professionals including clinicians (excluding ophthalmologists), non-clinical doctors, and paramedical staff such as nurses, physiotherapists, and paramedical technicians working within the institution. Participants were recruited through announcements and invitations, and participation was entirely voluntary. Those with specialized training in ophthalmology were excluded from the study to prevent bias in knowledge assessment.

After obtaining approval from the Institutional Human Ethics Committee (IHEC), data collection was carried out using a pre-designed structured questionnaire administered through Google Forms. The index page of the online questionnaire included a brief description of the study purpose. Participants provided informed consent by selecting the “Agree and continue” option before accessing the questionnaire. The questionnaire consisted of two sections. Section A collected demographic details including age, gender, and profession. Section B evaluated awareness and knowledge of glaucoma, comprising 15 closed-ended questions. One question assessed awareness (whether the participant had heard of glaucoma), and the remaining 14 questions were used to assess knowledge of glaucoma, including items on its etiology, risk factors, course, and treatment. Each question required a response in one of three categories: Yes, No, or Not Sure.

A sample size of 200 was estimated based on prior prevalence rates reported in similar studies. For instance, Komolafe et al. reported that 31.7% of clinical participants recognized family history as a risk factor for glaucoma and 26.7% had no knowledge of any risk factors for the disease [10]. Using a relative precision of 20% and a 95% confidence level, the sample size was calculated using single proportion formula and determined to be approximately 200.

The responses were automatically recorded in Google Forms and exported to Microsoft Excel for data cleaning and preliminary arrangement. Statistical analysis was performed using SPSS software. Descriptive statistics such as frequencies and percentages were used to summarize categorical variables. The association between profession and knowledge levels was assessed using the chi-square test. A p-value less than 0.05 was considered statistically significant. Ethical considerations included the maintenance of

confidentiality and anonymity of all participants. No incentives were provided, and participants retained the right to withdraw at any time without penalty.

For the purpose of this study, the level of knowledge regarding glaucoma was assessed using 14 structured questions related to etiology, risk factors, clinical course, and treatment. Each correct response was scored as 1, and incorrect or "not sure" responses were scored as 0, resulting in a total possible score ranging from 0 to 14. Based on the total score obtained, participants were categorized into three levels of knowledge: scores between 0–4 were classified as poor knowledge, 5–9 as moderate knowledge, and 10–14 as good knowledge. This classification is adapted from commonly used cutoffs in similar KAP (Knowledge, Attitude, Practice) studies assessing disease awareness among healthcare professionals, which recommend interpreting scores as a percentage of the maximum possible score to standardize comparisons and simplify analysis [5].

Results

Among the 218 participants included in the study, the majority were female healthcare professionals (82.1%), while only 17.9% were male. This gender disparity may reflect the actual composition of healthcare staff in the study setting, especially in paramedical fields where female representation tends to be higher.

The responses to the 14 knowledge-based questions on glaucoma revealed variable levels of understanding among participants. High levels of knowledge were noted regarding glaucoma being non-infectious (74.6%), its association with diabetes (88.6%), and that it can cause blindness (92%). Additionally, most participants correctly identified that glaucoma has a familial disposition (69.7%) and requires lifelong use of eye drops (68.7%). However, misconceptions still existed—about 49.3% wrongly associated glaucoma with overuse of mobile phones, and 64.7% believed that spectacle use increases glaucoma risk. Only 56.2% knew about early visual field involvement, and just over half (50.7%) recognized that blindness due to glaucoma is not completely curable. These results highlight gaps in understanding of the disease's course and risk factors among healthcare professionals. (Table 1)

Table 1. Distribution of Study Population According to Knowledge

PARAMETERS	**No knowledge**		**Adequate knowledge**	
	F	%	F	%
GLAUCOMA IS INFECTIOUS	51	25.4	150	74.6
GLAUCOMA HAS A FAMILIAL DISPOSITION	61	30.3	140	69.7
DIABETES IS A RISK FACTOR FOR	23	11.4	178	88.6

GLAUCOMA				
PEOPLE WEARING SPECTACLES HAVE A HIGHER RISK OF GLAUCOMA	130	64.7	71	35.3
GLAUCOMA IS PREVALENT AMONG PEOPLE WITH OVER USAGE OF MOBILE PHONES	102	50.7	99	49.3
GLAUCOMA AFFECTS ALL AGE GROUPS	52	25.9	149	74.1
GLAUCOMA IS A SPIRITUAL CURSE	34	16.9	167	83.1
GLAUCOMA HAS AN ASYMPTOMATIC COURSE	76	37.8	125	62.2
VISUAL FIELD IS AFFECTED EVEN IN THE EARLY STAGE OF GLAUCOMA	88	43.8	113	56.2
GLAUCOMA CAN CAUSE BLINDNESS	16	8.0	185	92.0
BLINDNESS DUE TO GLAUCOMA IS COMPLETELY CURABLE	99	49.3	102	50.7
EYE DROPS FOR GLAUCOMA SHOULD BE USED LIFELONG	63	31.3	138	68.7
GLAUCOMA CAN BE CONTROLLED	122	60.7	79	39.3
GLAUCOMA CAN ALSO BE TREATED WITH SURGERY	24	11.9	177	88.1

The distribution of total scores from the 14 knowledge questions shows that most participants had a moderate to high level of knowledge. A significant proportion scored between 8 and 11, with the highest frequencies observed for scores of 9 (18.4%) and 11 (18.4%). A smaller proportion scored the maximum (14) or minimum (0–2), indicating that while few had very poor knowledge, very few had complete knowledge either. The data suggests that although general awareness is present, there remains scope for strengthening detailed and accurate understanding of glaucoma among healthcare professionals (Table 2).

Table 2: Distribution of Study Population According to Total Marks Obtained

Knowledge Level	Score Range	Frequency	Percentage
Poor Knowledge	0–4	8	3.98%
Moderate Knowledge	5–9	93	46.27%
Good Knowledge	10–14	100	49.75%

Discussion

In the present study, out of 218 healthcare professionals surveyed, 92.2% were aware of the term "glaucoma." This is consistent with the findings of Chakrabarty et al., where 93% of healthcare professionals had heard of glaucoma [6]. Similarly, a South Indian study by Nageeb and Kulkarni reported awareness levels of 92.5% among health professionals in a tertiary care setting [2]. These high awareness levels reflect the exposure of healthcare professionals to medical education and clinical environments. However, awareness alone does not ensure adequate knowledge of the disease, as evident from our knowledge-based question responses.

Knowledge regarding glaucoma etiology, risk factors, clinical course, and management showed considerable variation in this study. While 88.6% knew that diabetes is a risk factor for glaucoma and 83.1% rightly denied the notion of it being a spiritual curse, only 56.2% were aware that visual field loss can occur even in early stages, and 50.7% believed blindness due to glaucoma to be completely curable. This highlights a significant gap in understanding the disease's asymptomatic progression and irreversible nature. Kizor-Akaraiwe et al. in Nigeria similarly reported that although 61.3% had heard of glaucoma, only 36.8% had good knowledge about it, with misconceptions about reversibility and symptoms being widespread [5].

Interestingly, in our study, nearly half of the participants (49.3%) wrongly believed that glaucoma may be caused by overuse of mobile phones, and 64.7% thought spectacle wearers are at higher risk. This is similar to the findings by Chakrabarty et al., who found that many paramedical staff mistakenly believed that prolonged screen use, stress, or reading caused glaucoma [6]. These misconceptions may be attributed to the influence of anecdotal beliefs and limited targeted education about glaucoma in non-ophthalmic disciplines.

Knowledge about treatment was moderate among participants. While 88.1% correctly identified that glaucoma can be treated surgically, only 68.7% were aware that the use of eye drops is typically lifelong. In our study, 92% of participants recognized that glaucoma can lead to blindness, which is consistent with findings from other regions. For instance, Kizor-Akaraiwe et al. in Nigeria reported a similar awareness level at 83.6% [5], while Rajendra et al. in South India observed it to be 71% [4]. However, nearly half of our study participants incorrectly believed that blindness due to glaucoma is reversible,

indicating a significant misconception. This was notably lower than other studies where better knowledge was reported—Kizor-Akaraiwe et al. found that 63.5% of participants had adequate knowledge [5], Lipi Chakrabarty reported 68.3% had adequate knowledge [6], and Nageeb and Kulkarni noted 42.9% had satisfactory understanding [2]. Rajendra et al. also observed a similar trend, with 70.7% of medical students acknowledging that glaucoma could cause blindness, but only about half were aware of its familial risk and the need for chronic treatment [4].

The overall score distribution in our study showed that most participants had moderate knowledge, with the highest cluster scoring between 9 and 11 out of 14. Only 2.5% scored a perfect 14, and 3.5% scored below 3, indicating a skewed distribution favouring average understanding but highlighting a need for educational reinforcement.

Importantly, multiple studies emphasize the role of healthcare professionals in identifying and referring high-risk patients for glaucoma screening. Since glaucoma shares risk factors with common systemic diseases such as diabetes and hypertension, primary care doctors and nurses serve as crucial links for early detection and referral [2,8,10]. Inadequate knowledge among these professionals could delay patient education and referral, thereby contributing to late presentation and irreversible visual loss.

Our findings highlight the need to reinforce continuing medical education (CME) programs focusing on common but often misinterpreted conditions like glaucoma. Standardized training modules across departments, particularly in non-ophthalmic settings, can help bridge the knowledge gap. Promoting self-screening behavior and improving access to accurate educational material are necessary steps forward.

Conclusion

The findings of this study indicate that while the overall awareness of glaucoma among healthcare professionals was high, significant gaps remain in the depth of knowledge regarding its risk factors, asymptomatic progression, irreversibility, and long-term management. Misconceptions such as associating glaucoma with mobile phone use or spectacle wear highlight the need for targeted educational interventions. The majority of participants demonstrated moderate to good knowledge, but a notable proportion still exhibited poor understanding, which may hinder early identification and referral of at-risk individuals. Given that healthcare professionals serve as the first point of contact for many patients, enhancing their knowledge through continuous medical education and interdisciplinary training is essential for promoting timely glaucoma screening, diagnosis, and management. Strengthening awareness at the provider level could ultimately contribute to reducing the burden of avoidable blindness in the population.

Statements and Declarations

Conflicts of interest

The authors declare that they do not have conflict of interest.

Funding

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ORIGINAL ARTICLE

Evaluation of Nalbuphine with that of Clonidine as an Adjuvant to IntraThecal 0.5% Hyperbaric Bupivacaine

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Abstract

Background and objectives: This study compares the clinical efficacy of nalbuphine and clonidine as adjuvants to 0.5% hyperbaric bupivacaine for Sub arachnoid block. The efficacy is compared in terms of onset of block, duration of block, and quality of sensory and motor blockade, as well as other associated side effects. **Methodology:** Sixty adult patients ranging between 18 to 65 years and having ASA physical status I or II and were scheduled for lower abdominal surgeries from January to December 2020, were enrolled in this randomized type of study. To ensure proper study without any bias, computer-generated randomisation sequence was used to allocate participants evenly into two groups (n=30 each). Group N received an intrathecal dose comprising 2.8 ml of 0.5% hyperbaric bupivacaine combined with 0.2 ml of nalbuphine (0.4 mg), whereas Group C was administered 2.8 ml of 0.5% hyperbaric bupivacaine along with 0.2 ml of clonidine (30 µg). Sensory and motor block assessments were performed using the pinprick method and the Bromage scale, respectively. **Results:** Clonidine had a sensory onset of 3 (0.83) minutes compared to 4.47 (1) minutes of Nalbuphine. Onset of motor blockade of Clonidine was 5.07 (0.86) minutes compared to 6.57(1) minutes of Nalbuphine. Motor blockade in Clonidine was 294.53 (25.93) min as compared to 240.53 (23.45) min of Nalbuphine. Duration of Sensory blockade of clonidine was 323.13 (27.20) as compared to 268.93 (23.67) of Nalbuphine**.** Clonidine demonstrated a quicker initiation and extended duration of both sensory and motor blockade in comparison to nalbuphine. **Conclusion:** Both nalbuphine and clonidine effectively prolong spinal anesthesia duration when used along with bupivacaine, though clonidine shows superior efficacy in terms of onset and duration.

Keywords: Spinal anesthesia, intrathecal nalbuphine, intrathecal clonidine, analgesia duration, bupivacaine.

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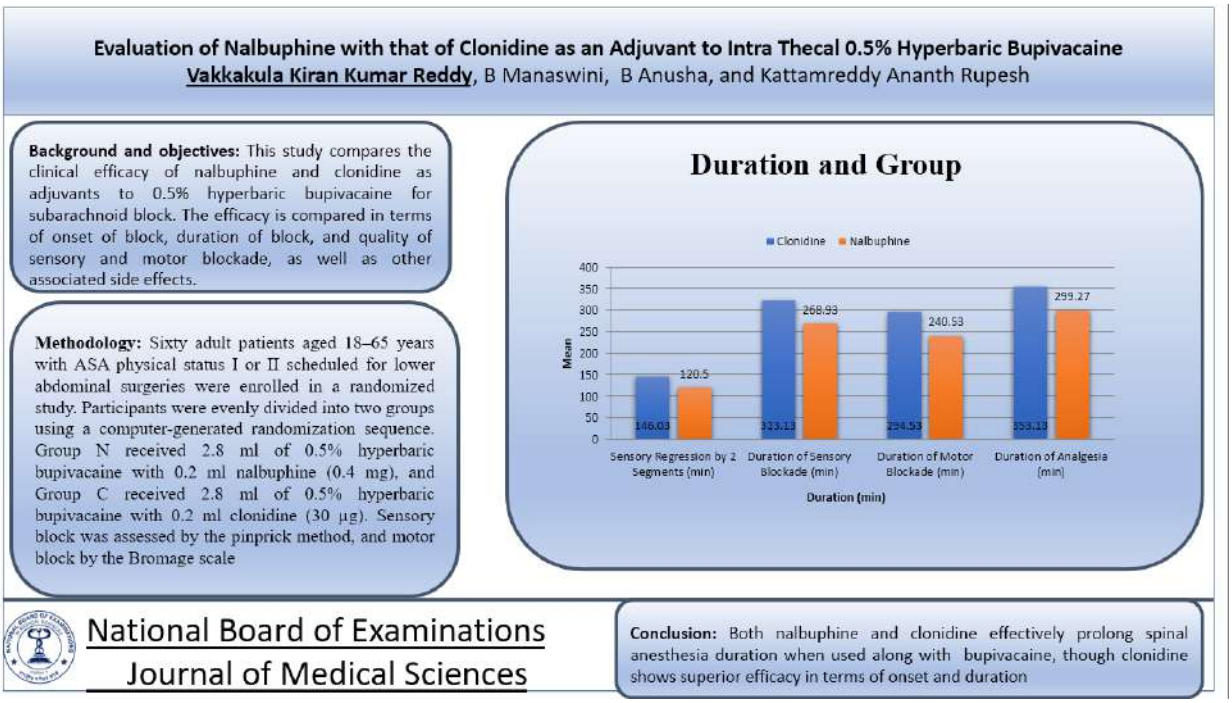
Graphical Abstract



Introduction

Spinal anesthesia is one of the most routinely performed procedure. Since its introduction by August Bier in 1898, spinal anesthesia has become a very routine, familiar and well used regional anesthesia techniques due to its procedural simplicity and cost-effectiveness. The addition of adjuvants or additives to local anesthetics which are primarily sodium channel blockers can prolong both analgesia and motor block duration, thereby improving anesthetic quality and patient satisfaction.

Nalbuphine is a semisynthetic opioid. The advantage of Nalbuphine is that it has both µ antagonist and k agonist features. Previous studies (Mukherjee et al. and Sapate et al.) demonstrated that nalbuphine, when combined with intrathecal bupivacaine, enhances motor and sensory blockade with minimal adverse effects [1-3].

Clonidine is an alpha-2 adrenergic agonist with a well documented drug kinetics and dynamics. It has long been used as an antihypertensive agent in clinical practice. Motor and sensory blockade can be increased by adding Clonidine to Spinal Anesthesia [4-6].

Addition of Alpha-2 agonists or opiods can minimize the usage of additional Anesthetic and analgesic drugs during peri operative period [7-11].

While the effectiveness of clonidine and nalbuphine as spinal adjuvants has been individually demonstrated in numerous studies, direct comparative evaluations between the two remain limited.". Hence the idea behind conceptualizing the study was to have a direct comparison of the two study drugs Clonidine and Nalbuphine. After going through various previous studies and drug pharmacodynamics and pharmacokinetics, we decided to compare the clinical effects of intrathecal bupivacaine after addition of

nalbuphine or clonidine. 2.8ML (0.5%) of intra thecal bupivacaine was taken and after addition with either nalbuphine 0.4 mg or clonidine 30 µg as adjuvant, was used in lower abdominal surgeries and anesthetic efficacy was compared. Anesthetic efficacy in terms of motor and sensory onset, duration of motor and sensory blockade, 2 segment regression and Anesthetic complications were assessed.

Materials and Methods

The study received prior permission from the Ethics Committee of the Institution in accordance with standard ethical protocols. Before incorporating any patient into the study group, proper written and informed consent was taken from all patients in their own language in which they can understand and apprehend.

Sixty patients, admitted to KAMSRC (Kamineni Academy of Medical Sciences and Research centre) in the year 2020 from January to December belonging to ASA grade I and II were selected. These were the patients who were scheduled for elective lower abdominal surgeries, of duration less than 3 hrs, under spinal anesthesia. After selection the 60 patients were included in one of the two groups after proper randomization through computer software.

Inclusion Criteria

Patients scheduled for elective lower abdominal surgeries, aged 18–65 years, and classified as ASA physical status I or II, were considered. Patients were selected after a thorough Pre anesthesia check up and assessment.

Exclusion Criteria

Exclusion criteria addressed known contraindications to spinal anesthesia such as history of allergic reactions to study drugs, spinal deformities, neurological deficits, and anticipated surgical duration exceeding three hours. Surgeries beyond three hours of duration were not included in the study.

Methods

Computer software was used to generate randomization to allocate patients to two groups. 2.8 ml of hyperbaric bupivacine (0.5%) + 0.4mg of nalbuphine =(3ml) was given to Group N. 2.8 ml of hyperbaric bupivacine (0.5%) + 30 µg of clonidine =(3ml) was given to Group C.

Monitoring

ECG monitoring was used intra operatively. It was done using three leads and monitoring was done in standard Lead II. Continuous ECG monitoring was performed intraoperatively using lead II, which is sensitive for early detection of myocardial ischemia. Blood pressure monitoring was done using automated Non invasive blood pressure monitoring at regular intervals. Oxygen saturation was monitored using pulse oximeter. Baseline vitals were noted and vitals were monitored at regular intervals.

Procedure

All patients had 20G or 18G IV cannula secured before surgery. A 25-gauge Quincke-type spinal needle, the standard instrument used at our institute, was utilized to administer spinal anesthesia. The intrathecal drug was administered at either the L3–L4 or L4–L5 interspace, chosen based on anatomical

accessibility and ease of lumbar puncture. All spinal procedures were conducted in the lateral decubitus position, using appropriate support and strict aseptic technique. Blood loss and vitals were assessed intra operatively and used as a guide for fluid replacements.

Post-block parameters including onset and duration of sensory and motor blockade, two-segment regression time, and analgesia duration were meticulously recorded. Sensory blockade was assessed using pin prick method and motor blockade was assessed using Bromage scale.

Various essential parameters such as Heart rate, Blood pressures were recorded at baseline, and then at 5, 10, 20, and 30 minutes, followed by every 30 minutes up to 120 minutes post-spinal block.

This included parameters like pulse rate, Blood pressures, oxygen saturations and respiratory rates. Complications and untoward incidents like changes in blood pressure, changes in heart rate, respiratory depression (that is respiratory rate less than 10 or SpO_2 <90%) nausea and vomiting were also documented. Any other surgical or anesthesia complications were also noted during the study.

Pain and sensory block assessments were conducted by employing the Visual Analogue Scale (VAS) at predetermined timings until rescue analgesia was required. Patient comfort and satisfaction was of utmost importance, hence VAS score 4 or more or if the patient complained of pain and demanded analgesia, rescue analgesics were given in the form of Injection Diclofenac 75 milligrams intra muscularly. Injection Emeset (Ondansetron) 4 milligrams intra venous was used for its anti emetic properties to treat peri operative nausea and vomiting. Patient was regularly monitored in the post operative period.

Statistical Methods

Robust statistical analysis was conducted to ensure accurate interpretation of the study findings. Advanced computing methods and computer software was used. Microsoft Excel (Windows 7; Version 2007) was used for data entry. Microsoft excel being easy to use and enter data, it was preferred for data entry. Statistical analyses are very important for proper interpretation and analyses of data. It is for this purpose that for statistical analyses SPSS software for Windows (version 22.0; SPSS Inc, Chicago) was used. Statistics such as mean ± standard deviation for continuous data and frequency distributions for categorical data which are all types of descriptive statistics were analyzed.

The variables were compared using the Chi-Square test for categorical variables. Unpaired t-test was employed to assess the means of variables which are quantitative after verifying normality with the Samuel Sanford Shapiro and Martin Wilk test. Pictorial representation was done to enhance the data.

P values were calculated for all the data we compared. A p-value below 0.05 was regarded as a data which is significant statistically; while a value below 0.001 was considered highly significant in terms of statistics. This is as per the standard statistical guidelines followed everywhere.

Results and Observations

Sixty patients in total were allocated to two groups, that is Group N (nalbuphine 0.4 mg) and Group C (clonidine 30 µg). All the patients were lying in the age group 18 to 65 years. These were non emergency surgeries posted for elective lower abdominal procedures. All the procedure were performed under spinal anesthesia. The relation between age of the patients and the study groups were documented and assessed. Computer-generated randomization yielded comparable demographic distribution between the groups, as indicated by a statistically non-significant p-value (Table 1).

Table 1. Relationship between Age and Study Group (N=60)

Age (Years)	**Category**	
	Clonidine (n=30)	**Nalbuphine (n=30)**
≤ 30	3 (10.0)	4 (13.3)
31-40	8 (26.7)	12 (40.0)
41-50	13 (43.3)	7 (23.3)
51-60	5 (16.7)	7 (23.3)
>60	1 (3.3)	
Mean (SD)	42.67 (9.71)	41.30 (9.55)
P Value = 0.396, Not Significant		

The mean age of participants was compared between the two groups and found to be similar (Group C: 42.67 ± 9.71 years; Group N: 41.30 ± 9.55 years), with no statistically significant difference (p = 0.396), indicating age distribution was well balanced. This was very important, as a study with variation in age groups may yield false results.

Table 2 displays the data of male and female distribution in both groups.Gender distribution, that is the distribution of male and female gender across the two groups had a p value which was greater than 0.05 and hence was not statistically significant. Indicative of even distribution of sexes across the two groups.

Table 2. Relationship between Gender and Study Group (N=60)

Gender	Category	
	Clonidine (n=30) n (%)	Nalbuphine (n=30) n (%)
Male	9 (30.0)	10 (33.3)
Female	21 (70.0)	20 (66.7)
P Value = 0.781		

Table 3 shows the patients based on ASA grading in the two groups. In Group N, 19 patients (47.50%) were classified as ASA grade 1, compared to 21 patients (52.50%) in Group C. For ASA grade 2, there were 11 patients (55.00%) in Group N and 9 patients (45.00%) in Group C. The difference in ASA grading across the two groups based on ASA grading is not statistically significant, as the derived p value is not statistically significant. ($p = 0.584$; $p > 0.05$).

Table 3. Relationship between ASA Classification and Study Group (N=60)

ASA	Category	
	Clonidine (n=30) n (%)	Nalbuphine(n=30) n (%)
I	21 (70)	19 (63.3)
II	9 (30.0)	11 (36.7)
P Value = 0.584		

Table 4 illustrates that the mean onset time of sensory blockade was 3.00(0.83) minutes in Group C (Clonidine) and 4.47(1.0) minutes in Group N (Nalbuphine). This indicates a statistically significant difference between the two compared groups ($p < 0.001$). Similarly, the average onset time for motor blockade was 5.07 (0.86) minutes in Group C and 6.57(1.0) minutes in Group N. This data when analyzed shows that there is statistical significance ($p<0.001$). The time taken to reach peak sensory blockade averaged 6.10 (0.75) minutes in the Clonidine group and 7.67(0.88) minutes in the Nalbuphine group. The data when analyzed and compared the peak sensory blockade showed a statistical difference with p value < 0.001. Similarly, the mean time to attain maximum motor blockade was 6.70(0.70) minutes in Group C compared to 8.37(0.76) minutes in Group N, with the difference being statistically significant ($p = 0.000$). In this table data comparison of sensory onset, motor onset, time for peak sensory level as well as maximum motor blockade all showed significant statistical difference.

Table 4. Comparison of Sensory and Motor Blockade Features across the Two Study Groups (N=60)

Parameter	Category		P Value
	Clonidine(n=30) Mean (SD)	Nalbuphine(n=30) Mean (SD)	
Sensory Onset (min)	3.00 (0.83)	4.47 (1.00)	<0.001*
Motor Onset (min)	5.07 (0.86)	6.57 (1.00)	<0.001*
Time for peak sensory level (min)	6.10 (0.75)	7.67 (0.88)	<0.001*
Time for Maximum Motor Blockade (min)	6.70 (0.70)	8.37 (0.76)	<0.001*
Unpaired t Test, P Value *Significant			

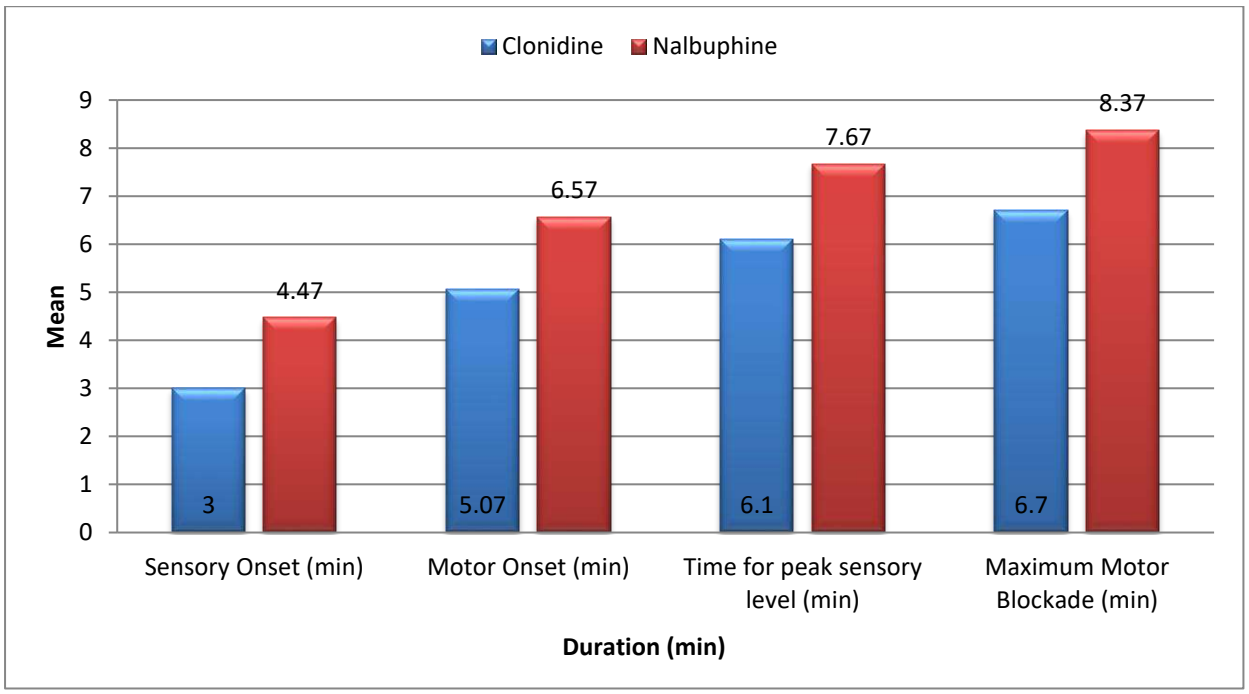


Figure 1. Duration and Group

Table 5 Throughout the study, patients' pulse rates in both groups remained near the baseline values. With ($p > 0.05$), there is no statistical difference between the groups and hence not significant for the outcomes of the study.

Table 5. Comparison of Heart Rate across the Two Study Groups (N=60)

Heart Rate	Category		P Value
	Clonidine(n=30) Mean (SD)	Nalbuphine(n=30) Mean (SD)	
Basal	89.73 (17.27)	84.33 (16.01)	0.214
0 min	94.83 (16.65)	89.03 (11.82)	0.125
2 min	88.90 (18.48)	89.67 (14.74)	0.860
5 min	78.97 (17.39)	86.50 (18.19)	0.107
10 min	74.40 (13.88)	81.67 (19.47)	0.101
20 min	75.40 (11.47)	79.77 (14.01)	0.192
30 min	75.23 (9.24)	76.80 (14.65)	0.622
40 min	76.57 (9.48)	76.93 (12.68)	0.900
50 min	78.33 (11.52)	78.77 (9.35)	0.874
60 min	78.63 (11.86)	79.93 (9.39)	0.640
80 min	80.70 (11.59)	78.77 (9.26)	0.478
100 min	80.07 (11.16)	77.97 (9.89)	0.444
120 min	79.77 (10.40)	79.27 (10.45)	0.853
Unpaired T Test, P Value Not Significant			

Table 6 shows the mean arterial blood pressures across the two groups were assessed and was found to have no statistical difference. ($p > 0.05$).

Throughout the study, hemodynamic parameters—including heart rate and mean arterial pressure—remained stable and showed no statistically significant differences between the groups ($p > 0.05$ for all time points) (Table 7 and Figure 2).

Table 6. Mean Arterial Pressure Comparison across the two study groups - Group C and Group N (N=60)

MAP	Group		P Value
	Clonidine (n=30) Mean (SD)	Nalbuphine (n=30) Mean (SD)	
Basal	96.03 (9.05)	96.60 (8.45)	0.803
0 min	94.27 (8.32)	94.07 (6.37)	0.917
2 min	89.50 (8.49)	90.07 (6.38)	0.771
5 min	84.23 (10.57)	87.37 (7.76)	0.196
10 min	82.53 (10.45)	86.00 (7.06)	0.138
20 min	84.23 (10.57)	84.57 (6.11)	0.882

30 min	82.80 (8.76)	83.97 (6.93)	0.570
40 min	84.50 (8.02)	84.93 (11.08)	0.863
50 min	85.27 (7.36)	85.80 (9.46)	0.808
60 min	85.30 (6.22)	86.47 (8.43)	0.544
80 min	86.27 (6.56)	85.60 (7.06)	0.706
100 min	86.13 (5.61)	85.67 (8.84)	0.808
120 min	86.80 (5.16)	85.63 (8.97)	0.540
Unpaired T Test, P Value Not Significant			

Table 7. Timings of Sensory blockade and Motor Blockade Features across the given Two Study Groups (N=60)

Parameter	**Category**		**P Value**
	Clonidine(n=30) Mean (SD)	**Nalbuphine(n=30) Mean (SD)**	
Sensory Regression by 2 Segments (min)	146.03 (20.23)	120.50 (19.39)	<0.001*
Duration of Sensory Blockade (min)	323.13 (27.20)	268.93 (23.67)	<0.001*
Duration of Motor Blockade (min)	294.53 (25.93)	240.53 (23.45)	<0.001*
Duration of Analgesia (min)	353.13 (26.39)	299.27 (23.26)	<0.001*

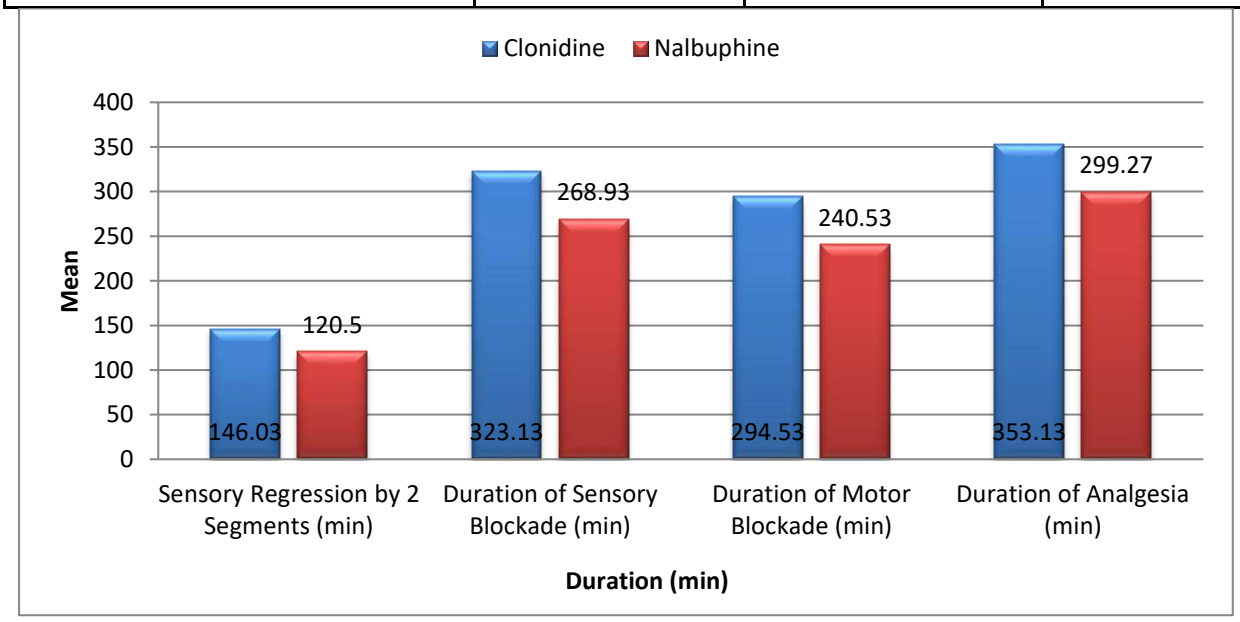


Figure 2. Duration and Group

The calculated mean time for two-segment regression of the sensory blockade was 146.03 ± 20.23 minutes in Group C and 120.50 ± 19.39 minutes in Group N. This when analyzed demonstrated a statistically highly significant difference ($p < 0.001$). Also the average duration of sensory blockade was significantly longer in Group C (Clonidine), at 323.13 ± 27.20 minutes, compared to 268.93 ± 23.67 minutes in Group N (Nalbuphine), with a p-value of < 0.001. The duration of motor blockade also differed significantly between the groups, with Group C showing a mean of 294.53 ± 25.9 minutes and Group N showing 240.53 ± 23.4 minutes ($p = 0.000$). Additionally, the average duration of analgesia was 353.13 ± 26.3 minutes in the Clonidine group and 299.27 ± 23.2 minutes in the Nalbuphine group, again indicating a highly significant statistical difference ($p < 0.001$).

Discussion

Neuraxial anesthesia that is spinal anesthesia or epidural anesthesia techniques are commonly preferred for lower abdominal surgeries. Good analgesia and proper muscle relaxation are the pillars of proper regional anesthesia. Neuraxial techniques have the advantage of being able to provide faster onset of surgical anesthesia (sensory loss) along with complete muscle relaxation.

Nalbuphine is an opioid. It's a partial agonist- antagonist drug. Nalbuphine is semi synthetic drug and belongs to phenanthrene class. It is structurally similar to drugs like oxymorphone and naloxone and interacts with μ-, κ-, and δ-opioid receptors.

Nalbuphine is a potent opioid and has been used for both Intra venous and Intra thecal administration. A lot of studies have documented its efficacy and safe usage in both forms. We went through a lot of online research to find the optimal/ required dose of Nalbuphine for usage and comparison. Tiwari et al. [12]. compared intrathecal administration of 0.2 mg and 0.4 mg Nalbuphine with bupivacaine and found that 0.4 mg offered a longer duration of postoperative analgesia. Based on these findings, in the present study we used 0.4 mg of Nalbuphine to compare its effects with 30 μg of Clonidine as an intrathecal additive.

Clonidine as a drug is a potent Alpha 2 adrenergic agonist and its being used in clinical purpose for a long time for various purposes. Clonidine also has been used in both Intravenous and Intra thecal route. Clonidine produces its analgesic/ sensory effect at the spinal level by activating presynaptic α2-adrenergic receptors. These are primarily located in the substantia gelatinosa of the spinal cord. It enhances both sensory and motor blockade of bupivacaine without increasing the risk of respiratory depression. Enhancing both sensory and motor blockade is a very useful trait in spinal anesthesia. In contrast, intrathecal nalbuphine exerts its action by stimulating opioid receptors in the dorsal grey matter (substantia gelatinosa) of the spinal cord. By stimulating opioid receptors it modulates afferent pain signal transmission, hence enhancing the quality of sensory blockade as well as duration of sensory lockade.

We have gone through a lot of online research to find studies which are comparable to our findings. The findings

which we found out are comparable to those of H. Saxena et al. [13], who reported a mean onset time of motor block of 2.30 minutes using 30 μg of clonidine. However, their study has a drawback as they did not clearly define the criteria for motor block onset.

Bupivacaine is a local anesthetic drug. Its primary action is by blocking voltage gated sodium channel. It is used in various regional anesthesia procedures such as Blocks, local infiltrations, Spinal and Epidural anesthesia procedures. Because of favorable kinetics and pharmaco dynamics, Hyperbaric bupivacaine is the commonly used drug in spinal anesthesia. Bupivacaine has a very safe profile as drug and is very effective in its sensory and motor blockades. Bupivacaine primarily functions by blocking voltage-gated sodium channels on axonal membranes and by presynaptic inhibition of calcium channels.

In our study, the distribution of patients based on age, gender, and ASA classification was similar across the two given groups, with no statistically significant differences ($p > 0.05$). This is very important as variations across the study groups in terms of age, gender and ASA classification may impact the study outcome and results will be not completely correct.

Onset of sensory blockade is of prime importance in Anesthesia as a drug with shorter onset will help in faster starting of surgery which in turn reduces the cost of Operation theatre. This is of lot of significance when the cumulative times of a good number of cases are done. The start of sensory blockade occurred significantly earlier in Group C, as compared to Group N ($p < 0.001$). Specifically, the mean onset time of sensory block was 3.00 ± 0.83 minutes in the clonidine group and 4.47 ± 1.00 minutes in the nalbuphine group. This when compared statistically indicated a significant difference between the two groups. A faster sensory onset which is statistically significant is of lot significance in a hospital setting and also more comfortable for the patient as it reduces the anxiety levels.

In the present given study, the mean onset time of motor block was 5.07 ± 0.86 minutes in the clonidine group and 6.57 ± 1.00 minutes in the nalbuphine group. This showed a statistically significant difference upon calculation. A shorter onset of motor blockade is very useful, especially in emergency scenarios where there is a need to start a surgery urgently.

A faster sensory onset and motor onset of clonidine over nalbuphine makes it a very useful attribute which will make clonidine to be preferred over nalbuphine. The duration required for two-segment regression of the sensory blockade was 146.03 ± 20.23 minutes in the clonidine group and 120.50 ± 19.39 minutes in the nalbuphine group. This on comparing the data showed statistical significance. Two segment regression implies the waning off of the effect of the spinal drug. Hence any drug which increases the two segment regression will have a longer sensory and motor duration and will be useful to the patient. In this case the longer two segment regression time of clonidine makes it a drug of longer duration for anesthetic usage.

Sapate et al. [14] compared a Nalbuphine group (0.5 mg) with a control group and reported a two-segment

regression time of 116.23 ± 9.17 minutes, which is closely comparable to the findings in our study. Sapate et al. as well as our study emphasizes the importance of two segment regression time and effectives of clonidine due to better two segment regression time.

In the present given study, the time elapsed for complete sensory recovery was 323.13 ± 27.20 minutes in the clonidine group which was longer in comparison to nalbuphine group at 268.93 ± 23.67 minutes. This difference in time was significant and with a p value of < 0.001 it had statistical significance.

The mean duration of motor blockade that was calculated during the study was 294.53 ± 25.93 minutes in the clonidine group and 240.53 ± 23.45 minutes in the nalbuphine group. This on comparison showed a highly significant statistical difference ($p < 0.001$). Similarly, the total duration of analgesia was significantly longer in the clonidine group (353.13 ± 26.39 minutes) compared to the nalbuphine group (299.27 ± 23.26 minutes). Statistical analysis of total duration of analgesia showed a p value <0.001, which is of statistical importance. There were no statistically significant differences between the two groups with respect to heart rate and blood pressure.

Throughout surgery duration in the operation theatre and after that in post op recovery room, no instances of nausea or vomiting were reported in either group. Additionally, none of the patients experienced any Apnoea or bradyapnoea episodes and all maintained peripheral oxygen saturation levels above 95% without the need for supplemental oxygen.

Conclusion

In our study we compared the efficacy of two drugs clonidine and nalbuphine as an additive/adjuvant to hyperbaric bupivacaine for sub arachnoid block. Based on various previous studies the doses of 30 microgm of clonidine and 0.4 mg of nalbuphine was finalized. Based on the comparison in patients aged between 18 to 65 undergoing lower abdominal surgeries, it can be concluded that both agents are clinically effective in providing adequate surgical conditions with similar hemodynamic stability.

However, intrathecal clonidine offers a longer duration of analgesia as well as extended sensory and motor blockade in comparison to nalbuphine. Hence in lower abdominal surgeries clonidine can be a better modality over nalbuphine as an adjuvant with hyperbaric bupivacaine, as it achieves superior outcomes without notable side effects.

Conflict of interest

The authors declare that they do not have conflict of interest.

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Ethics committee approval

Approved by IEC, KAMSRC, Hyderabad dated 29/10/2019

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ORIGINAL ARTICLE

Progression of Tricuspid Regurgitation in Participants Undergoing Surgeries for Other Cardiac Diseases and Factors Influencing

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Abstract

Introduction: Tricuspid regurgitation (TR) frequently coexists with left-sided valvular disease and may progress despite surgical correction of the primary lesion. Although once considered clinically insignificant, evidence increasingly supports early recognition and intervention. This study was undertaken to evaluate the progression of TR in Participants undergoing cardiac surgery for other primary lesions and to identify factors influencing its progression. **Materials and Methods:** A prospective observational study was conducted on 50 Participants with preoperative TR who underwent cardiac surgery for left-sided valvular or structural heart disease. Ethical clearance and informed consent were obtained. Participants underwent comprehensive preoperative and serial postoperative echocardiographic evaluation, including tricuspid annulus diameter, tricuspid annular plane systolic excursion (TAPSE), right ventricular (RV) dimensions, and ejection fraction (EF). Follow-up assessments were performed at six months and one year. Data were analysed using SPSS, with significance set at $p<0.05$. **Results:** The mean age was 45.8 ± 9.3 years, with 62% male predominance. Severe mitral stenosis was the most common primary lesion (56%). At baseline, mean tricuspid annulus was 30.2 mm and TAPSE 17.3 mm, with no RV dilatation. By one year, the mean annulus had increased to 36.1 mm ($p<0.001$), TAPSE declined to 15.0 mm ($p<0.001$), and RV dilatation was observed in 38% of Participants. Nineteen Participants (38%) developed severe TR, most commonly in mitral stenosis and CAD+MR subgroups. Advancing age was significantly associated with persistence of regional wall motion abnormalities ($p=0.020$), while gender showed no influence. **Conclusion:** TR progression after cardiac surgery is frequent, strongly influenced by disease type and age, and identifiable through simple echocardiographic parameters. Systematic postoperative surveillance and timely intervention are essential to prevent severe symptomatic TR and preserve right ventricular function.

Keywords: Tricuspid Regurgitation, Mitral Stenosis, Cardiac Surgery, Echocardiography, Right Ventricular Function

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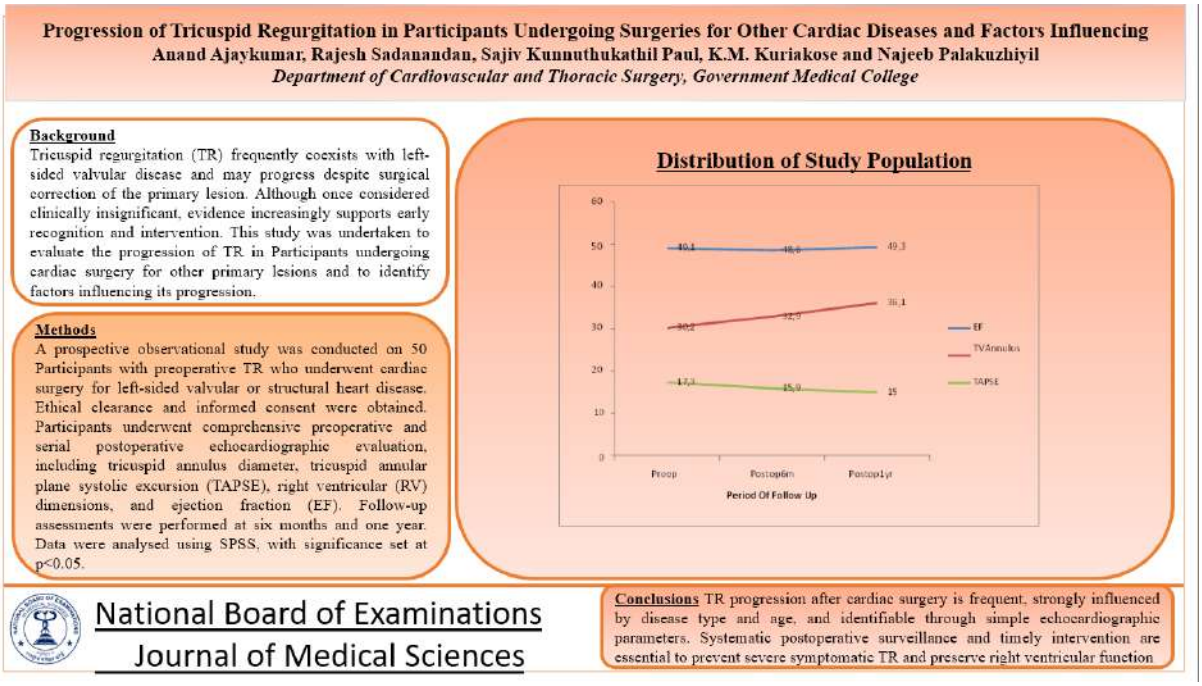
Graphical Abstract



Introduction

Pathology of the left-sided heart valves is frequently associated with significant tricuspid regurgitation (TR), which may not always resolve after correction of the left-sided lesion. The latest European guidelines [1] recommend tricuspid valve surgery in Participants with severe TR, or when the annular diameter is ≥40 mm, regardless of regurgitation severity, highlighting the need for prophylactic intervention even in less advanced disease [1,2]. Despite these recommendations, concomitant correction of functional TR in Participants undergoing left heart surgery remains underutilised. Pulmonary arterial hypertension, right ventricular dilatation, tricuspid annular enlargement, and right-sided heart failure are common contributors to worsening TR [3,4]. Nearly half of Participants undergoing mitral valve surgery are reported to have associated TR [5], and the majority of those with right ventricular dilatation and annular enlargement develop functional TR [6]. Additional causes include iatrogenic injury such as pacing leads, rheumatic heart disease, infective endocarditis, and rare conditions such as carcinoid syndrome [7].

Although literature on tricuspid annuloplasty and repair techniques in this setting remains relatively limited, evidence indicates that concomitant tricuspid valve repair, particularly ring annuloplasty, is a safe and effective option. A recent meta-analysis demonstrated that performing tricuspid valve repair during left-sided valve surgery in Participants with moderate TR improves survival and reduces the progression of regurgitation without increasing operative mortality [8]. Similarly, a 2024 study confirmed that tricuspid ring annuloplasty at the time of mitral surgery significantly decreased late TR progression while maintaining acceptable perioperative risk [9]. Long-term follow-up data from a Japanese cohort

also showed excellent survival and durable freedom from recurrent TR following combined procedures, though preoperative right heart condition was an important predictor of outcome [10].

With the growing recognition that TR is often overlooked despite being clinically significant, there has been a rising trend in the incidence of severe symptomatic disease that might have been prevented with timely intervention. Structural changes such as a 5.9 mm increase in annular diameter and a 2.2 mm decline in TAPSE represent meaningful deterioration, corresponding to TR progression and emphasising the importance of systematic post-operative surveillance in high-risk Participants. Hence, this study was undertaken to evaluate the progression of tricuspid regurgitation in Participants undergoing other cardiac surgeries and to identify the factors influencing its progression.

Materials and Methods

This prospective observational study was conducted after obtaining approval from the Institutional Human Ethics Committee. The study adhered to the principles outlined in the Declaration of Helsinki. Participants who were scheduled to undergo cardiac surgery for left-sided valve or other structural heart diseases in the cardiothoracic unit of the Institute were screened for eligibility. Those with associated congenital heart disease, prior tricuspid valve intervention, or significant structural abnormalities of the right heart valves unrelated to functional tricuspid regurgitation were excluded.

All eligible Participants were contacted and Participant Information sheet was issued. After adequate time and counselling for the doubts they had, Written informed consent was obtained. Baseline demographic data including age, sex, height, weight, body surface area, and relevant clinical characteristics were recorded. A detailed medical history was obtained, with particular attention to comorbidities such as hypertension, diabetes mellitus, chronic obstructive pulmonary disease, atrial fibrillation, pulmonary arterial hypertension, and prior cardiac interventions. Clinical examination focused on signs of right-sided heart failure and jugular venous distension.

Comprehensive preoperative evaluation was carried out using transthoracic echocardiography (TTE). Parameters assessed included severity of tricuspid regurgitation graded according to American Society of Echocardiography recommendations, tricuspid annular diameter, right ventricular basal diameter, right atrial size, right ventricular systolic pressure, and tricuspid annular plane systolic excursion (TAPSE). In addition, left ventricular ejection fraction, left atrial diameter, and severity of associated left-sided valve disease were documented. In selected Participants with suboptimal transthoracic windows, transesophageal echocardiography (TEE) was employed for confirmation. Baseline laboratory investigations, electrocardiography, and chest radiography were also performed as part of preoperative assessment.

All Participants underwent standard cardiac surgical procedures under cardiopulmonary bypass according to the indication, which included mitral valve replacement or repair, aortic valve replacement, or combined procedures. The tricuspid valve was inspected intraoperatively and managed according to the discretion of the operating surgeon in line with current guidelines. Participants

who underwent concomitant tricuspid valve annuloplasty were documented separately. Intraoperative data including cardiopulmonary bypass time, aortic cross-clamp time, type of surgical procedure performed, and immediate operative complications were recorded.

Postoperatively, Participants were monitored in the intensive care unit with standard hemodynamic and biochemical surveillance. Echocardiographic reassessment was carried out before discharge, and follow-up evaluations were performed at six months and one year. The severity of tricuspid regurgitation, annular dimensions, TAPSE values, right atrial and right ventricular dimensions, and pulmonary pressures were serially compared to determine progression. Any need for subsequent tricuspid valve intervention, occurrence of right heart failure, or all-cause mortality were noted during follow-up.

Data were compiled systematically and entered into Microsoft Excel using appropriate coding and analysed in SPSS (IBM SPSS Statistics, version 27) . Continuous variables such as annular diameter, TAPSE, and ventricular dimensions were expressed as Mean ± Standard Deviation, and categorical variables such as sex, comorbidities, and severity grades of TR were presented as Proportions Or Percentages. Comparison of means between groups was done using the T-test or ANOVA as appropriate. Categorical variables were analysed using the chi-square test or Fisher's exact test. A p-value <0.05 was considered statistically significant.

Results

The baseline characteristics of the study population are summarized in **Table 1**. The mean age of Participants was 45.8 ± 9.3 years (range 25–63 years), with a male predominance (62%). Mitral stenosis was the most common primary cardiac lesion (56%), followed by aortic stenosis (16%), mitral regurgitation (12%), combined CAD with MR (10%), and aortic regurgitation (6%).

Table 1. Baseline Characteristics of the Study Population (N=50)

Characteristic	Value
Age, years (mean ± SD)	45.8 ± 9.3
Age range	25–63
Male, n (%)	31 (62.0)
Female, n (%)	19 (38.0)
Primary Cardiac Disease	
- MS / AS / MR / CAD+MR / AR	28 / 8 / 6 / 5 / 3

At baseline, the mean ejection fraction (EF) was 49.1 ± 7.5%, the mean tricuspid annulus diameter was 30.2 ± 3.4 mm, and the mean tricuspid annular plane systolic excursion (TAPSE) was 17.3 ± 1.4 mm. Six Participants (12%) demonstrated regional wall motion abnormalities (RWMA), while none showed right ventricular (RV) dilatation (Table 2).

Table 2. Echocardiographic Parameters at Baseline, 6 Months, and 1 Year

Parameter	Baseline (Mean ± SD)	6 Months	1 Year	p-value
EF (%)	49.1 ± 7.5	48.6 ± 6.3	49.3 ± 6.2	0.71 (NS)
TV Annulus (mm)	30.2 ± 3.4	32.9 ± 3.6	36.1 ± 4.7	<0.001
TAPSE (mm)	17.3 ± 1.4	15.9 ± 1.3	15.0 ± 1.5	<0.001
RV Dilatation (%)	0	20	38	<0.001
RWMA (%)	12	12	12	NS

At six months after surgery, EF remained stable at 48.6 ± 6.3% (p=0.49 vs baseline). However, significant structural and functional changes were evident on the right side. The mean tricuspid annulus diameter increased to 32.9 ± 3.6 mm (p<0.001 compared to baseline), and TAPSE declined to 15.9 ± 1.3 mm (p<0.001). Ten Participants (20%) developed new-onset RV dilatation, whereas the prevalence of RWMA remained unchanged at 12%.

At one-year follow-up, progression of tricuspid regurgitation was more pronounced. The mean tricuspid annulus diameter further increased to 36.1 ± 4.7 mm, with 19 Participants (38%) crossing the threshold for severe TR (≥40 mm). TAPSE declined further to 15.0 ± 1.5 mm, with 19 Participants (38%) showing values <14 mm, indicating poor RV function. RV dilatation was documented in 38% of the cohort, while EF remained unchanged at 49.3 ± 6.2% (p=0.71 vs baseline) (Table 2 and Figure 1).

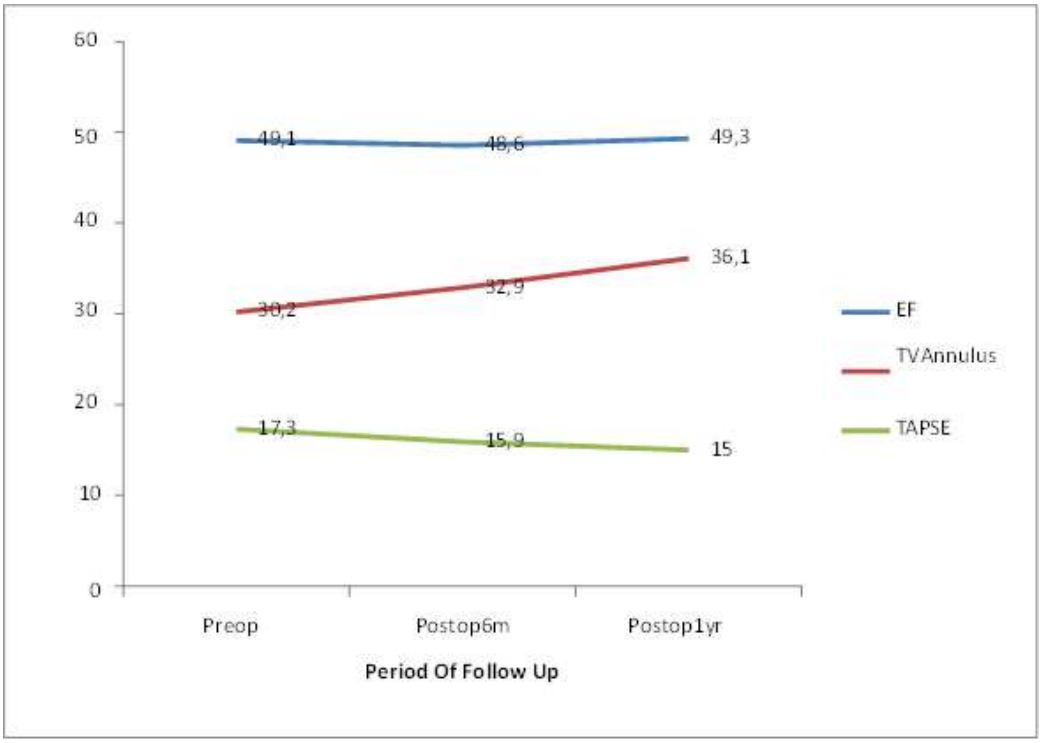


Figure 1. Serial echocardiographic changes in EF, TV annulus, and TAPSE at baseline, 6 months, and 1 year.

Subgroup analysis revealed significant variability in progression patterns according to the underlying cardiac disease. Table 3 shows the disease-specific outcomes at one year following surgery. Participants with mitral stenosis (MS) demonstrated the most severe deterioration, with mean annular dilatation of +8 mm and TAPSE decline of –2.5 mm; 50% developed severe TR and RV dilatation. CAD+MR Participants were also at very high risk, with 40% developing severe TR and RV dilatation, despite showing improvement in LV function. In contrast, Participants with aortic regurgitation and pure MR exhibited minimal annular enlargement and TAPSE decline. These patterns are illustrated in Figures 2–4, where MS and CAD+MR groups showed the steepest deterioration compared to other subgroups.

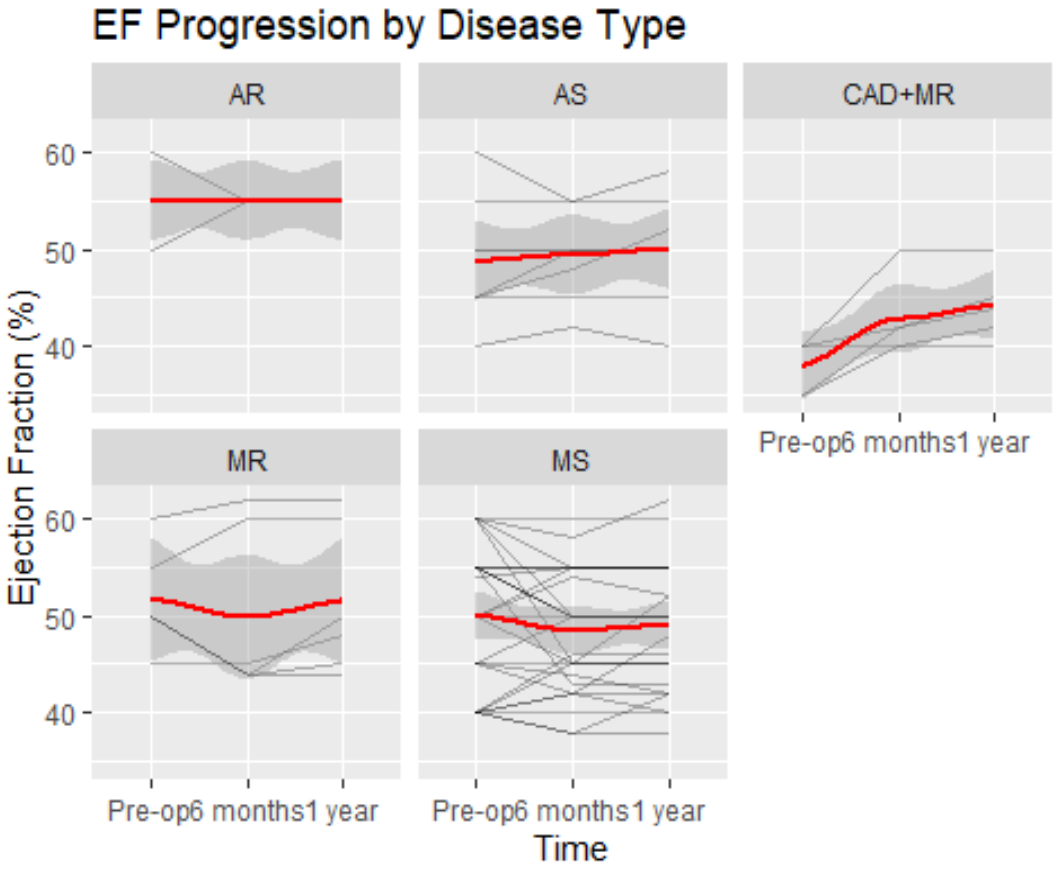


Figure 2. Disease-specific EF trajectories over one year following surgery.

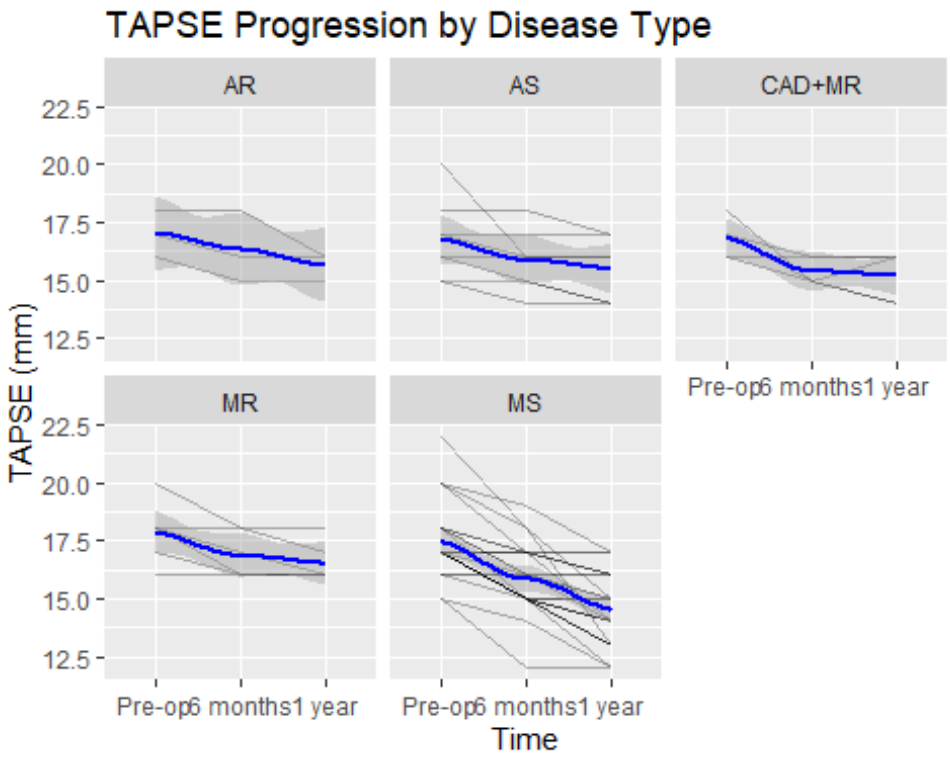


Figure 3. Disease-specific TAPSE decline over one year following surgery.

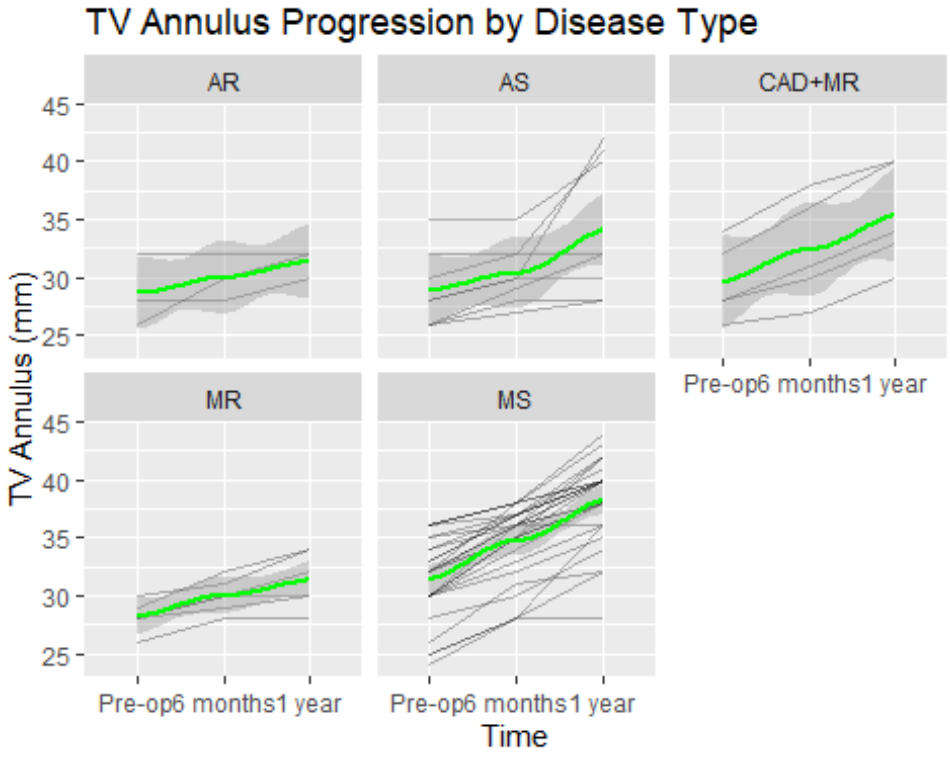


Figure 4. Disease-specific TV annulus progression over one year following surgery.

Table 3. Disease-Specific Progression at 1-Year Follow-up (Post-surgery)

Disease Type	n	Severe TR (≥40mm), n (%)	RV Dilatation, n (%)	Mean Annular Increase (mm)	Mean TAPSE Decline (mm)	Risk Category
Mitral stenosis	28	14 (50.0)	14 (50.0)	+8.0	–2.5	High
CAD + MR	5	2 (40.0)	2 (40.0)	+6.0	–1.5	Very High
Aortic stenosis	8	3 (37.5)	3 (37.5)	+4.0	–1.5	Moderate
Mitral regurgitation	6	0 (0.0)	0 (0.0)	+4.0	–1.0	Low
Aortic regurgitation	3	0 (0.0)	0 (0.0)	+2.0	–1.0	Low

Age-related analysis demonstrated that RWMA incidence was significantly higher in Participants above 50 years (p=0.020). As shown in Figure 5, RWMA prevalence reached 66.7% in Participants aged 61–70 years, compared to <6% in those younger than 50 years. No significant association was found between gender and TR progression.

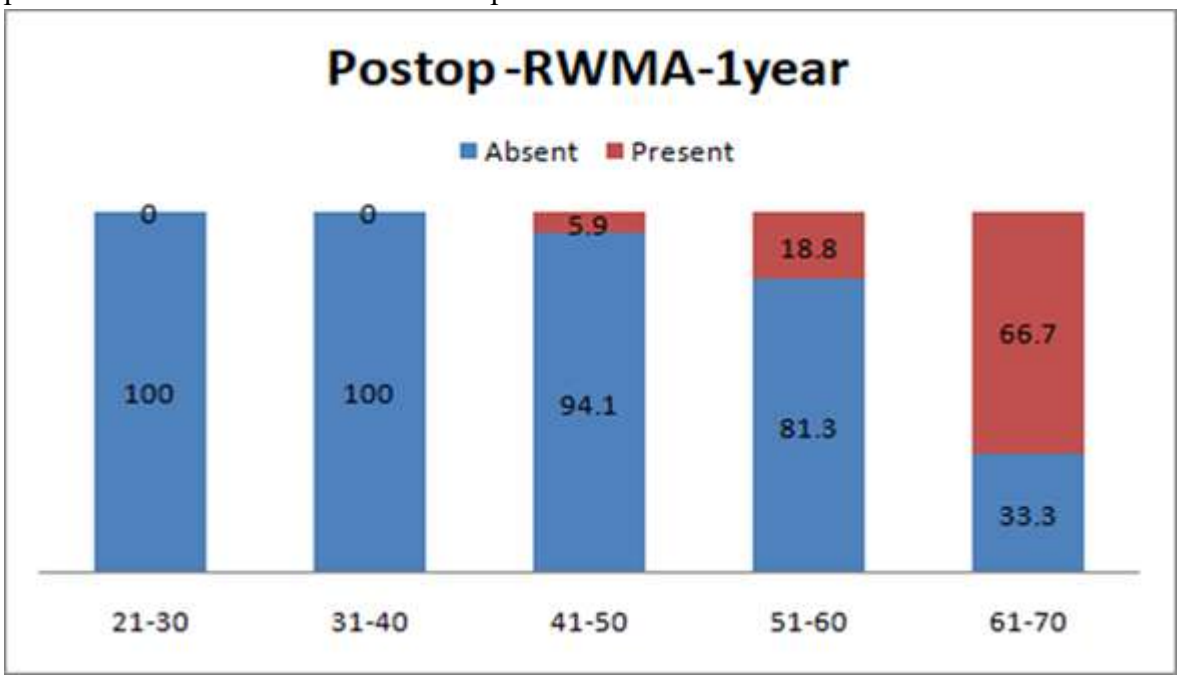


Figure 5. Age-stratified RWMA prevalence at one-year follow-up.

In summary, within one year of follow-up, more than one-third of Participants developed severe TR after cardiac surgery, characterized by annular dilatation ≥40 mm and TAPSE <14 mm. The degree of deterioration (mean annular increase of 5.9 mm and TAPSE decline of 2.2 mm) was clinically meaningful and strongly influenced by the type of primary cardiac disease and age at presentation.

The progression of tricuspid regurgitation was not uniform across the cohort but was significantly influenced by patient-specific factors. Disease type emerged as the strongest determinant, with mitral stenosis and CAD+MR Participants

showing the most severe deterioration in annular dilatation and TAPSE decline (Figures 2–4). Advancing age (>50 years) was also associated with higher prevalence of RWMA (p=0.020), suggesting reduced myocardial reserve in older Participants (Figure 5). In contrast, gender showed no significant association with TR progression. These findings indicate that both underlying cardiac pathology and age are important modifiers of disease trajectory.

Discussion

Tricuspid regurgitation is frequently encountered in Participants undergoing surgery for cardiac disease, particularly those with valvular heart pathology, with severe mitral stenosis being the most common substrate [11-13]. Historically, the tricuspid valve was neglected, and surgical attention was primarily directed at the left-sided lesions. However, long-term studies such as those by Dreyfus et al. [14] and Topilsky et al. [15] demonstrated that untreated TR can progress over time, often leading to symptoms and eventual need for surgical or medical management. In support of this, Kilic et al. [16,17] and Navia et al. [18] reported symptomatic improvement and stabilization of right ventricular function when concomitant tricuspid repair was performed.

In our study of 50 Participants with preoperative TR undergoing surgery for primary cardiac disease, serial echocardiographic evaluation was performed to document progression. The mean age was 45 years, with a male predominance (62%). Severe mitral stenosis accounted for over half of the cases, whereas only a small proportion (6%) had aortic regurgitation as the primary lesion. Regional wall motion abnormalities (RWMA) were documented in 12% of Participants preoperatively, without any new cases during follow-up. Left ventricular ejection fraction (EF) remained largely stable, with a minor decrease at six months followed by recovery at one year.

Importantly, right heart parameters showed progressive deterioration. No patient had right ventricular dilatation preoperatively, but 20% developed RV dilatation at six months, increasing to 38% at one year. Tricuspid annular diameter increased from 30.2 mm at baseline to 36.1 mm at one year, with 19 Participants (38%) crossing the threshold of ≥40 mm, consistent with severe TR. Similarly, TAPSE declined from a mean of 17.3 mm to 15.0 mm over one year, with 38% demonstrating TAPSE <14 mm, signifying impaired RV function. These findings confirm that TR progression after left-sided cardiac surgery is both structural and functional, aligning with previously published literature [16-18].

The second objective of our study was to identify factors influencing the progression of tricuspid regurgitation. Our results demonstrate that progression is strongly dependent on the type of primary cardiac disease, with mitral stenosis and CAD+MR Participants at the highest risk for developing severe TR within one year of follow-up. In addition, older age (>50 years) was significantly associated with persistence of RWMA, further contributing to adverse remodeling. Conversely, gender did not appear to affect outcomes. Thus, disease type and advancing age represent key determinants of TR progression that should be taken into account in clinical decision-making. These findings are consistent with contemporary data indicating that rheumatic mitral pathology and ischemic substrates impose significant

load on the right heart, accelerating TR progression [19,20].

Our results also suggest that echocardiographic markers such as annular dilatation (>40 mm) and TAPSE <14 mm should be considered red flags during follow-up. These parameters reflect clinically meaningful deterioration and may warrant earlier intervention before the onset of irreversible right ventricular dysfunction. Recent multicentric analyses confirm that proactive tricuspid valve repair during left-sided surgery is safe and may prevent late symptomatic TR, reducing the need for high-risk reoperations [21,22].

Conclusion

Our study highlights that tricuspid regurgitation, often overlooked during left-sided cardiac surgery, shows frequent progression within one year of follow-up, particularly in Participants with mitral stenosis and CAD with MR. Simple echocardiographic parameters such as tricuspid annular diameter, TAPSE, and right ventricular dimensions provide reliable markers for monitoring severity and progression. In our cohort, 38% of Participants developed severe TR (annulus ≥40 mm, TAPSE <14 mm, and RV dilatation) within one year, underscoring the importance of systematic surveillance and timely surgical correction. Early recognition and intervention in high-risk Participants may prevent irreversible right ventricular dysfunction and improve long-term outcomes.

Statements and Declarations

Conflicts of interest

The authors declare that they do not have conflict of interest.

Funding

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ORIGINAL ARTICLE

Study of Incidence of Various Complications of Tracheostomy Following Prolonged Endotracheal Intubation

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Abstract

Background: Endotracheal intubation is necessary to establishing and maintaining a patent upper airway. However, this procedure is associated with complications that need to be detected early and managed appropriately. This study was undertaken to determine and understand the common complications seen in patients undergoing tracheostomy following prolonged endotracheal intubation. **Objectives:** To determine and analyze various complications in patients undergoing tracheostomy following prolonged endotracheal intubation. **Methodology:** 40 patients requiring artificial/assisted ventilation were observed during the period of the study for indications, duration of ventilation, complications of tracheostomy following prolonged endotracheal intubation, tube change, and decannulation. **Results:** The common complications observed were vocal edema, self extubation and Angle of mouth / lip ulceration. Many of the complications encountered after delayed tracheostomy can lead to morbidity and mortality, hence early tracheostomy and good endotracheal tube management can reduce complications and its late sequelae. **Conclusion:** Endotracheal intubation is a life-saving procedure but nevertheless, prolonging the same may be associated with its own set of complications and side effects.

Keywords: Prolonged intubation, Tracheostomy, Tracheostomy complication

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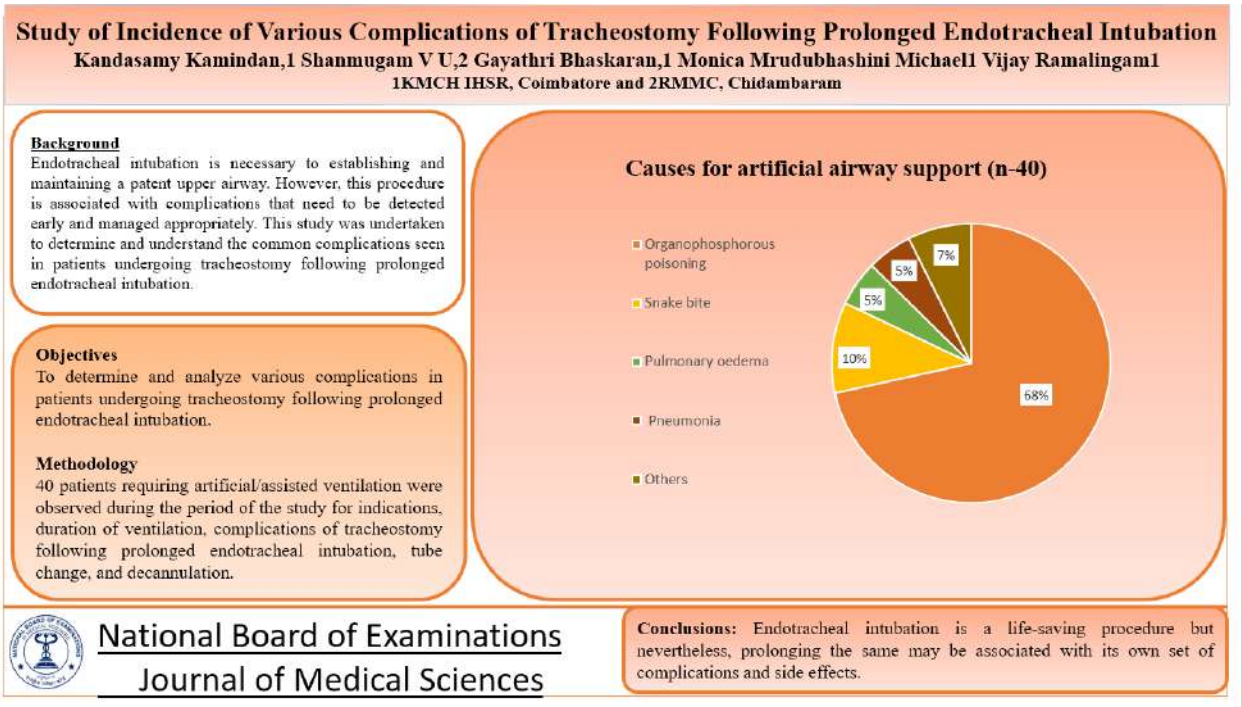
Graphical Abstract



Introduction

Establishing and maintaining a patent upper airway is a vital step in the basic life support and maintenance of airway is the most fundamental aspect of such support [1]. Different techniques available for maintaining artificial airway are Endotracheal Intubation (ET), Tracheostomy, Cricothyroidotomy, Percutaneous Tracheostomy, Surgical Tracheostomy and Laryngeal airway mask. Endotracheal intubation is one of the commonly performed procedures in the emergency department to ensure airway integrity, assurance of oxygenation, Ventilation and prevention of aspiration. It is predominantly done to correct hypoxia or hypercarbia and prevent impending hypoventilation.

However, this procedure is associated with complications like ulcerations, dysphagia, infections, intermittent aphonia, trauma, Vocal cord paralysis etc. [2]. This makes it imperative to either extubate the patient promptly or maintain patency of the airway through other methods.

Studies assessing the complications arising from prolonged ET from USA by Dauna Lundy et al. [1] and Michelle Gill et al [2] reported development of subglottic stenosis and granulomas in patients with long-term intubation and a success rate of 50%. Boubaker Charra et al. [3] from Morocco concluded that patients undergoing tracheostomy leads to decreased ventilation duration and delayed infections in comparison to endotracheal intubation.

Yamanaka et al. [4] from Osaka, Japan also reported incidence of voice hoarseness in 49% patients undergoing ET along with arytenoid dislocation.

Though there is adequate literature to establish the incidence and prevalence of complications in patients with prolonged intubation, there is a dearth of evidence for the same in our region.

This study was therefore conceptualized to determine the immediate, intermediate and long-term complications in patients undergoing tracheostomy following prolonged endotracheal intubation.

Materials and Methodology

This was a hospital-based study conducted in a tertiary care setting in Chidambaram, Tamil Nadu, India from 2016 to 2018.

Patients admitted in our institute for various medical/surgical conditions and requiring artificial airway and ventilatory support were considered for the study. They were intubated with appropriate size endotracheal tube with cuff, and underwent tracheostomy on or after 7 days, as their condition required prolonged mechanical ventilation.

***Exclusion criteria**:*

Patients under the age of 12 and patients who were tracheostomized in other centres were excluded from the study.

***Sample Size**:*

A total of Forty patients admitted and undergoing artificial airway management and ventilatory support were included in this study after ascertaining the inclusion and exclusion criteria.

Sampling

Purposive sampling

Data collection methodology

The study was conducted after the approval of the Institutional Human ethics committee clearance. Written informed consent was obtained from patients/relatives prior to performing the procedure and collecting data for this study. The general and systemic examination was done for the patient followed by examination of oral cavity/throat/neck, Direct laryngeal examination, Video Laryngoscopy, Endoscopic examination of trachea through stoma using topical 10% Lidocaine anesthetic spray, Radiological examination of the neck were done at the time of first tube change, discharge, and before decannulation. All the observations were documented and tabulated.

Study variables for ET like indication, duration, condition of the patient at time of intubation (unconscious/sedated), indication for tracheostomy, complications encountered in patients undergoing tracheostomy following prolonged ET were documented.

Patients were intubated with Portex cuffed endotracheal intubation tube and Portex cuffed tracheostomy tube was used for patients for tracheostomy.

Patient requiring tracheostomy underwent routine pre-operative check-up and was taken up for surgery with anaesthetic concurrence. Patient was positioned supine with neck extension and the neck was painted and draped. Surface marking done, Vertical incision made along the midline between lower border of the cricoid cartilage and a cm above the sternal notch. The soft tissue and strap muscles were separated. There were minor bleedings encountered, which were coagulated with bipolar cautery and ligatures when necessary. The thyroid isthmus was retracted upwards using a single hook retractor. The trachea was identified by saline bubble aspiration technique. Tracheotomy was done using a 11 number scalpel and Bjork's flap was fixed with soft tissue. At this point, the endotracheal tube was deflated and slowly withdrawn till the tracheotomy site by the Anaesthetist. A Portex tracheostomy tube

with cuff of appropriate size was chosen, inserted and cuff inflated. The position of the tube was checked by auscultation method. Then the endotracheal tube was completely withdrawn and removed. The tracheostomy tube was safely secured. The cuff was inflated for a period of twelve hours postoperatively. After 12 hours the cuff was deflated for ten minutes every 4th hour. The tracheal stoma was dressed using betadine gauze and changed every 8th hour. The cuff was completely deflated when the patient no longer needed ventilatory support and changed to Fullers metal tube of appropriate size. As and when the patient was comfortable with phonation and clearing out secretions, corking was done for 48 hours. After successful corking tolerance, the Fuller's tube was removed, and the tracheal stoma was closed under local anaesthesia.

The collected data was entered into Microsoft excel and analyzed using appropriate statistical software. Results were expressed in proportions and percentages.

Results

This study analyzed data of a total of 40 patients.

Majority (45%) of patients were of age 41- 50 years of age (Median age – 39 years) with a male predominance (85%).

The common clinical conditions requiring airway support were as depicted in Figure 1.

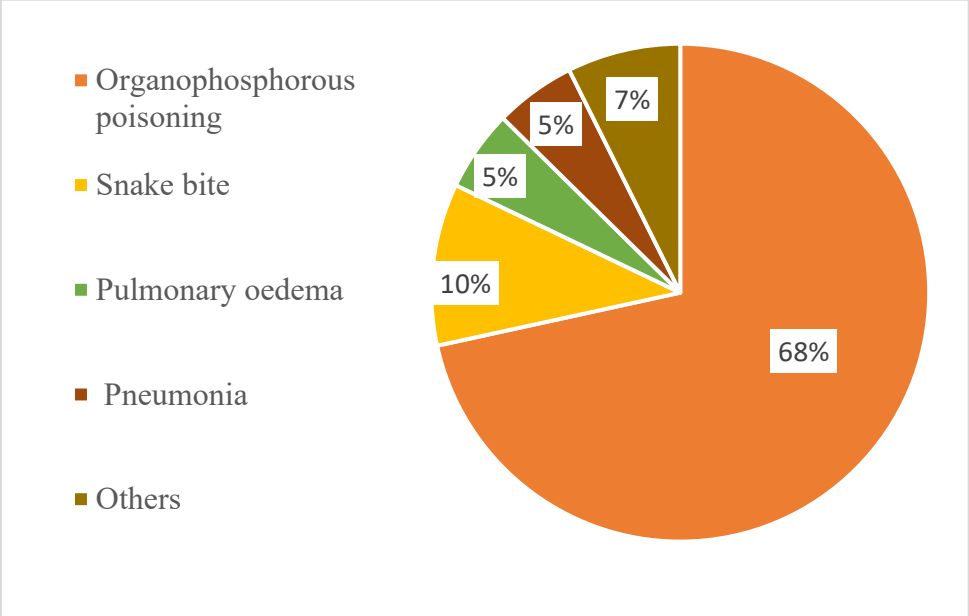


Figure 1. Causes for artificial airway support (n-40)

The most common indications in those patients requiring ET and tracheostomy were 'Imminent respiratory failure' (75%) and 'expectant prolonged endotracheal intubation' respectively.

In our study of 40 patients the median (IQR) days of intubation was 10 (8, 12).

There were Twenty-two instances of complications seen in patients who underwent tracheostomy following prolonged ET.

The common complications were as shown in Figure 2.

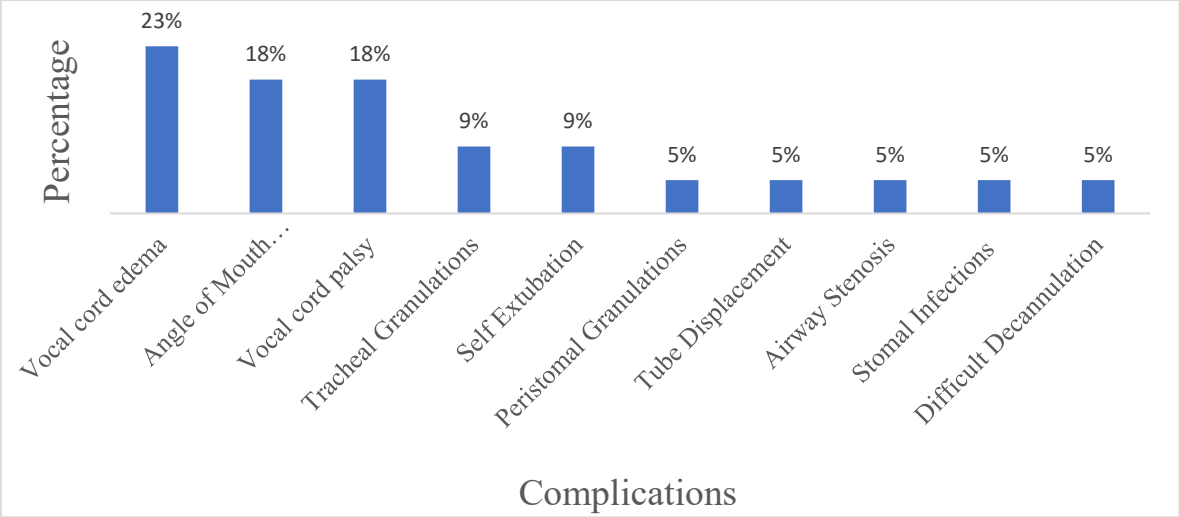


Figure 2. Complications (n-22)

Discussion

This hospital based cross sectional study analyzed the various complications seen in patients with delayed tracheostomy following prolonged ET.

ET is one of the commonly employed methods of maintaining a patent airway. However, study by Austin et al concluded that prolonged ET was reversible and avoids complications of tracheal stoma but also carries serious risk of injury to larynx along with blockage and displacement of tubes [5].

The median age of participants in our study was 39 years with most (45%) of the patients in the age group of 41- 50 years.

This was a lower age group compared to the studies in other countries that reported average ages ranging from 56 – 58 years [6,7].

We observed male preponderance in our group of 40 patients, which was comparable to most studies [6-9].

The clinical diagnosis of the patient who required prolonged endotracheal ventilation followed by Tracheostomy was varied, the most common clinical diagnosis in our study was organophosphorus compound poisoning which points to the kind of problems prevalent in this part of the world that requires attention.

Imminent respiratory failure was the most common indication for endotracheal intubation in our study. John L Stauffer et al. [6] and Astrachan et al. [9] in their research work also observed that the respiratory failure being the common indication for intubation.

We observed that median (IQR) days of intubation was 10 (8, 12) for the 40

patients included in our study. Chopra et al [10] in their study from North India, observed 20 patients had complications following more than 7 days of intubation. John Stauffer et al. [6] had the least mean duration of intubation - 5.4 days. Stacey L Halum et al [7] in their study keenly noted that 35% were intubated for less than 7 days, 31% were intubated for period of 1-2 weeks and 35% were intubated for more than 2 weeks. A Ashoor et al. [8] documented duration of prolonged intubation from 13 to 42 days.

This variation may be attributed to the difference in the kind of presentation and the decision to decide the time duration of intubation being predominantly clinical and experience based.

Ventilatory dependence and prolonged endotracheal intubation were the indications for tracheostomy in our study which was similar to the findings in the other studies [7,8].

Average number of days a patient remained with tracheostomy tube was 34 days (11 – 93 days) in this study, whereas it was 24.4 days in John Stauffer et al. [6] and 64 days in Stacey Halum et al. [7] study. This again indicates the wide variation in the number of days and requires an evidence-based consensus statement to decide on the most appropriate duration for maintaining a patient on tracheostomy to prevent complications.

Complications and management

The complications developing during the study were appropriately managed.

The most common complication in the patients in our study was vocal cord edema (23%). Other Indian study by Chopra et al [10] observed 15% of the patients had vocal cord edema while John Stauffer et al. [6] and Austin [5] reported 2% and 5% respectively.

Nine percent of the patients self-extubated in the ICU and were re intubated and none of the incidents were fatal. Self-extubation, even though simple can lead to catastrophe if the patient is not under continuous monitoring. This was similar to the findings of Austin et al. [11] whereas Astrachan et al. [9] found staggering 21% of the patients self-extubating during their stay in ICU.

John Stauffer et al. [6] had observed 15% of the patient had lip ulceration, which was comparable to our study in which we observed 18% of the patients had an angle of mouth or lip ulceration due to constant pressure from the endotracheal tube itself.

Peristomal granulations were noted in 5% of our study group. This percentage was comparable with the study by Ashoor et al. [8] in which 2.4% of the patients had granulation. Prescott [12] documented 6% of their study population developed granulation during the first 4 weeks, 12% during 2–4 weeks and 13% later than 4 weeks which was higher than what was observed in our study.

Another noticeable complication was tracheal granulations due to the contact friction on the trachea. 10% of the patients had tracheal granulations, which settled after decannulation. Chopra et al. [10] had similar experience with 5% of the patients in his study.

With strict dressing protocol we could limit the stomal infection to about 5%, when suspected of infection, swabs were taken for culture / sensitivity and patients were treated with culture directed antibiotics. Astrachan et al. [9] noted 8% of the patients had stomal infection and John Stauffer et al. [6] had 36% of the patients presenting with stomal infections.

Tracheostomy tube displacement was noted in 5% of the study population post tracheostomy during their stay in the ICU, which was promptly noted and re-insertion done without any difficulty. T E Dane et al [12] in his study noted 10% of the patient needed re-insertion of displaced tube.

The serious and life-threatening complication that was documented in our study was subglottic stenosis (5%). These patients did not tolerate trial decannulation, following which patients were subjected to rigid bronchoscopy and computed tomography of neck. Patient diagnosed with subglottic stenosis, Graded by Cotton-Myer grading system and were managed accordingly.

Even though complications like lip ulceration, self extubation and subglottic stenosis were not directly related to tracheostomy, they were still significant complications of prolonged endotracheal intubation. Hence, we were compelled to include the same in our results as they were observed in the patients who underwent tracheostomy and presented post decannulation in case of subglottic stenosis.

Conclusion

Endotracheal intubation is a life-saving procedure but nevertheless, prolonging the same may be associated with its own set of complications and side effects.

Many of the complications encountered after prolonged endotracheal intubation and tracheostomy can lead to morbidity and mortality, hence prompt diagnosis and management is essential.

Early tracheostomy reduces the number of days on intubation hence facilitates early weaning and early decannulation, thereby minimizing the complications following prolonged endotracheal intubation and its late sequelae.

This study indicates the need for a robust evidence based consensus statement on the duration of ET as well as more studies with larger sample and prolonged period of evaluation for better understanding of the evolution of complications, diagnosis and management.

Limitations

Follow up schedule was a major hindrance to the study.

Declaration of Ethical Issues

The authors hereby declares that there were no ethical issues involved in the publishing of this article in any journal.

Declaration of Conflicting Interests

The authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

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ORIGINAL ARTICLE

Efficacy of Amiodarone Versus Amiodarone and Dexmedetomidine on Heart Rate and Rhythm Following Aortic Cross-Clamp Opening During Cardiopulmonary Bypass and the Early Postoperative Period in Patients Undergoing Valve Replacement Surgery With Rheumatic Mitral Valvular Disease and Chronic Atrial Fibrillation: A Prospective, Randomized, Controlled, Double-Blinded Trial

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Abstract

Background: Long-standing atrial fibrillation (AF) is a common arrhythmia, often associated with rheumatic valvular disease, particularly mitral valve disease, which results in left atrial enlargement. In developing nations such as India, AF is found almost exclusively in association with rheumatic mitral stenosis and mitral regurgitation. **Objective:** To assess the effectiveness of amiodarone and dexmedetomidine in the treatment of atrial fibrillation after cardiac surgery, especially in patients undergoing cardiopulmonary bypass (CPB). **Methods:** The study compared the effects of amiodarone, an antiarrhythmic drug classified as a class III agent, with those of dexmedetomidine, a selective α2-adrenergic agonist, on rate control and recovery of normal sinus rhythm (NSR) after cardiac surgery. Their pharmacological effects, including adrenergic stimulation inhibition, modulation of sodium, potassium, and calcium channels, and anti-inflammatory effects, were experimented upon in the treatment of postoperative AF. **Results:** Amiodarone exhibited a high rate of conversion and maintenance of NSR in 50–70% of patients with minimal hemodynamic instability. The combination of amiodarone and dexmedetomidine had an additive effect that improved postoperative AF control and prevented hemodynamic fluctuations. **Conclusion:** Both amiodarone and dexmedetomidine are useful in the treatment of postoperative AF; amiodarone is better at controlling rhythm, while dexmedetomidine is better at controlling inflammation and hemodynamic stability.

Keywords: Randomized, Valve Replacement Surgery, Amiodarone, Dexmedetomidine

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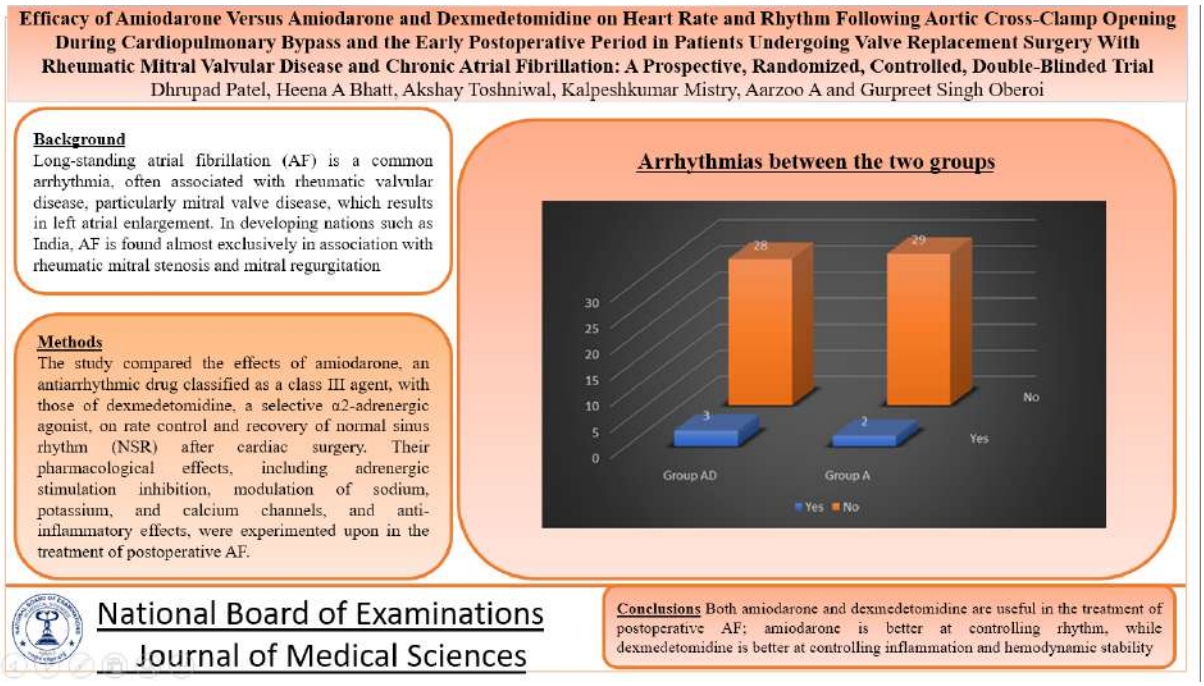
Graphical Abstract



Introduction

Chronic atrial fibrillation (AF) is a common arrhythmia frequently associated with rheumatic valvular disease (RHD), particularly mitral valve disease, which causes left atrial enlargement in the long run [1]. The prevalence of AF is increasing across the globe, while an increase in age in Western nations is a predominant factor. Rheumatic mitral stenosis (MS) and mitral regurgitation (MR) are the main causes in emerging nations like India. Controlling the rate is essential because AF's rapid ventricular rate (VR) and irregular rhythm impair cardiac function. Restoration of the normal sinus rhythm (NSR) is particularly critical after cardiac surgery to reduce morbidity [2]. Atrial fibrosis is a key element in the multifactorial aetiology of atrial fibrillation (AF), which is responsible for the onset and maintenance of the arrhythmia. Atrial tamponade, epicardial inflammation, hypoxia, acidosis, electrolyte imbalances, and sympathetic nervous system stimulation are other contributing factors that are frequently observed in valvular surgeries. Given this complexity, combining drugs with different pharmacological effects may enhance the efficacy of AF management postoperatively. Beta-blockers and calcium channel blockers, which are frequently employed in the management of AF, are known to induce hemodynamic instability, especially in cardiac surgery [3].

Amiodarone, a class III antiarrhythmic drug, blocks adrenergic stimulation and influences sodium, potassium, and calcium channels, greatly extending action potential and repolarization. This is followed by decreased atrioventricular conduction and enhanced sinus node function, rendering it useful in rate control of the ventricle without much hemodynamic instability. Intravenous amiodarone has been found to be effective in converting and sustaining NSR in 50–70% of patients because of its quick onset of action. It is not administered orally because of its extensive first-pass

metabolism, with an intravenous half-life of about six hours, and the kidneys mainly excrete its metabolites [4]. Dexmedetomidine is a selective α2-adrenergic agonist with sympatholytic action, which influences presynaptic and postsynaptic receptors in the central nervous system. It has sedative, analgesic, and anti-inflammatory properties, decreases heart rate and inhibits sinus and atrioventricular nodal function. By enhancing myocardial oxygen demand, it is a possible prophylactic treatment for postoperative AF [5].

Cardiopulmonary bypass (CPB) induces a systemic inflammatory reaction that may lead to profound organ dysfunction, with the additional risk of AF. Dexmedetomidine's sympatholytic and anti-inflammatory properties could have an additive effect when used in conjunction with amiodarone, enhancing rhythm control during CPB weaning [6]. The objective of this research is to compare the effectiveness of amiodarone with a combination of amiodarone and dexmedetomidine in the control of heart rate and rhythm after aortic cross-clamp opening during cardiopulmonary bypass and in the postoperative period. Patients with rheumatic mitral valvular disease complicated by persistent atrial fibrillation who are having valve replacement surgery are the focus of the study. The main goal is to compare the efficacy of intravenous (IV) amiodarone alone with IV amiodarone plus dexmedetomidine in maintaining rhythm and heart rate after opening of the aortic cross-clamp and during early postoperative hours. The secondary goals involve assessing the effects of these regimens on several hemodynamic variables, including heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure. The study will also assess whether pacing is necessary after opening the aortic cross-clamp during surgery and in the postoperative period.

Materials and Methods

The study was conducted as a prospective, randomized, controlled, double-blinded trial. Institutional Research Ethical Board clearance and written informed consent from the patient were obtained before starting the study at Geetanjali Medical College and Hospital, Udaipur. The study patients were those undergoing valve replacement surgery for rheumatic mitral valvular disease with chronic AF on CPB between January 2021 and July 2022.

Group randomization and blinding were secured by keeping the data collector and the patient unaware of the group assignment. The study drug was administered by an independent anesthesiologist who was not participating in the study, as per the assigned group. The pre-anesthetic check-up was routine one day prior to surgery, and the patients were kept nil per os for eight hours prior to the surgery. Randomization with the aid of a computer randomization schedule resulted in two equal groups of 31 patients each. After starting CPB, Group A received a bolus of amiodarone (3 mg/kg) in 20 mL of normal saline and a placebo in 20 mL of normal saline (NS). Amiodarone 0.4 mg/kg/h (450 mg in 50 mL NS) and a placebo infusion (50 mL NS) were then administered intravenously for 24 hours after surgery. A bolus of dexmedetomidine (2 mcg/kg) and amiodarone (3 mg/kg) in 20 mL NS was given to Group AD. Additionally, an IV infusion of dexmedetomidine 0.1 mcg/kg/h (100 mcg in 50 mL NS) and amiodarone 0.4 mg/kg/h

(450 mg in 50 mL NS) was administered for 24 hours after surgery.

Sample size determination:

The sample size has been calculated from a prevalence of cardiac surgery of 2% for mitral valve disease with an absolute error of 7% at a 95% confidence level using the formula:

$$N=((Z\alpha +Z1-\beta)^2*P(100-P))/E2$$

Where $Z\alpha=1.96$ at a 95% confidence level and $Z1-\beta=0.8413$ at 80% study power, the required sample size was calculated to be 31 patients in each group, making a total of 62 patients.

Adult patients aged 18 to 70 years and classified as ASA grade I, II, or III with BMI ≤28 kg/m² and an ejection fraction of ≥60% were studied. Patients who underwent valve replacement surgery with chronic AF were included. The exclusion criteria were baseline heart rate <50/minute, atrioventricular (AV) nodal block, thyroid dysfunction, abnormal liver function tests, serum creatinine >2 mg/dL, allergy to the study drugs, and pre-existing neurological, psychiatric, or respiratory illness.

Data collection method

As soon as the patient arrived in the operating room, initial measurements of heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), respiratory rate (RR), and oxygen saturation (SpO_2) were taken. An arterial line was inserted in the radial artery for invasive blood pressure monitoring, and a central venous catheter was inserted under local anaesthesia for central venous pressure monitoring. Baseline arterial blood gas (ABG) was analyzed. General anaesthesia was induced using midazolam (2 mg), fentanyl (5 µg/kg), etomidate (0.3 mg/kg), vecuronium (0.1 mg/kg), and lignocaine (1.5 mg/kg). Oxygen, air, and sevoflurane were used to maintain patients.

Intravenous heparin (400 IU/kg) was used to target an activated clotting time (ACT) of 480 seconds. The CPB circuit was primed with lactated Ringer's solution, sodium bicarbonate, mannitol, and heparin. After CPB initiation, the assigned study drugs were given over 10 minutes and subsequently by continuous infusion according to the group assignment. Haematocrit was 21–28% during CPB. Protection of the myocardium was done with antegrade cold cardioplegia (St. Thomas' solution-derived crystalloid-blood cardioplegic solution, 1:4 ratio, 20 mL/kg) at 20-minute intervals following aortic cross-clamping. The valve replacement was done under CPB with mild hypothermia, and all the patients were rewarmed to 37°C prior to weaning from bypass. The serum potassium was kept between 4 to 4.5 mEq/L in order to avoid arrhythmias secondary to electrolyte imbalance.

Once the aortic cross-clamp was released, the first cardiac rhythm was noted. If HR was <50/minute, epicardial pacing was started. In VF or VT, stepwise treatment with magnesium, lignocaine (1.5 mg/kg), and internal defibrillation (up to 50 J) was done. AV block was treated with AV sequential pacing and inotropic support with adrenaline (0.05–0.1 µg/kg/min) was started if SBP dropped below 90 mmHg.

After weaning from CPB, the residual effects of heparin were reversed using protamine sulfate (1:1 ratio to heparin). After surgical closure, patients were transported to the postoperative ICU and were observed for arrhythmias for 24 hours.

Important parameters monitored included rhythm and heart rate following aortic cross-clamp release, ventricular rate, pacing requirement, and DC cardioversion requirement. Continuous monitoring was done for heart rhythm, HR, SBP, DBP, MAP, SpO_2, and $EtCO_2$ for 24 hours after surgery.

Statistical analysis

Statistical analysis was performed with SPSS version 27.0. Continuous variables, including CPB time, aortic cross-clamp time, amount of cardioplegia utilized, and pre-aortic cross-clamp release potassium levels, were compared using the Student's t-test. Categorical variables were compared with the Chi-square test. A p-value <0.05 was taken to be statistically significant.

Results

Table 1. Demographic variables between groups

Parameters	Group AD	Group A	p-value
Age (years)	52.39±14.35	48.32±12.09	0.232
Males	13 (41.93%)	12 (37.20%)	0.999
Females	18 (58.06%)	19 (61.29%)	
Weight (kgs)	62.48±7.58	65.64±8.47	0.166
Height (cms)	166.09±8.01	168.32±10.01	0.337
BMI	23.0±3.35	23.0±2.93	1

Table 1 shows the various demographic variables like age, gender (male, female), weight, height and BMI in groups AD and A and were found to be statistically non-significant (p>0.05).

Table 2. Comparison of HR at various time intervals between groups

Duration	Group AD		Group A		t-test	p-value
	Mean	SD	Mean	SD		
5 minutes	89.41	6.58	87.41	8.02	-1.07	0.28
10 minutes	86.77	5.2	85.61	8.62	-0.6	0.52
15 minutes	82.64	7.66	82.51	9.12	-0.06	0.95

30 minutes	69.58	10.57	77.29	7.73	-3.278	0.002*
1 Hour	66.39	11.56	75.13	9.77	-3.215	0.002*
2 Hours	66.55	10.74	75.13	9.07	-3.398	0.001*
6 Hours	64.48	10.3	74.61	9.33	-4.058	<0.001*
16 Hours	65.93	9.68	73.68	9.15	-3.239	0.002*
24 Hours	63.35	6.35	72.29	8.45	-4.709	<0.002*

Table 2 shows the comparison of HR of patients in groups AD and A at different time intervals. It was found that there was statistical significance between both groups in the time intervals 30 minutes, 1 hour, 2 hours, and 6 hours post-aortic cross-clamp opening and postoperatively at 16 and 24 hours, respectively ($p < 0.05$). Still, there was no significance between time intervals of 5 minutes, 10 minutes, and 15 minutes, respectively ($p > 0.05$), in the ACC opening.

Table 3. Comparison of SBP between two groups at various time intervals

Duration	**Group AD**		**Group A**		**t-test**	**p-value**
	Mean	**SD**	**Mean**	**SD**		
5 minutes	130.25	11.11	128.22	6.63	-0.87	0.385
10 minutes	129.71	11.98	128.93	6	-0.32	0.748
15 minutes	130.16	12.34	129.45	5.13	0.26	0.768
30 minutes	121.61	14.08	137.9	12.03	-4.89	<0.001*
1 Hour	124.39	14.35	139.03	11.95	-4.37	<0.001*
2 Hours	122.71	14.56	140.45	12.21	-5.19	<0.001*
6 Hours	123.23	13.79	140.35	10.02	-5.59	<0.001*
16 Hours	121.87	11.67	137.93	13.11	-5.09	<0.001*
24 Hours	121.77	13.19	135.09	11.46	-4.24	<0.001*

Table 3 shows the comparison of SBP in patients between the AD and A groups. There was statistical significance between both groups in the time intervals 30 minutes, 1 hour, 2 hours, and 6 hours post-aortic cross-clamp opening and postoperatively at 16 and 24 hours, respectively ($p<0.05$). There was no significance between time intervals of 5 minutes, 10 minutes and 15 minutes, respectively ($p>0.05$) of ACC opening.

Table 4. Comparison of DBP between two groups at different time intervals

Duration	Group AD		Group A		t-test	p-value
	Mean	SD	Mean	SD		
5 minutes	76.03	3.57	75.48	4.79	0.51	0.611
10 minutes	75.51	4.97	75.38	5.86	-0.09	0.925
15 minutes	74.06	4.44	76.32	6.02	1.68	0.098
30 minutes	62.7	8.04	76.45	4.47	-8.32	<0.001*
1 Hour	63.58	8.09	75.48	4.35	-7.21	<0.001*
2 Hours	61.22	7.21	75.51	4.86	-9.15	<0.001*
6 Hours	61.74	8.09	76.32	4.39	-8.82	<0.001*
16 Hours	60.54	6.4	75.64	4.71	-10.58	<0.001*
24 Hours	60.93	6.71	74.45	4.96	-9.02	<0.001*

Table 4 shows the comparison of DBP in patients between groups AD and A. There was statistical significance between both groups in the time intervals 30 minutes, 1 hour, 2 hours, and 6 hours post-aortic cross-clamp opening and postoperatively at 16 and 24 hours, respectively ($p<0.05$). There was no significance between time intervals of 5 minutes, 10 minutes, and 15 minutes ($p>0.05$) for the ACC opening.

Table 5. Comparison of MAP between two groups at different time intervals

Duration	Group AD		Group A		t-test	p-value
	Mean	SD	Mean	SD		
5 minutes	94.1	3.72	93.06	3.81	-1.09	0.2802
10 minutes	93.58	5.81	93.23	4.37	-0.26	0.7933
15 minutes	92.76	3.85	94.03	4.79	1.14	0.2553
30 minutes	82.34	6.74	96.93	4.49	-10.37	<0.001*
1 Hour	83.84	7.57	96.66	4.56	-10.46	<0.001*
2 Hours	81.72	6.19	97.16	5.47	-11.91	<0.001*
6 Hours	82.23	6.82	97.66	4.87	-11.62	<0.001*
16 Hours	80.98	5.28	96.4	5.39	-11.38	<0.001*
24 Hours	81.21	6.32	94.66	5.06	-9.25	<0.001*

Table 5 shows the comparison of MAP in patients between groups AD and A. There was statistical significance between both groups in the time intervals 30 minutes, 1 hour, 2 hours, and 6 hours post-aortic cross-clamp opening and postoperatively at 16 and 24 hours, respectively ($p<0.05$). There was no significance between time intervals of 5 minutes, 10 minutes, and 15 minutes ($p>0.05$) for the ACC opening.

Table 6. Comparison of SpO2 between two groups at different time intervals

Duration	Group AD		Group A		t-test	p-value
	Mean	SD	Mean	SD		
5 minutes	98.25	1.36	98.25	1.34	0	1
10 minutes	97.96	1.3	98.41	1.28	-1.37	0.179
15 minutes	97.96	1.6	97.8	1.47	-0.01	0.99

30 minutes	98.45	1.5	98.16	1.29	0.82	0.42
1 Hour	97.93	1.31	98	1.46	-0.2	0.843
2 Hours	98.45	1.41	98.77	0.8	-1.1	0.27
6 Hours	98.9	0.7	99.12	0.84	1.14	0.256
16 Hours	98.12	1.56	97.93	1.28	0.52	0.6
24 Hours	98.06	1.23	98	1.43	0.18	0.86

Table 6 shows the comparison of SpO2 of patients in groups AD and A at different time intervals, and it was found that there was no significance between time intervals of 5 minutes, 10 minutes, 15 minutes, 30 minutes, 1 hour, 2 hours, 6 hours post aortic cross-clamp opening and postoperatively at 16hours, 24hourss respectively ($p>0.05$).

Table 7. Incidence of arrhythmias between the two groups

VT/VF	Group AD	Group A	p-value
Yes	3	2	0.6
No	28	29	

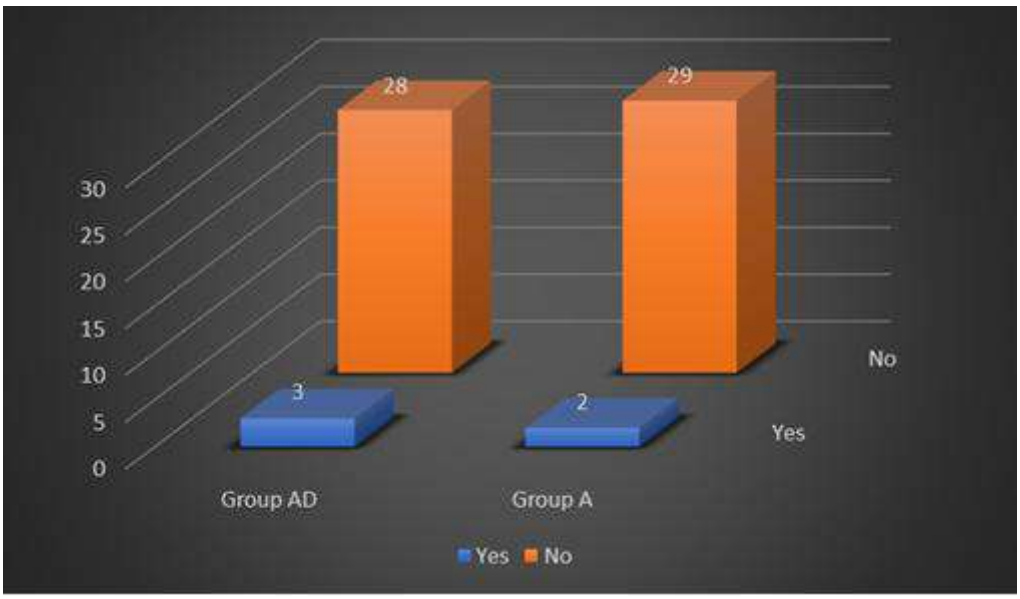


Figure 1. Graphical presentation of arrhythmias between the two groups

Table 7 and Figure 1 shows the incidence of arrhythmias in patients who had ventricular tachycardia (VT) and ventricular fibrillation (VF) post aortic cross-clamp opening between groups AD [n=3, 9.6%] and A [n=2, 2.45%] which was statistically non-significant (p>0.05).

Table 8. Incidence of Rhythm between two groups

Rhythm	Group AD	Group A	Chi-Square Value	p-value
SR	27	19	4.128	0.042*
AF	4	12		

Table 8 and Figure 2 show the incidence of rhythm, such as NSR and AF, in patients between groups AD [n=27, 87.1%] and A [n=19, 61.3%], which was statistically significant (p<0.05).

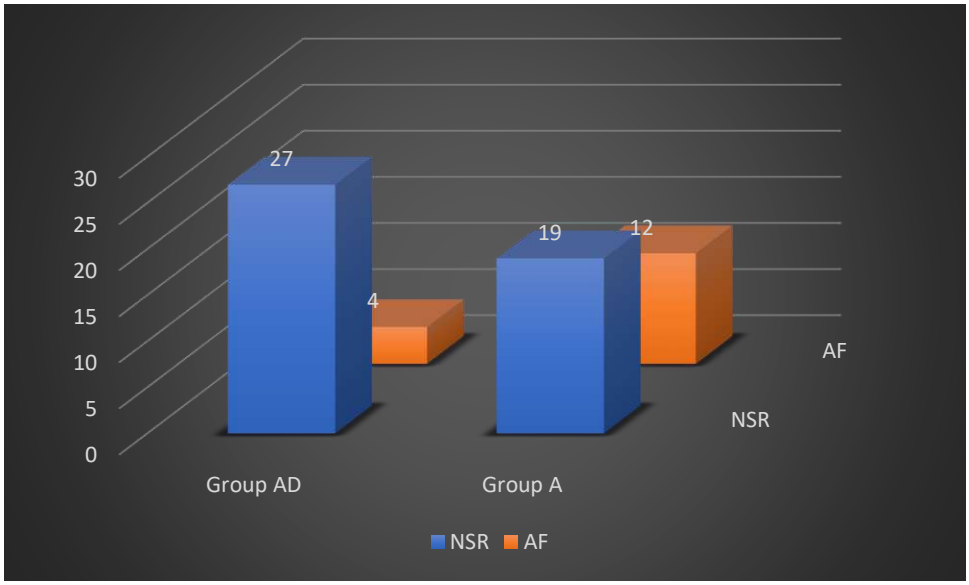


Figure 2. Graphical comparison of Sinus rhythm and Atrial fibrillation between two groups

Table 9. Comparison of incidence of need for pacing between two groups

Need for Pacing	Group AD	Group A	Chi-Square Value	p-value
Yes	11	3	4.521	0.033*
No	20	28		

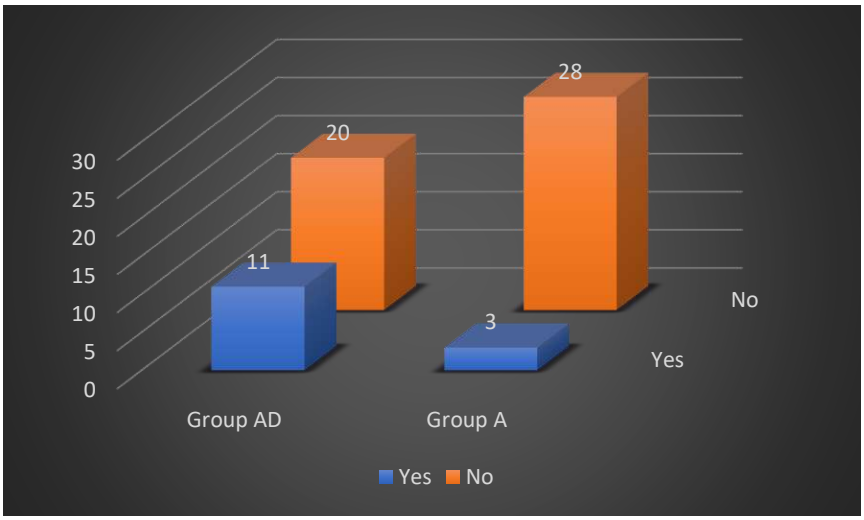


Figure 3. Comparison of incidence of need for pacing between two groups

Table 9 and Figure 3 show the comparison of the incidence of the need for pacing in patients, which was found to be statistically significant between groups AD (n=11, 35.5%) and A (n=3, 9.7%), respectively ($p<0.05$).

Table 10. Incidence of postoperative complications between two groups

Post Operative Complications	Group AD	Group A
Arrhythmia	6	7
Bradycardia	6	2
Hypotension	4	1

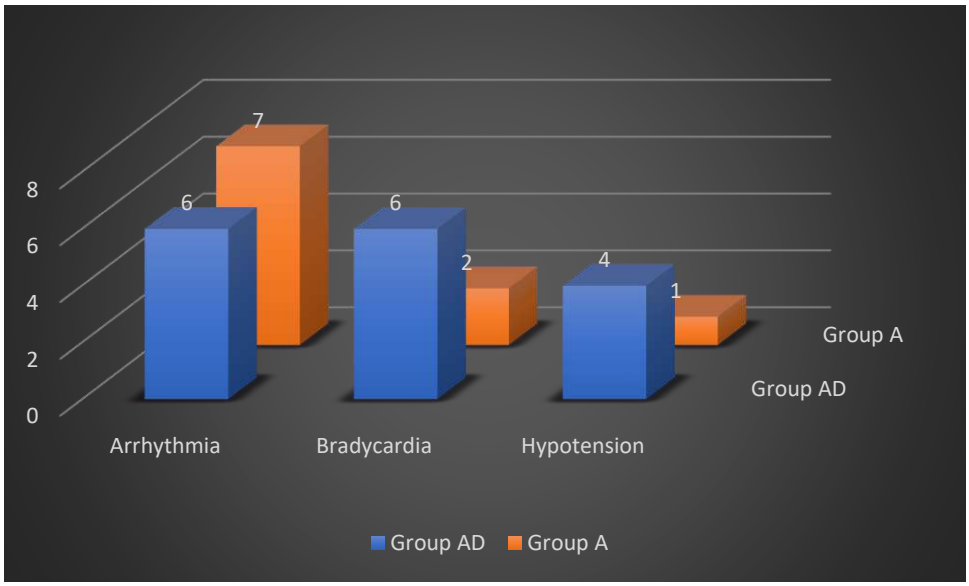


Figure 4. Incidence of postoperative complications between two groups

Table 10 and Figure 4 show the incidence of postoperative complications like arrhythmia, bradycardia and hypotension in patients between two groups, AD and A.

Discussion

Postoperative AF is a frequent and clinically relevant morbidity after MVR, especially for RHD. AF is related to higher morbidity, such as thromboembolic complications, hemodynamic compromise, increased duration of hospital stay, and more postoperative adverse events. Effective control and prevention of postoperative AF, despite evolving surgical and perioperative care measures, remain a persistent challenge. In most instances, AF continues even after the treatment of structural heart disease, which requires pharmacologic and non-pharmacologic therapies for successful rhythm control [7].

Treatment of postoperative AF is either rate control, which reduces the ventricular rate but permits AF to continue, or rhythm control, which seeks to restore and sustain sinus rhythm. Whereas rate control is the preferred choice in stable hemodynamic patients, rhythm control is an option for symptomatic AF, hemodynamic instability, or when maintaining sinus rhythm long-term. Of the antiarrhythmic drugs on hand, amiodarone is most commonly utilized because of its wide-range electrophysiological properties, which include extension of the action potential, blockade of various ion channels, and inhibition of ectopic atrial activity. Yet, amiodarone by itself is not always adequate, especially in those with high sympathetic drive or recurrent AF. Its delayed action and possible side effects, including bradycardia and hypotension, can also restrict its use in some clinical situations [8,9].

Dexmedetomidine, a very selective α2-adrenoceptor agonist, has received growing interest in the perioperative care of cardiac surgery patients because of its distinct pharmacological characteristics. It produces sedation, analgesia, and anxiolysis without causing severe respiratory depression. Most significantly, it possesses sympatholytic activity by preventing the release of catecholamines, thereby attenuating the hyperadrenergic state associated with cardiac surgery. The sympatholytic action leads to reduced heart rate and improved hemodynamic stability, and dexmedetomidine is a valuable adjunct in patients with arrhythmias. Since it is potent to modulate autonomic tone and to suppress overactive sympathetic activity, dexmedetomidine is presumed to enhance the therapeutic effectiveness of amiodarone in rhythm control by reducing the inducers of AF, such as tachycardia and hemodynamic instability [6,10].

The current research was designed to compare the therapeutic efficacy of amiodarone alone with amiodarone combined with dexmedetomidine in the maintenance of sinus rhythm and hemodynamic stability in MVR patients. The primary results revealed that the application of dexmedetomidine significantly improved the rate of maintenance of sinus rhythm, reduced heart rate variability, and facilitated improved blood pressure control, thereby improving overall hemodynamic stability. More of the amiodarone-dexmedetomidine patients were in sinus rhythm when the observation time was over. 87.1% remained in sinus rhythm, compared with 61.3% for the amiodarone-alone group. The number was statistically significant and represents the

potential value of dexmedetomidine as a valuable adjunct to treatment for rhythm control after surgery. The increased rhythm stability in the dexmedetomidine group may be attributed to its sympatholytic effect that diminishes adrenergic drive, a strong predictor of postoperative AF initiation and sustenance. These results were similar to the findings of previous studies [11,12].

The other notable finding was the impact of dexmedetomidine on heart rate regulation. In the postoperative period, the amiodarone-dexmedetomidine group maintained lower heart rates compared with the amiodarone-alone group during the period. This would mean that dexmedetomidine's action to prevent inappropriate sympathetic stimulation played a critical role in maintaining cardiac function stably. Tachycardia is an adequately proven postoperative precipitant for AF, and management of tachycardia is crucial in attempting sinus rhythm maintenance. Due to heart rate variability, dexmedetomidine might have supported the generation of a more stable electrophysiological environment and thus eradicated the recurrence of AF. The results were similar to previous studies [12,13].

Blood pressure levels for the two groups also differed quite significantly. Reduced SBP, DBP and MAP at various postoperative intervals were noted among the patients given dexmedetomidine. This was to be expected as dexmedetomidine is capable of inhibiting sympathetic outflow and producing mild hypotension. No patient who received dexmedetomidine had severe hypotension necessitating stopping therapy, indicating that the decrease in blood pressure was near the upper end of the clinically acceptable range. The amiodarone group had more significant blood pressure variability, which could have caused a less stable postoperative course. The incidence of other arrhythmias, VF and VT, was minimally increased in the amiodarone-dexmedetomidine group, but this did not reach significance. This finding suggests that the amiodarone-dexmedetomidine combination did not increase the risk of lethal arrhythmias, an essential consideration in the evaluation of new rhythm control adjunctive treatments. Furthermore, the rate of other antiarrhythmic therapy, i.e., electrical cardioversion or rescue medication, was reduced with amiodarone-dexmedetomidine, a further indication of its rhythm-stabilizing ability. These were in accordance with previously done studies [14,15].

Hemodynamic side effects, including the need for vasopressor support, were less in the amiodarone-dexmedetomidine group. Fewer episodes of severe hypertension or hypotension needing treatment were noted in patients in this group. The reduced requirement for vasopressor therapy suggests that dexmedetomidine may assist in obtaining a more stable postoperative hemodynamic course by reducing abrupt blood pressure fluctuations. In addition, the anxiolytic and sedative effects of dexmedetomidine may have been responsible for avoiding stress-related hemodynamic alterations in the early postoperative period. The overall safety profile of the combination of dexmedetomidine-amiodarone was satisfactory. Although bradycardia occurred more frequently in the group treated with dexmedetomidine, it was not of sufficiently large clinical magnitude to warrant stopping the drugs. Severe bradycardia requiring pacing or urgent intervention did not occur in any patient. The finding is consistent with previous accounts that

dexmedetomidine at therapeutic doses is not typically to blame for hemodynamically significant bradycardia in stable patients undergoing cardiac surgery [16–19].

Conclusion

The findings of the study introduce the potential advantages of the combination of dexmedetomidine and amiodarone in patients undergoing MVR. The combination was associated with an extremely high incidence of maintenance of sinus rhythm, improved heart rate and blood pressure control, lower hemodynamic complications, and reduced need for additional antiarrhythmic interventions. Importantly, no increased risk of significant arrhythmias or other severe adverse events was noted with the combination. These findings support the addition of dexmedetomidine to postoperative AF treatment protocols, particularly in high-risk patients for recurrent AF following MVR. Larger populations and longer follow-up are required to determine these benefits and individualize dosing regimens.

Statements and Declarations

Conflicts of interest

The authors declare that they do not have conflict of interest.

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ORIGINAL ARTICLE

Comparison of the Efficacy of Fentanyl and a Paracetamol–Magnesium Combination in Attenuating Hemodynamic Response to Sternotomy in Patients Undergoing CABG

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Abstract

Introduction: Fentanyl is commonly used to attenuate hemodynamic responses during cardiac surgery but is associated with adverse effects. Paracetamol and magnesium sulfate offer a potential opioid-sparing alternative. This study compared the efficacy of fentanyl versus a paracetamol-magnesium combination in controlling intraoperative hemodynamic changes and postoperative pain. **Materials and Methods:** In this prospective comparative study, 90 adult patients undergoing elective cardiac surgery via median sternotomy were randomized into two groups: Group F (fentanyl) and Group PM (paracetamol 15 mg/kg + magnesium sulfate 30 mg/kg). Hemodynamic parameters (SBP, DBP, MAP, HR) were recorded perioperatively. Postoperative pain (VAS scores), morphine consumption, and extubation time were assessed. Statistical analysis was performed with $p < 0.05$ considered significant. **Results:** Baseline characteristics were similar. Group PM had significantly lower SBP at 4 and 5 minutes post-sternotomy ($p=0.041$, $p=0.031$). DBP and MAP were also lower in Group PM from 1 minute onward ($p < 0.05$). At 24 hours, 80% of Group PM had minimal pain (VAS 1) versus 24.4% in Group F. Morphine usage was comparable ($p=0.904$). Extubation was earlier in Group PM, though not statistically significant. **Conclusion:** Paracetamol-magnesium provided better hemodynamic control and postoperative analgesia without delaying extubation. It is a safe and effective alternative to fentanyl in cardiac anesthesia.

Keywords: Fentanyl, Paracetamol, Magnesium sulfate, Hemodynamic response, Coronary artery bypass grafting

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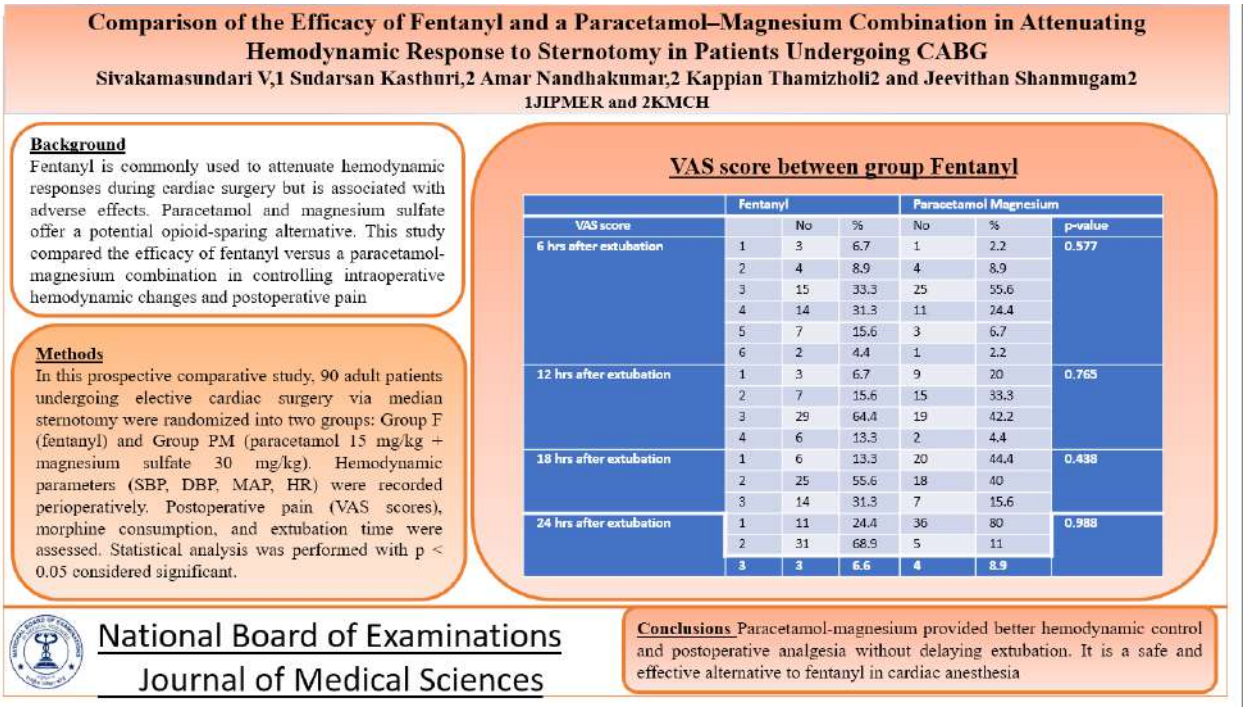
Graphical Abstract



Introduction

Cardiac surgery, particularly procedures involving sternotomy and cardiopulmonary bypass, is associated with significant perioperative stress responses triggered by intense nociceptive stimulation. These responses are characterized by sharp elevations in heart rate, blood pressure, and systemic vascular resistance, all of which may increase myocardial oxygen demand and potentially precipitate ischemic events, arrhythmias, or hemodynamic instability in vulnerable patients. Managing this stress response is therefore a cornerstone of anesthetic management in cardiac surgery, aiming to ensure cardiovascular stability, optimize perfusion, and improve patient outcomes [1].

High dose opioids like fentanyl have been used all these years to manage these sympathetic responses during the cardiac surgeries. Fentanyl is a well established potent μ-opioid receptor agonist and it is preferred for its rapid onset and cardiovascular stability. However, there are few drawbacks. Opioid-based anesthesia has been associated with respiratory depression, delay in extubating, ileus, increased risk of nausea and vomiting, and also opioid-induced hyperalgesia [2,3]. Currently more emphasis on enhanced recovery after surgery (ERAS) protocols and patient-centered outcomes is being stressed. The importance of minimizing opioid exposure is also being stressed nowadays. Hence, there is a preference towards multimodal, opioid-sparing analgesia [4].

Paracetamol and magnesium sulfate have been individually studied for their roles in analgesia and perioperative hemodynamic modulation. Paracetamol is a centrally acting NSAID that inhibits prostaglandin synthesis and activates descending serotonergic pathways, while magnesium sulfate acts as an NMDA receptor antagonist and calcium channel

blocker. This dual mechanism delivered not only analgesic effects but also contributed to sympatholysis and blunting of stress responses during noxious stimuli like intubation or surgical incision. Favourable safety profiles and reduced sedation make them attractive candidates as alternatives or adjuvants to opioids in high-risk surgeries such as cardiac procedures [3,5].

Albeit the benefits of paracetamol and magnesium have been well documented in non-cardiac surgeries, the evidence supporting their combined use in cardiac surgery remains very limited in intraoperative hemodynamic profiles and postoperative analgesic efficacies. Hence this study was planned for developing opioid-sparing protocols that align with enhanced recovery goals without compromising intraoperative stability or analgesic effectiveness [4,6].

Materials and Methods

This study was conducted after Institutional Human Ethics Committee (IHEC) approval from our institution. All procedures followed the ethical principles as per the Declaration of Helsinki. Prior to enrolment, a written informed consent was obtained from all eligible participants after explaining the nature, purpose, benefits, and potential risks of the study in a language they could understand.

This was a prospective, comparative study. Those receiving Fentanyl-based anesthesia and the other receiving a combination of Paracetamol and Magnesium sulfate as part of a multimodal analgesia regimen were termed as Group A and Group B respectively. Patients aged 18 years and above, belonging to ASA physical status III or IV, undergoing cardiac surgery via median sternotomy were included. Patients with known hypersensitivity to study drugs, deranged hepatic or renal function, on opioids or sedative medications were excluded.

In group A, induction and maintenance of anesthesia included standard doses of intravenous fentanyl, titrated to the surgical response. In the group B, intravenous paracetamol (15 mg/kg) was administered 15 minutes prior to induction, along with magnesium sulfate (30 mg/kg) for over 10 minutes. Both groups received standard balanced anesthesia with agents such as midazolam, etomidate, muscle relaxants, and sevoflurane or isoflurane as per institutional protocol.

Hemodynamic parameters including systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), and heart rate (HR) were recorded at predefined intervals: baseline, after induction, before and after skin incision, and every minute from 1 to 5 minutes following sternotomy. Pain was assessed using the Visual Analog Scale (VAS) at 6, 12, 18, and 24 hours post-extubation. Additional data collected included time to first breakthrough pain, total morphine requirement in the first 24 hours post-extubation, and time to extubation.

All clinical observations were recorded using a standardized study proforma. The patient information sheet and informed consent form were approved by the ethics committee and administered prior to enrollment.

Statistical Analysis

Data were analyzed using appropriate statistical software SPSS 27. Continuous variables were expressed as

mean ± standard deviation (SD) and compared using the unpaired t-test. Categorical variables were presented as frequencies and percentages, and analyzed using the chi-square test or Fisher's exact test as applicable. A p-value of < 0.05 was considered statistically significant.

Results

The age distribution between the two groups showed that the mean age in the Fentanyl group was 63.6 years (SD = 6.82) with a median of 64, while in the Paracetamol Magnesium group it was slightly lower at 61.4 years (SD = 4.81) with a median of 62. Although this indicates that participants in the Fentanyl group were marginally older, the difference was not statistically significant (p = 0.107). Gender distribution was identical across both groups, with 88.9% males (40 out of 45) and 11.1% females (5 out of 45) in each, showing no significant difference (p = 0.918). Regarding ASA physical status grading, a higher proportion of patients in the Fentanyl group were classified as ASA grade 3 (86.7%, 39 patients), while the Paracetamol Magnesium group had more patients with ASA grade 4 (31.1%, 14 patients). Nonetheless, the difference in ASA distribution between the two groups was also not statistically significant (p = 0.899).

The comparison of systolic blood pressure (SBP) between the Fentanyl and Paracetamol Magnesium groups at various perioperative time points revealed no statistically significant differences until 3 minutes after sternotomy. SBP readings remained largely comparable at baseline (138 vs. 136 mmHg, p=0.263), after induction (146 vs. 143 mmHg, p=0.105), and around skin incision. However, from the 4th minute after sternotomy, SBP was significantly higher in the Fentanyl group compared to the Paracetamol Magnesium group (142 vs. 138 mmHg, p=0.041), and the trend continued at the 5th minute (143 vs. 139 mmHg, p=0.031), suggesting that the Paracetamol Magnesium group had better SBP control during this period of surgical stimulation (Table 1).

Table 1. Comparison of SBP between group Fentanyl and group Paracetamol magnesium

SBP	Groups	Mean	SD	T test	p-value
Before induction	Fentanyl	138	11.23	1.134	0.263
	Paracetamol Magnesium	136	7.41		
After induction	Fentanyl	146	13.23	1.658	0.105
	Paracetamol Magnesium	143	8.60		
Before skin incision	Fentanyl	125	10.43	-0.879	0.384
	Paracetamol Magnesium	127	6.65		
After skin	Fentanyl	131	11.69		

incision	Paracetamol Magnesium	130	6.59	1.053	0.298
During sternotomy	Fentanyl	134	14.65	0.828	0.412
	Paracetamol Magnesium	132	6.58		
After 1 minute of sternotomy	Fentanyl	138	11.68	1.681	0.100
	Paracetamol Magnesium	135	6.73		
After 2 minutes of sternotomy	Fentanyl	140	11.12	1.867	0.069
	Paracetamol Magnesium	137	7.84		
After 3 minutes of sternotomy	Fentanyl	142	10.58	1.804	0.078
	Paracetamol Magnesium	139	7.61		
After 4 minutes of sternotomy	Fentanyl	142	10.38	2.103	0.041
	Paracetamol Magnesium	138	7.50		
After 5 minutes of sternotomy	Fentanyl	143	10.61	2.225	0.031
	Paracetamol Magnesium	139	6.83		

Diastolic blood pressure (DBP) was similar between both groups at baseline and remained statistically insignificant up to the period of sternotomy. However, from 1 minute post-sternotomy onward, the Fentanyl group exhibited significantly higher DBP values than the Paracetamol Magnesium group. Specifically, DBP after 1 minute (78.2 vs. 75.6 mmHg, p=0.022), 2 minutes (80.0 vs. 76.9 mmHg, p=0.010), 3 minutes (80.4 vs. 77.7 mmHg, p=0.033), and 4 minutes (again 73.6 vs. 73.7 mmHg with p=0.022), as well as 5 minutes (79.5 vs. 79.6 mmHg, p=0.006), all showed significant elevations in the Fentanyl group. This indicates more stable DBP control in the Paracetamol Magnesium group during periods of surgical stress (Table 2).

Table 2. Comparison of Diastolic blood pressure between group Fentanyl and group Paracetamol magnesium

DBP	Groups	Mean	SD	T test	P value
DBP before induction	Fentanyl	73.6	9.04	-0.0289	0.977
	Paracetamol Magnesium	73.7	7.90		
DBP after induction	Fentanyl	79.5	8.23	-0.0273	0.978
	Paracetamol Magnesium	79.6	6.81		
DBP before skin incision	Fentanyl	68.5	7.05	-0.9996	0.323
	Paracetamol Magnesium	69.6	6.74		
DBP after skin incision	Fentanyl	72.6	6.12	-0.2834	0.778
	Paracetamol Magnesium	72.9	5.22		
DBP during sternotomy	Fentanyl	76.0	6.30	1.2326	0.224
	Paracetamol Magnesium	74.8	5.36		
DBP after 1 minute of sternotomy	Fentanyl	78.2	5.70	2.3805	0.022
	Paracetamol Magnesium	75.6	5.03		
DBP after 2 minutes of sternotomy	Fentanyl	80.0	5.42	2.6999	0.010
	Paracetamol Magnesium	76.9	5.06		
DBP after 3 minutes of sternotomy	Fentanyl	80.4	5.86	2.205	0.033
	Paracetamol Magnesium	77.7	5.32		
DBP after 4 minutes of sternotomy	Fentanyl	73.6	9.04	2.3654	0.022
	Paracetamol Magnesium	73.7	7.90		
DBP after 5 minutes of sternotomy	Fentanyl	79.5	8.23	2.8712	0.006
	Paracetamol Magnesium	79.6	6.81		

Mean arterial pressure (MAP) was comparable at most time points, except notably before skin incision, where the Paracetamol Magnesium group had significantly higher MAP (95.1 vs. 87.4 mmHg, $p < 0.001$), indicating better hemodynamic stability before incision. Additionally, during sternotomy (1 to 5 minutes), MAP values were consistently higher in the Fentanyl group, and these differences were statistically significant at 1 minute (98.1 vs. 95.3 mmHg, p=0.025), 2 minutes (100.1 vs. 96.9 mmHg, p=0.011), 3 minutes (100.9 vs. 98.0 mmHg, p=0.026), 4 minutes (101.2 vs. 97.8 mmHg, p=0.016), and 5 minutes (101.6 vs. 98.0 mmHg, p=0.006). These findings suggest that Paracetamol Magnesium provided a more controlled and attenuated MAP response during the critical surgical period (Table 3).

Table 3. Comparison of Mean arterial pressure between group Fentanyl and Paracetamol magnesium

Mean arterial pressure	Groups	Mean	SD	T test	p-value
MAP before induction	Fentanyl	95.1	9.17	0.443	0.660
	Paracetamol Magnesium	94.4	7.25		
MAP after induction	Fentanyl	101.8	9.23	0.685	0.497
	Paracetamol Magnesium	100.7	6.64		
MAP before skin incision	Fentanyl	87.4	7.02	-5.953	< .001
	Paracetamol Magnesium	95.1	5.57		
MAP after skin incision	Fentanyl	92.2	6.98	0.442	0.661
	Paracetamol Magnesium	91.8	4.36		
MAP during sternotomy	Fentanyl	95.2	8.04	1.215	0.231
	Paracetamol Magnesium	93.8	4.52		
MAP after 1 minute of sternotomy	Fentanyl	98.1	7.06	2.317	0.025
	Paracetamol Magnesium	95.3	4.50		
MAP after 2 minutes of sternotomy	Fentanyl	100.1	6.59	2.663	0.011
	Paracetamol Magnesium	96.9	4.76		
MAP after 3 minutes of sternotomy	Fentanyl	100.9	6.61	2.309	0.026
	Paracetamol Magnesium	98.0	5.14		
MAP after 4 minutes of sternotomy	Fentanyl	101.2	6.70	2.502	0.016
	Paracetamol Magnesium	97.8	5.14		
MAP after 5 minutes of sternotomy	Fentanyl	101.6	6.90	2.901	0.006
	Paracetamol Magnesium	98.0	4.92		

Heart rate (HR) was consistently lower in the Fentanyl group compared to the Paracetamol Magnesium group before induction (77.6 vs. 81.9 bpm), after induction (88.8 vs. 92.1 bpm), and prior to skin incision (71.2 vs. 74.1 bpm). Although p-values are missing or misprinted, the differences appear notable. Following skin incision and during sternotomy, HRs between both groups were relatively similar, with minor fluctuations and statistically insignificant differences. This suggests that both analgesic regimens maintained comparable heart rate control during surgical stimulation, with possibly a slightly attenuated response in the Fentanyl group preoperatively (Table 4).

Table 4. Comparison of Heart rate between group Fentanyl and group Paracetamol magnesium

Heart rate	Groups	Mean	SD	T test	p-value
HR before induction	Fentanyl	77.6	12.54	-4.333	2.63
	Paracetamol Magnesium	81.9	10.40		
HR after induction	Fentanyl	88.8	13.90	-3.244	2.76
	Paracetamol Magnesium	92.1	12.31		
HR before skin incision	Fentanyl	71.2	9.95	-2.933	1.99
	Paracetamol Magnesium	74.1	9.46		
HR after skin incision	Fentanyl	80.9	10.22	-1.23	0.298
	Paracetamol Magnesium	83.3	9.27		
HR during sternotomy	Fentanyl	82.3	9.18	-1.067	1.88
	Paracetamol Magnesium	83.3	10.24		
HR after 1 minute of sternotomy	Fentanyl	86.4	9.86	-0.289	1.88
	Paracetamol Magnesium	86.6	10.30		
HR after 2 minutes of sternotomy	Fentanyl	88.0	9.42	0.467	1.82
	Paracetamol Magnesium	87.5	10.44		
HR after 3 minutes of sternotomy	Fentanyl	89.1	10.07	1.578	1.77
	Paracetamol Magnesium	87.5	11.47		
HR after 4 minutes of sternotomy	Fentanyl	89.7	10.99	1.667	1.88
	Paracetamol Magnesium	88.1	11.33		
HR after 5 minutes of sternotomy	Fentanyl	89.6	9.10	1.622	1.58
	Paracetamol Magnesium	88.0	9.24		

Visual Analog Scale (VAS) pain scores at various intervals after extubation showed differing pain perceptions between the groups. At 6 hours, more patients in the Paracetamol Magnesium group reported mild pain scores (VAS 3 in 55.6% vs. 33.3% in Fentanyl group), and fewer experienced higher scores. At 12 hours, VAS scores favored the Paracetamol Magnesium group, with 20% reporting minimal pain (VAS 1) compared to 6.7% in the Fentanyl group. By 18 and 24 hours, pain relief in the Paracetamol Magnesium group appeared better sustained, with 80% reporting a VAS score of 1 at 24 hours, compared to only 24.4% in the Fentanyl group. These trends suggest better overall postoperative analgesia in the Paracetamol Magnesium group, though p-values remained statistically non-significant (Table 5).

Table 5. VAS score between group Fentanyl and group Paracetamol Magnesium

	Fentanyl			Paracetamol Magnesium		
VAS score		No	%	No	%	p-value
6 hrs after extubation	1	3	6.7	1	2.2	0.577
	2	4	8.9	4	8.9	
	3	15	33.3	25	55.6	
	4	14	31.3	11	24.4	
	5	7	15.6	3	6.7	
	6	2	4.4	1	2.2	
12 hrs after extubation	1	3	6.7	9	20	0.765
	2	7	15.6	15	33.3	
	3	29	64.4	19	42.2	
	4	6	13.3	2	4.4	
18 hrs after extubation	1	6	13.3	20	44.4	0.438
	2	25	55.6	18	40	
	3	14	31.3	7	15.6	
24 hrs after extubation	1	11	24.4	36	80	0.988
	2	31	68.9	5	11	
	3	3	6.6	4	8.9	

The time of first breakthrough pain occurrence was longer in the Fentanyl group (29.1 ± 38.2 minutes) compared to the Paracetamol Magnesium group (18.1 ± 23.9 minutes), though this difference was not statistically significant (p=0.105). The total morphine requirement in the first 24 hours post-extubation was nearly identical between both groups (8.03 mg vs. 7.94 mg; p=0.904), indicating that both analgesic strategies provided comparable opioid-sparing effects. The time taken for extubation was slightly shorter in the Paracetamol Magnesium group (3.44 ± 1.69 hours) compared to the Fentanyl group (4.01 ± 1.58 hours), though again, this difference was not significant (p=0.332). Overall, both groups demonstrated similar outcomes in terms of postoperative pain management and recovery timelines (Table 6).

Table 6. Postoperative Recovery Parameters Between the Groups

Parameters	Fentanyl		Paracetamol Magnesium		T test	P value
	M	SD	M	SD		
Time of first breakthrough pain occurrence	29.1	38.2	18.1	23.9	1.638	0.105
Total dose of morphine required in first 24 hours post extubation	8.03	3.54	7.94	3.52	0.121	0.904
Time taken for extubation	4.01	1.58	3.44	1.69	0.585	0.332

Discussion

This study was conducted to evaluate the effectiveness of a paracetamol-magnesium sulfate combination as an alternative to fentanyl in attenuating the hemodynamic response during cardiac surgery, and to assess their comparative analgesic efficacy in the postoperative period. Both groups were comparable in terms of demographic and baseline characteristics such as age, gender distribution, and ASA grading, ensuring a homogenous population for comparison.

The hemodynamic response to sternotomy is a well-established marker of intraoperative stress and sympathetic activation. In this study, from the 4th and 5th minute after sternotomy, group A exhibited significantly higher SBP compared to group B. The combination provides a better attenuation of the surgical stress response during this crucial period [1].

Similarly, diastolic blood pressure (DBP) and mean arterial pressure (MAP) were significantly lower in the group B after the first minute post-sternotomy, which indicates a consistent sympatholytic effect. The stable and lower DBP and MAP in the paracetamol-magnesium group imply that the combination could blunt the hyperdynamic response better than fentanyl alone [2,3]. It supports the hypothesis that the combination of paracetamol and magnesium sulfate—both having central and peripheral mechanisms—could provide a synergistic effect in reducing the nociceptive and hemodynamic responses towards the surgical stimuli [4].

Magnesium sulfate blocks catecholamine release and inhibits calcium influx at the neuronal level thereby contributing to cardiovascular stability during surgical stress [7]. Its role as an NMDA receptor antagonist has also been linked to prolonged analgesia and decreased postoperative pain [8]. Paracetamol, while acting primarily through central COX inhibition, also modulates descending serotonergic pathways, further aiding in pain modulation without significant sedation or cardiovascular effects [9].

In contrast, fentanyl—though effective in blunting acute responses—has well-known adverse effects such as respiratory depression, ileus, and potential for delayed extubation, particularly in cardiac patients. Therefore, opioid-sparing strategies are highly sought after in fast-track cardiac anesthesia protocols [5,10].

The heart rate (HR), although numerically lower in the Fentanyl group before and after induction, did not differ significantly at most points, including after

sternotomy. This observation reinforces that both groups maintained satisfactory chronotropic control during the perioperative period, but the trend towards stable hemodynamics in the paracetamol-magnesium group remained notable [5].

Postoperative analgesia, assessed using VAS scores, showed a clear trend of improved outcomes in the Paracetamol-Magnesium group. At 6, 12, 18, and especially at 24 hours post-extubation, a greater proportion of patients in this group reported lower pain scores compared to those who received fentanyl. Notably, 80% of patients in the Paracetamol-Magnesium group had a VAS score of 1 at 24 hours, compared to only 24.4% in the Fentanyl group [6]. These results are in line with earlier reports that magnesium reduces postoperative opioid consumption and prolongs the time to first analgesic requirement [6,8].

The time to first breakthrough pain was longer in the Fentanyl group, although not statistically significant. However, the total morphine requirement in the first 24 hours post-extubation was nearly equal in both groups, suggesting that the initial analgesic regimen—whether fentanyl or paracetamol-magnesium—had comparable overall opioid-sparing effects. Interestingly, the extubation time was shorter in the Paracetamol-Magnesium group, albeit not significantly. This trend may be clinically relevant, particularly in fast-track cardiac anesthesia where early extubation is a key objective [6,11].

These findings highlight the potential utility of a paracetamol-magnesium regimen as an effective alternative to opioids like fentanyl, especially in contexts where opioid minimization is desirable. The improvement in hemodynamic stability and pain without the need for prolongation of extubation provides a compelling advantages for this combination therapy. Also considering the adverse effects and dependency concerns associated with the use of opioids, the use of such multimodal strategies may be recommended [6,10,12].

Conclusion

The present study clearly shows the paracetamol and magnesium sulfate combination as an effective alternative to fentanyl in attenuating the hemodynamic response during cardiac surgery, particularly during sternotomy. Participants on paracetamol-magnesium combination therapy exhibited a significantly more stable systolic, diastolic, and mean arterial pressures without any comprise in heart rate control. The Postoperative pain control was also better in this group with less need for orphine.

The use of paracetamol-magnesium did not delay the extubation, thereby confirming its suitability for use in fast-track cardiac anesthesia protocols. These findings support the growing role of opioid-sparing, multimodal analgesic strategies in modern cardiac surgical practice. Further large-scale multicenter studies are warranted to confirm these findings and explore long-term outcomes such as recovery profiles, ICU stay duration, and patient satisfaction.

Statements and Declarations

Conflicts of interest

The authors declare that they do not have conflict of interest.

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ORIGINAL ARTICLE

Assessment of Awareness of Cervical Cancer Among Adult Women Attending OPD in a Tertiary Care Hospital in Krishnagiri, Tamil Nadu: A Cross-Sectional Study

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Abstract

Background: Across the country, cervical cancer continues to affect a large number of women both by morbidity and mortality. Despite availability of effective screening methods, only 9.8% of women of 30 to 49 years underwent cancer screening, indicating poor compliance. Assessing awareness helps in designing targeted measures to boost screening participation and decrease the burden. **Objectives:** Among adult women attending a tertiary care hospital OPD, Assessing awareness and its determinants about cervical cancer and its screening is our objective. **Methodology:** This hospital-based cross-sectional study was conducted among 400 women attending the OPD of a tertiary care hospital during June–July 2023, selected through systematic random sampling. Data were collected using a validated, semi-structured, interviewer-administered questionnaire. Continuous variables were expressed as mean and standard deviation, while categorical variables were presented as percentages. Associations between variables were analyzed using chi-square statistics. **Results:** 42.3±12.5 years was the Mean age of the study participants. 48% (192) reported that they are aware of cancer cervix. Awareness was significantly lower among illiterate, casual laborers and housewives. Of 129 who reported as aware about the screening facilities, only 57 (44.2%) had undergone screening. 12 (6.25%) were vaccinated against HPV. The mean knowledge score was dismally poor. Only 3 scored in the moderate range while none had good knowledge. **Conclusion:** The study revealed alarmingly low awareness levels and knowledge scores about cancer cervix among the study participants, underscoring the urgent need for implementing comprehensive awareness campaigns for effective control and prevention.

Keywords: Cancer cervix prevention, Knowledge and awareness, Screening, HPV

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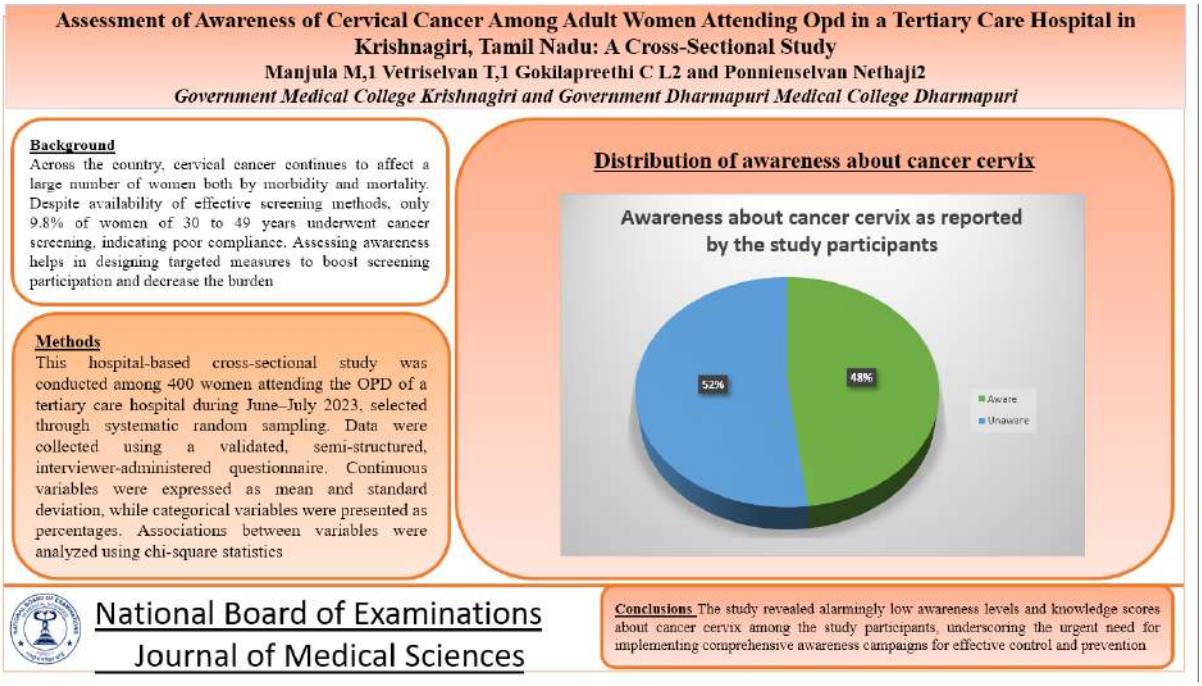
Graphical Abstract



Introduction

According to the World Health Organization (WHO), cervical cancer accounts for 12% of all cancers in women and represents one of the most common gynaecological malignancy globally [1]. Globally, cervical cancer is the fourth most common cancer among women, with about 604,000 new cases and 342,000 deaths reported in 2020. Most of this burden falls on low- and middle-income countries, where limited access to screening, treatment, HPV vaccination, and broader socioeconomic factors contribute to the higher incidence and mortality. Timely screening and treatment of pre-cancerous lesions, coupled with Prophylactic HPV vaccination constitutes effective and cost-efficient measures for preventing cervical cancer. Notably, early diagnosis and prompt treatment offer a cure for cervical cancer. By adopting a thorough strategy encompassing prevention, screening, and treatment, it is possible to win over cancer cervix as a public health concern within a single generation [2].

India is home to one-fifth of the global female population afflicted by this ailment [3]. Unfortunately, over three-fourths of these individuals receive diagnoses at advanced stages, significantly diminishing the likelihood of long-term survival and recovery [4]. Based on a Crude Incidence Rate of 23.5, it is currently estimated that 134,420 women are diagnosed with cancer cervix in India annually. Projections suggest that, the number of new cancer cervix cases could rise to 203,757 by 2025 [5].

The Tamil Nadu Cancer Registry (TNCR) ranks cancer cervix as the second most common cancer among women, constituting 16.1% of all female cancer cases. The age-adjusted incidence rate of cancer cervix in Tamil Nadu is documented at 14.1 per 1,00,000 women. TNCR findings reveal that the mortality rate attributed to cervical cancer in Tamil Nadu stands at 5.3 per 100,000 women [6].

Background and Justification

Pap smear testing is one of the simple, yet effective screening method to detect cancer cervix at an early stage, reducing mortality by at least 80%. However, in India, Pap smear testing utilization is low, ranging from only 2.6% to 6.9% [7].

Despite the availability of free cancer screening through the initiative named "Makkalai Thedi Maruthuvam (MTM)" in Tamil Nadu, the recent National Family Health Survey (NFHS-5) reports only 9.8% of women of 30-49 years in the state have reported undergoing screening for cervical cancer [8], which highlights a significant gap in preventive healthcare utilization.

While early detection and vaccination can either prevent or combat the morbidity and mortality caused by this malignancy, the low utilization of screening facilities may be linked to the insufficient awareness regarding the risk factors, symptoms, and screening methods among women in India, highlighting the knowledge gap as stated in previous studies done in different territories [7].

Therefore, conducting an awareness study in our setting is important to identify those gaps in knowledge and attitudes towards cancer cervix screening and prevention, so as to develop targeted interventions to upscale awareness levels and increase screening uptake.

Objectives

To assess the awareness and its determinants about cervical cancer and its screening methods among adult women attending OPD in a tertiary care centre.

Review of Literature

A study among women in rural Chennai reported around 66.8% (197 out of 295) lacked awareness regarding cervical cancer. Of the remaining participants, 27.6% (27 out of 98) demonstrated a good level of knowledge, while 72.4% (71 out of 98) exhibited insufficient knowledge concerning cervical cancer [9].

A district-level analysis of screening for cancer breast and cancer cervix in India highlighted the common factors linked to participation in screening both cancers, including women from a general caste, residing in rural areas, being presently married, and having a relatively favorable economic status. Possessing insurance was specifically correlated with an increased likelihood of undergoing cancer screening. This research contributes to spatial insights by revealing the regional disparities in cancer screening rates across different districts in India [10].

A web-based cross-sectional survey among educated women in Tamil Nadu, revealed that over 50% of individuals, including those with higher educational backgrounds, lacked awareness regarding infection of HPV, cancer cervix, and vaccines for HPV [11].

A study among 100 professional female college students revealed that the majority of participants were not familiar with cancer cervix, PAP smear screening, and HPV vaccines [12].

Thus, multiple research works highlight a significant gap in awareness levels among the stakeholders regarding screening and prevention of cancer cervix. The potential tragedy of deaths from cancer cervix, a slow-developing and treatable condition preventable through screening, underscores the importance of addressing negative attitudes and knowledge gaps at an

early stage, well before women reach the ages appropriate for cancer screening and HPV vaccination [12].

Subjects and Methods

This Cross-sectional study, a hospital-based work was done among adult women attending out-patient department in a tertiary care centre (GMCHK) with inclusion criteria as married (at least once) women attending OPD, giving consent for the study. Women who were not comfortable with the local language and those who were in the process of medical consultations or had other medical commitments were excluded from the study. Assuming 50% maximum variability, 5% alpha error, and 5% absolute precision, Sample size is estimated using the formula, $N = Z_{\alpha}^2 \times pq / d^2$. With Z value for α at 0.05=1.96, Considering a 5% non-response rate, sample size was arrived as 400. The average number of female outpatients in a tertiary care hospital per day is 977. Considering the female OPD attendance per day as the sampling frame, by systematic random sampling method, every 50th woman was selected and If she doesn't fit as per inclusion criteria, consecutive women satisfying the criteria were included and proceeded further with 50 as the sampling interval. The study was continued in the same pattern till the required sample size was achieved.

Data collection was done with a Interviewer administered, Semi-structured Questionnaire derived from a KAP questionnaire used in a hospital-based survey in south India [13], using Epicollect5 tool. The collected data were compiled in MS Excel and analyzed using SPSS version 16. Descriptive statistics were applied, with continuous variables presented as mean ± standard deviation and categorical variables expressed as percentages. For inferential statistics, associations between categorical variables were assessed using the chi-square test.

Results

Socio-demographic profile

The mean age of 400 study participants was 42.3±12.5 years. The majority of them (70.8%) were in the age group of 30-60. About three-fourths had education levels up to high school. Over half (53.5%) were unemployed or housewives, while one-fifth were casual laborers. 57.5% belonged to urban areas and almost half (49.3%) were in the middle and lower middle socioeconomic classes as per Modified B.G. Prasad classification [14]. Socio-demographic details of the study participants are depicted in Table 1.

Table 1. Socio-demographic details of the study participants (n=400)

Socio-demographic variable	Category	Frequency (n)	Percentage (%)
Age	**<30 years**	88	22.0
	30-60 years	283	70.8
	>60 years	29	7.3
Educational status	**Illiterate**	117	29.3
	Primary school	61	15.3

	Middle school	81	20.3
	High school	74	18.5
	Diploma	28	7.0
	Graduate	38	9.5
	Professional	1	.3
Occupation	**Unemployed / Housewife / Retired**	214	53.5
	Casual laborer/Daily wage worker	83	20.8
	Self-employed (Business/Agriculture)	62	15.5
	Salaried	41	10.3
Residence	**Rural**	170	42.5
	Urban	230	57.5
SES as per Modified B.G.Prasad classification	**Class 1**	59	14.8
	Class 2	79	19.8
	Class 3	88	22.0
	Class 4	109	27.3
	Class 5	65	16.3

Risk profile

The mean age at menarche, marriage, birth of 1st child, and menopause among the eligible participants was 13.7 ±1.4 years, 19.1 ±3.3 years, 20.8 ±3.6 years, and 46.3 ±4.8 years. 37.1% (148) were multiparous, 6% (24) and 3.8% (15) of the study participants reported having long-term use of OCPs and family history of cervical cancer respectively (Table 2).

Table 2. Association between Socio-demographic variables and awareness about cancer cervix among the study participants (n=400)

Variable		**Aware about cancer cervix (n=400)**		**p-Value**
		Yes	**No**	
Age category	**<30 Years**	43	45	0.16
	30-60 years	140	143	
	>60 years	9	20	
	Illiterate	36	81	**0.0001***
	Upto schooling	109	107	

Education	**>schooling**	47	20	
Occupation	**Unemployed / Housewife / Retired**	77	137	**0.0001***
	Casual laborer /Daily wage worker	33	50	
	Self-employed (Business/Agriculture)	48	14	
	Salaried	34	7	
Residence	**Rural**	87	83	0.27
	Urban	105	125	
SES as per Modified BG prasad classification	**Class I**	33	26	
	Class II	48	31	
	Class III	34	54	**0.004***
	Class IV	55	54	
	Class V	22	43	
Age at Menarche	**<13 years**	98	112	0.57
	>13 years	94	96	
Age at Marriage	**<18 years**	89	116	0.06
	>18 years	103	92	
Parity	**Nulliparity**	6	7	
	≤ 2	132	107	0.002
	>2	54	94	
Age at Menopause (n=142)	**< 45 years**	24	41	
	45-50 years	20	32	0.62
	>50 years	12	13	
Long-term use of OCP	**Yes**	12	12	0.84
	No	180	196	
Family H/o Ca cervix	**Yes**	14	1	**0.0001***
	No	178	207	

*p<0.05-statistical significance

Awareness about cancer cervix

Overall 192 (48%) study participants reported that they are aware of cancer cervix. Among the women who reported as aware, undue vaginal bleeding (46.4%) and foul-smelling discharge (28.3%) were regarded as the symptoms they are aware of cancer cervix. Multiple sexual partners (31.2%) and prolonged use of OCP (19.1%) were perceived as risk factors for cervical cancer among the study participants who were aware of cancer cervix. Most of them were aware of the availability of surgical treatment modality (40%) followed by chemotherapy (36.1%) and radiotherapy (23.9%) Figures 1, 2 and 3 depict the distribution of awareness of cancer cervix among the study participants, symptoms and risk factors that they were aware of, respectively.

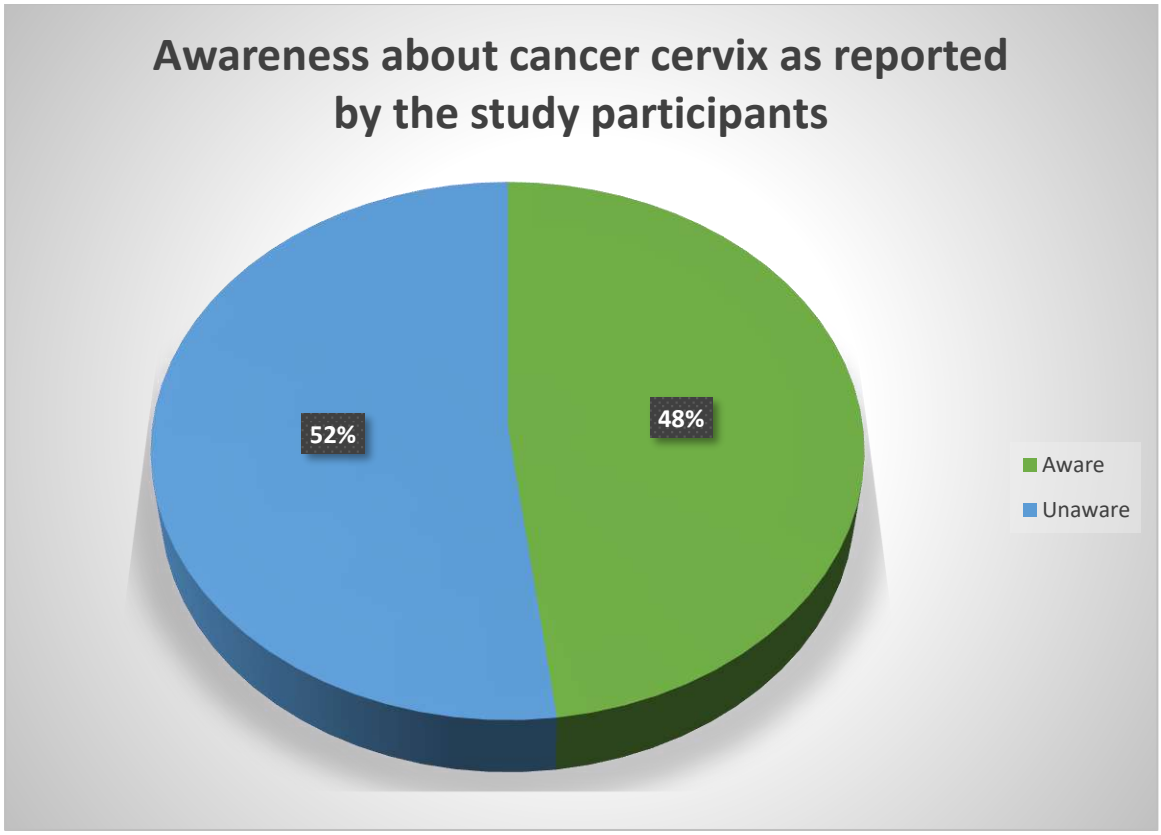


Figure 1. Distribution of awareness about cancer cervix (n=400)

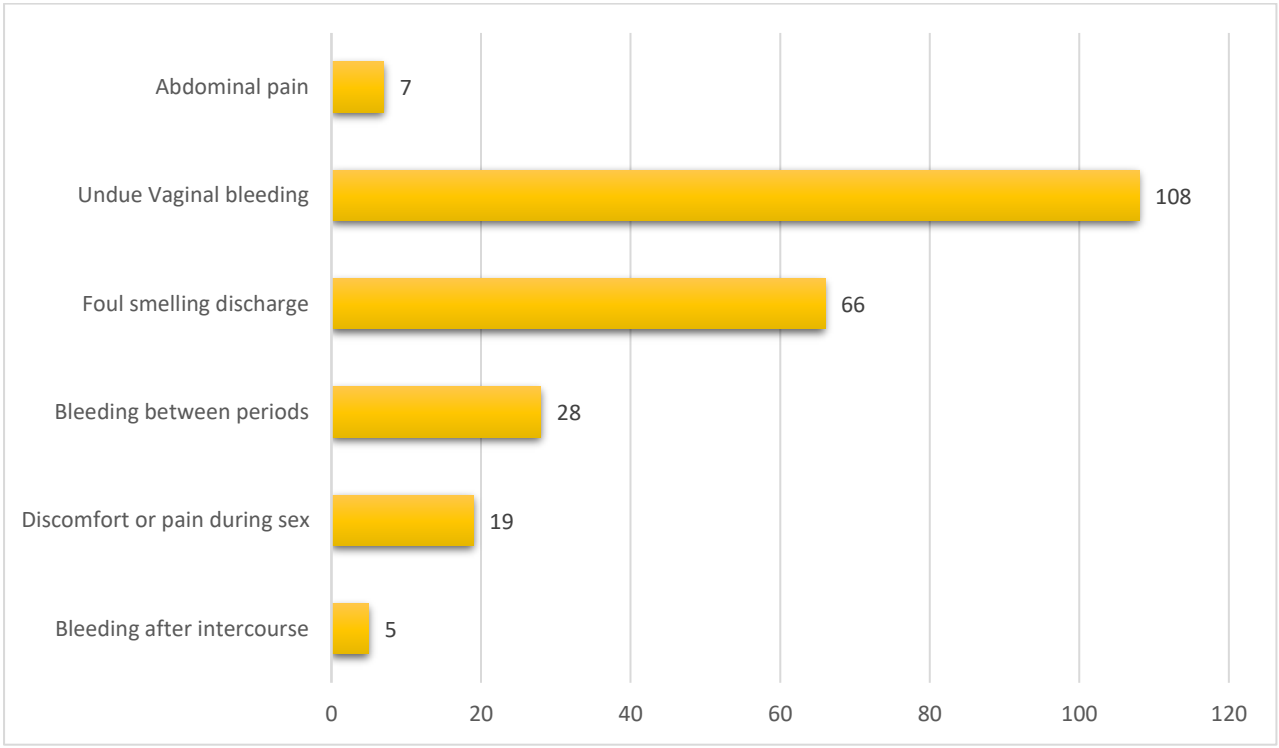


Figure 2. Symptoms recognized by study participants as being associated with cancer cervix

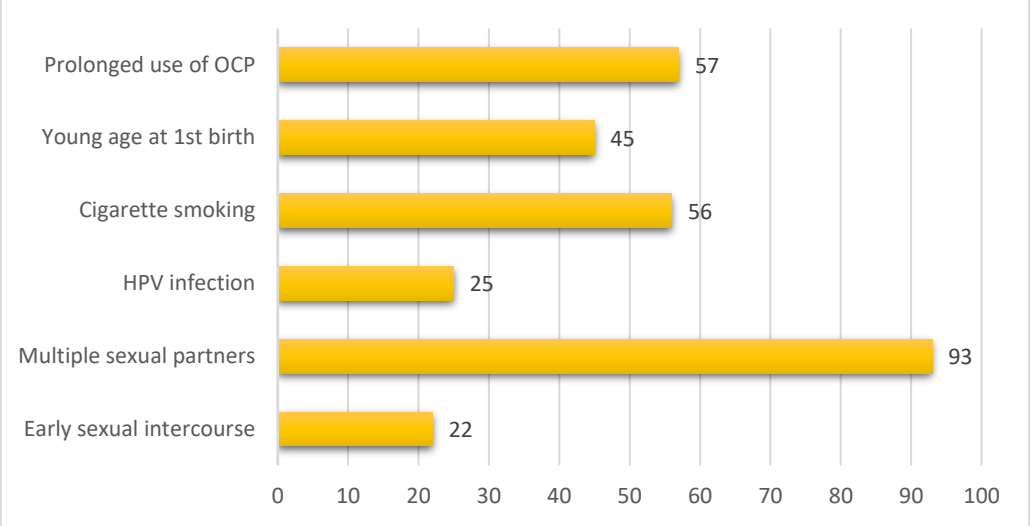


Figure 3. Risk factors identified by the study participants as being associated with cervical cancer

Awareness was significantly lower among illiterate women compared to those with schooling and above ($p<0.001$). It was also lower among casual laborers and unemployed housewives compared to self-employed and salaried women ($p<0.001$).

Among aware women, the most common source of information about cervical cancer were friends / relatives (38%), followed by health workers (34.6%). Two-thirds (67.2%) knew about availability of screening tests for cervical cancer. This knowledge was significantly higher among younger women and unemployed housewives ($p<0.05$). The majority (80.6%) were aware that the screening test is available free of cost in government hospitals. Figure 4 shows the distribution of sources of information among those who reported as aware of the cervical cancer.

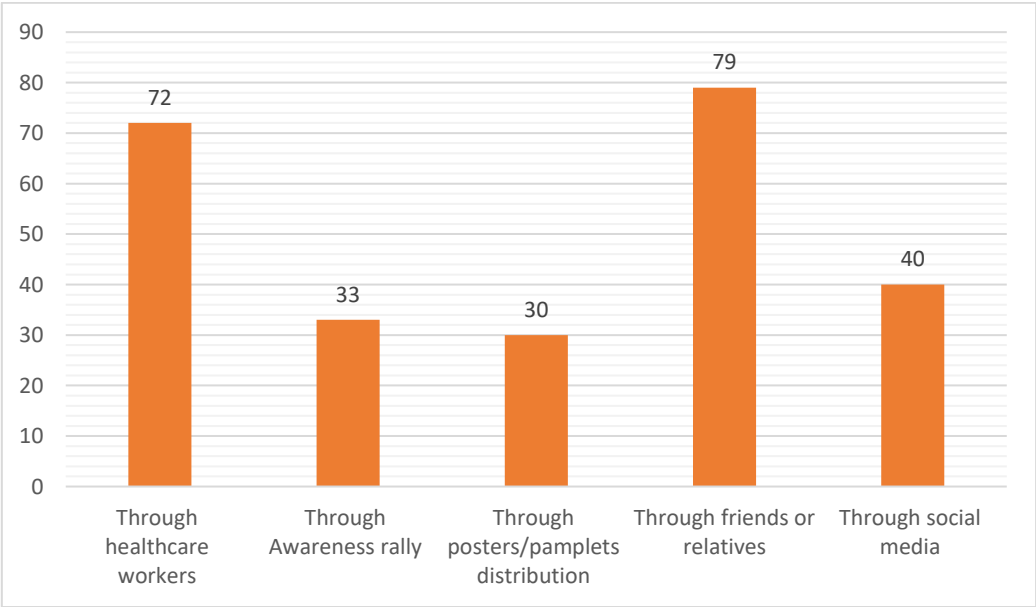


Figure 4. Sources of information reported by participants who were aware of cervical cancer

Screening practices

Out of 129 women who reported as aware about the availability of screening facilities for cancer cervix, only 57 (44.2%) had undergone cervical cancer screening. Screening was significantly lower among women aged below 30 years (despite around 40% of them had education levels beyond schooling) and those with higher parity ($p<0.05$). It was higher among illiterate women and casual laborers compared to literate and working women, respectively. Over half had undergone screening in government hospitals (52.6%) while around one-third (35%) were in private facilities and the rest of them (12.3%) had it done in special camps.

HPV Vaccination

Only 12 women (6.25%) were vaccinated against HPV. Vaccine uptake was marginally higher in younger women and nulliparous women.

Knowledge about cervical cancer

A composite score was used to assess the participants' overall knowledge about cervical cancer, with scores >16 classified as good knowledge, scores between 12–15 as moderate knowledge, and scores <12 as poor knowledge. The mean knowledge score was as low as 2.9 among all the study participants (n=400). The mean score was not too high (5.9±2.6) among those who have reported being aware of cancer cervix (n=192). Only 3 women scored in the moderate range while none had good knowledge. Knowledge was marginally better among salaried women compared to unemployed and laborers. Figure 5 shows the knowledge scores of the study participants about the cervical cancer.

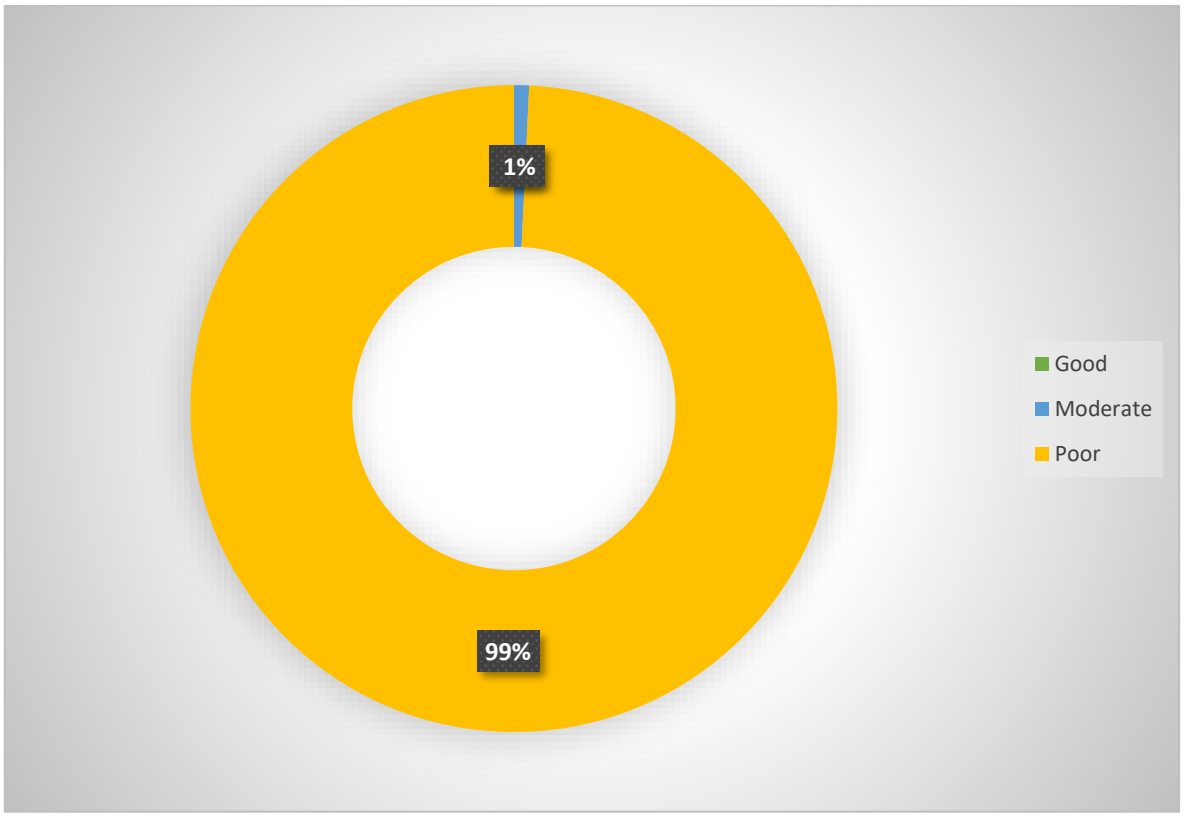


Figure 5: Overall knowledge levels of the study participants regarding cervical cancer

Discussion

In our study, most participants were aged between 30–60 years (70.8%), with a mean age of 42.3 ± 12.5 years. This is relatively higher compared to similar studies by Tamilarasi et al. [9] (a field-based study) and Narayana et al. [13], (hospital-based) where the mean ages were 32.9 and 34.8 years, respectively. The socio-demographic characteristics (education, occupation, and socioeconomic status) of our participants were comparable to those reported by Bansal et al. [15] in their study among women of reproductive age attending the OPD at AIIMS, Bhopal.

16.3% of the participants reported to have long-term use of OCP in a cross-sectional survey among women attending a tertiary care centre in Puducherry by Siddharthar et al. [16], which is as low as 6% in our study which might be attributed to the variance in the age group of the study participants.

48% of our participants were aware of cancer cervix, which is comparable with the results generated by similar hospital-based studies [16,17]. Regarding symptoms of cervical cancer among those who reported as aware, most regarded undue vaginal bleeding (41.2%) and foul-smelling discharge (28.3%) as symptoms of cancer cervix, which adds to the evidence generated by Narayana et al., where 48.3% and 27.8% regarded undue vaginal bleeding and foul smelling discharge respectively, as symptoms of cervical cancer [13]. The most common source for information was friends/relatives (38%) in our study whereas it was reported as media/ internet sources in a few other similar research works [13]. Education and occupation of the study participants were statistical determinants in awareness about cancer cervix in our study which echoes the findings by Singh et al. [17], and Bansal et al. [15].

14.25% of study participants had underwent screening for cervical cancer which is comparable with the results of Bansal et al. [15], but quite lower when compared to the results of Siddharthar et al. [16], where around 30% of our study participants had underwent screening for cervical cancer, and better than the 5.4% as evidenced by Narayana et al. [13], and 6.9% as evidenced by Aswathy et al. [7]. It is also quiet higher than the national average of 1.9% and state average of 9.8% [8]. Age, parity and literacy levels were the determinants for uptake of screening for cancer cervix in our study which is in support of the works by Aswathy et al. [7], Sankaranarayanan et al. [18], and Nene et al. [19]. The higher screening among illiterate, multi-para, and older women could possibly be provider-initiated owing to their higher risk status. The lower screening uptake among literate and working women as supported by findings of an online survey across multiple states in India by Agarwal et al. [20], highlights the need for targeted and tailored health education and motivation for promoting screening in this group.

6.25% (12) of the study participants reported to have received the HPV vaccine earlier, which is quite higher than expected in a setup with a rural backdrop and socio-demographical challenges, especially when HPV is not still a part of routine immunization programs. Lack of awareness about the vaccine availability and its role in cancer prevention appears to be the bottleneck to improved uptake of the HPV vaccine [21].

The overall levels of knowledge on cervical cancer, its symptoms, risk factors, screening modalities, and treatment options

available was sub-optimal among our study participants which is similar to the results generated by Thulaseedharan et al. [22], in their systematic review and way too less than the literature of similar kind [15], which signifies the need to work on the awareness generating campaigns to a larger scale. The findings of this study align with those of Adedemiji et al., who reported that micro-level factors—such as limited knowledge and awareness about cervical cancer and inadequate access to information—act as significant barriers for women in utilizing cervical cancer screening services [23].

Cervical cancer despite being the primary cancer affecting women, this research highlights the knowledge and awareness gap about its symptoms, risk factors, and screening facilities. This presses the need for widespread health education activities specifically targeting the stakeholders to enhance their awareness and underscore the significance of periodical screening as the guarding tool to prevent cancer cervix.

Conclusion

The findings signify the demanding necessity for comprehensive strategic communication and awareness campaigns specifically targeted towards women. Cervical cancer, although preventable, continues to remain a significant threat to public health globally. Increasing awareness and knowledge about this condition, its symptoms, risk factors, prevention strategies, and the role of regular screening is paramount. By enhancing understanding and promoting early detection through regular screening, timely interventions can be implemented, potentially saving countless lives and limiting the overall burden of cancer cervix.

While knowledge is a crucial component, addressing the barriers that hamper access to cancer screening services is equally vital. Disparities in socioeconomic status, geographical limitations, and cultural beliefs can all contribute to the restricted access to these life-saving services. In addition to improving access, it is essential to address the cultural and social stigma surrounding cancer cervix and its associated risk factors. Cultural beliefs, misconceptions, and taboos often hinder open discussions and seeking preventive care. Engaging community leaders, religious figures, and influential personalities in awareness campaigns can help normalize conversations about cancer cervix and encourage women to prioritize their health. Furthermore, enhancing education and training for healthcare professionals can ensure that they are equipped to provide reliable information, dissipate myths, and offer compassionate and culturally sensitive care to women seeking screening and treatment for cancer cervix.

Limitation

As a cross-sectional study conducted among women from rural areas attending a tertiary care centre, the findings may not be representative of a specific population or generalizable to the community with multiple socio-demographic differences. The use of interviewer-administered questionnaires could have influenced the results, as some women may have provided socially desirable responses, particularly for close-ended questions.

As this was a quantitative study, it could not explore in depth the psycho-socio-cultural reasons for not undergoing screening. Conducting qualitative research

could provide deeper insights into the factors influencing those who have not opted for screening and help understand the perspectives of non-responders.

Author Contributions

MM: Contributed to the conceptualization and definition of the intellectual content of the manuscript; VT was responsible for the design of the study, data analysis, and statistical analysis, and contributed to the definition of intellectual content; GCL and PN played a key role in literature search, data acquisition, manuscript editing, and manuscript review. PN will serve as the corresponding author / guarantor of the manuscript

Conflicts of interest

The authors declare that they do not have conflict of interest.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to restrictions (their containing information that could compromise the privacy of research participants).

Ethical committee approval

This study has been approved by the Institution Ethics Committee - Government Medical College Krishnsgiri carrying EC Reg No (COSCO): EC/NEW/INST/2023/15250, with Approval number 22012024, dated 11.05.2023

Informed Consent

Informed consent has been obtained form the study participants after explaining the information on the study protocol, potential risks and benefits, which included consent to participate and publish the data ensuring confidentiality, anonymity and data privacy

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REVIEW ARTICLE

Artificial Intelligence in Scholarly Publishing: Enhancing Editorial Efficiency While Preserving Human Expertise

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Abstract

Use of artificial Intelligence (AI) is increasing significantly in scholarly publishing. It can potentially enhance editorial workflows and reduce the burden on reviewers. AI applications, like plagiarism detection, formatting checks, and reviewer assignment, can improve efficiency and transparency during initial manuscript processing stages. However, the peer review process extends beyond mere technical tasks. It encompasses critical evaluation that requires human expertise, contextual understanding, and ethical consideration. This review highlights the constraints of using AI in peer review while examining both present and future uses of AI in editorial activities. A fair framework has been created, and AI can assist with editorial tasks rather than replace human reviewers. Peer review's integrity, legitimacy, and constructive character depend on human judgment. This review also emphasises the mounting issues facing the traditional peer review system, such as rising submission numbers, reviewer exhaustion, and delays in decision-making. To ensure that scientific publishing upholds its exacting standards, this narrative emphasises the importance of keeping human evaluation at the centre of the review process by addressing both advantages and disadvantages of integrating AI.

Keywords: Artificial Intelligence; Peer Review; Editorial Policies; Scholarly Journals; Research Integrity; Scientific Misconduct

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Key Highlights

- AI has the potential to streamline editorial workflows
- Requires human expertise, contextual understanding, and ethical discernment.
- A balanced framework in which AI supports editorial processes without replacing human intervention

Introduction

Peer review is essential to scientific publishing, ensuring that research disseminated to the academic community is accurate and meaningful [1]. Despite its importance, the editorial and publishing system faces several challenges of growing submission volumes, reviewer fatigue, delays in decision-making, and concerns over inconsistency and bias [2]. These challenges have prompted discussion of their technological solutions, including Artificial Intelligence (AI), to improve the efficiency and reliability of academic publishing.

AI has already been used in a few related publishing domains, such as plagiarism detection, grammar checking, and image integrity screening [3]. A more ambitious application involves using AI-generated peer review reports, which is still under discussion [4]. While these uses of AI in the peer review process may offer short-term gains, in the near future, they will complicate questions about the role of human judgment in evaluating scientific knowledge [5].

This review synthesises evidence on opportunities and limitations of AI in peer review, arguing for a clear boundary, stating that "AI can support editorial efficiency, but critical appraisal must remain human-led."

Opportunities for Editorial Efficiency

Increased submission volumes and ongoing peer review process delays put pressure on scientific publishing to operate smoothly. These difficulties draw attention to areas where editorial operations can be improved. Across fields, the time to first decision varies significantly. Typical public health and medicine duration is roughly 8–9 weeks, while the average duration in non-medical specialties is approximately 16–18 weeks [6]. When several rounds of revision are considered, the review process can take up to 12–14 weeks in the medical sciences and frequently more than 25 weeks in non-medical professions [7]. Such extended timescales can irritate authors and delay the spread of knowledge.

Desk rejection is a common gatekeeping technique editorial offices use to control the reviewers' workload. Desk rejection rates in a select few journals range from 30% to over 50%, with an average of 40% [8]. Depending on journal scope and editorial criteria, reported desk rejection rates vary significantly across fields, ranging from as low as 7% to as high as 88% [8].

Some publications have adopted effective screening procedures despite these delays. For instance, one medical journal in the psychiatry specialty had a median desk rejection time of three days, meaning that more than half of submissions were either desk-rejected or progressed to peer review within the first week [9]. This shows that prompt early decisions can be made, saving reviewer capacity and reducing needless waiting times for authors.

When taken as a whole, these statistics highlight obstacles and chances to increase editorial productivity. Journals can improve author experience overall, reduce

delays, and better utilise reviewer resources by integrating innovations like AI-assisted triage with strong early screening procedures. The opportunities to enhance scientific scholarship can be further discussed under headings (Table 1).

Table 1. Opportunities for AI in Editorial Efficiency

Editorial Task	Current Challenge	AI Application	Potential Impact	Status
Plagiarism detection	Time-consuming manual checks	Similarity check software (iThenticate, Turnitin)	Faster detection, reduced reviewer burden	Currently Implemented
Formatting and language editing	Inconsistent submissions, burden on reviewers	Grammarly, Writefull, automated formatting tools	Improved readability, consistency	Currently Implemented
Statistical validation	Misreported or inappropriate analyses	Automated stat checkers, algorithm-based flagging	Early error detection, fewer flawed reviews	Emerging Applications
Image/data integrity	Fabrication/manipulation is challenging to spot manually	AI image forensics, anomaly detection	Reduced misconduct, stronger reliability	Emerging Applications
Reviewer selection	Time-intensive search, mismatch of expertise	AI reviewer matching algorithms (Publons, Expert Finder)	More efficient, expertise-aligned assignment	Currently Implemented

Plagiarism Detection

AI-based similarity detection tools such as iThenticate and Turnitin have become standard in many journals [10]. These tools rapidly flag overlapping text, duplicate publications, and suspected self-plagiarism, enabling editors to make informed decisions before sending manuscripts to review. This has significantly reduced the burden on reviewers, who otherwise would spend time identifying such issues.

Formatting and Language Editing

AI-driven writing assistants such as Grammarly and Writefull can identify grammar errors, awkward phrasing, and formatting inconsistencies. They are particularly valuable for authors writing in a second language and for journals that receive submissions with varied adherence to style guidelines. Automated pre-screening ensures that reviewers focus on content rather than superficial errors [11].

Statistical Validation

Emerging AI tools can evaluate whether statistical methods are appropriate for the data type, identify mismatches between reported results and figures, and detect common methodological flaws [12]. automated software can flag missing sample size justifications, inconsistencies between trial registration and reporting, or incorrect p-value interpretations. These applications reduce technical errors before peer reviewers engage with the manuscript.

Image and Data Integrity

AI algorithms are increasingly sophisticated at detecting image duplication, inappropriate manipulation, or statistical anomalies that may suggest fabrication [13]. Editorial offices' Early application of these tools strengthens the quality assurance process before manuscripts undergo critical evaluation.

Reviewer Selection

AI platforms such as Publons Reviewer Locator and Elsevier's Expert Finder analyse publication databases to recommend appropriate reviewers [14]. These tools can match reviewer expertise with manuscript content more efficiently than manual searches, reducing delays and minimising conflicts of interest.

AI tools can be trained to detect potential reviewer biases, such as an unusual number of self-citations or systematic preference for specific authors or institutions [15]. For example, algorithms may flag when a reviewer disproportionately recommends their work, but the final judgment about whether this constitutes undue bias still requires human editorial oversight.

Limits to Critical Appraisal

While AI excels at mechanical checks, several essential elements remain outside its scope (Table 2).

Table 2. Limits of AI in Critical Appraisal

Domain	Why AI Falls Short	Human Reviewer Contribution
Conceptual novelty	AI relies on past data, struggles with originality	Judges' innovation, context, relevance
Ethical oversight	Cannot interpret nuanced ethical considerations	Ensures compliance with patient/animal/research ethics
Bias handling	May reinforce existing publishing biases	Promotes diversity, fairness, and novel approaches
Constructive feedback	Cannot mentor or suggest nuanced improvements	Provides developmental and collegial feedback
Accountability	No ownership of evaluations or errors	Assumes responsibility, maintains transparency

Conceptual Novelty

AI systems are trained on past literature and patterns, but peer review often involves evaluating novelty, originality, and conceptual significance; dimensions that extend beyond pattern recognition [16]. Human reviewers assess whether a study advances knowledge, addresses a relevant gap, or challenges existing paradigms, something AI cannot reliably judge.

Ethical Oversight

Evaluating whether a study adheres to ethical norms, such as informed consent, animal welfare standards, or responsible data use, requires nuanced human interpretation [17]. AI cannot weigh cultural, contextual, or situational subtleties inherent in ethical judgments.

Bias Handling

AI reflects biases present in its training data [18]. If trained predominantly on established literature, AI tools may undervalue innovative or interdisciplinary research that deviates from conventional patterns [19]. This risks reinforcing conservative publishing practices and marginalising underrepresented voices or novel approaches.

Constructive Feedback

Peer review is not only evaluative but also developmental. Reviewers provide constructive feedback, suggest alternative methods, recommend additional literature, and mentor authors, particularly early-career researchers [20]. AI cannot replicate this collegial, dialogic role that fosters scientific growth.

Accountability

Peer reviewers assume responsibility for their judgments and can be held accountable by editors and authors [21]. AI-generated reviews lack ownership, raising questions about responsibility, liability, and trustworthiness. The opacity of many AI systems ("black-box" algorithms) further complicates accountability in scholarly communication [22].

Balancing AI and Human Roles

A balanced and practical approach positions AI as a supportive tool in the editorial pre-screening phase, rather than replacing human reviewers. Peer-review inefficiencies remain a persistent burden for both editors and reviewers. A significant fraction of submissions, approximately 21%, are desk-rejected before peer review, yet in many cases, these decisions take more than four weeks to be communicated, prolonging delays for authors [8]. Meanwhile, reviewers dedicate substantial time and effort, averaging 11.5 hours per manuscript. This amounts to an estimated 15 million hours annually spent on peer review, a considerable proportion of which is consumed by manuscripts ultimately rejected at later stages [23].

Recent analyses have highlighted that reviewers may demonstrate bias toward articles that cite their work, with approval rates significantly higher when self-citations are included. This reflects an inherent vulnerability of peer review where subjective incentives override objective appraisal, a dimension that current AI-assisted tools could flag for editorial oversight [15].

By delegating routine, automatable tasks to AI, such as checking for formatting inconsistencies, reference style errors, or plagiarism, human reviewers can focus their efforts where they matter most: the critical appraisal of scientific novelty, methodological rigour, ethical standards, and overall contribution to the field. One leading publisher has emphasised that plagiarism detection and related technical assessments are more appropriately considered "a role of editorial assessment, not a peer-review process." This highlights a natural boundary where AI can enhance efficiency while preserving the

irreplaceable role of human expertise in scientific judgment [24].

The most pragmatic use of AI in peer review is as a supportive, pre-screening tool within the editorial office rather than replacing human reviewers [25]. Just as plagiarism detection software has become standard practice in nearly all journals, AI can conduct additional technical checks before a manuscript is passed to reviewers. These checks may include formatting compliance, statistical screening, language and clarity checks, image integrity verification, and reviewer selection assistance.

By taking over these repetitive and administrative tasks, AI allows reviewers to focus their expertise on more profound questions: Does this study advance knowledge? Is the methodology rigorous and ethical? Do data support conclusions? This division of labour enhances efficiency, minimises reviewer fatigue, and shortens decision timelines without eroding the integrity of the peer review system.

Equally important, journals should maintain transparency about where and how AI has been used. Authors and reviewers should be informed if AI tools screened their manuscripts or contributed to workflow decisions. Such openness fosters trust in the editorial process and guards against misuse or overreliance on algorithms.

Future Directions

The integration of AI into peer review is still evolving, and future directions must focus on creating a balanced system that leverages efficiency without undermining critical human appraisal. Several key areas deserve attention (Figure 1).

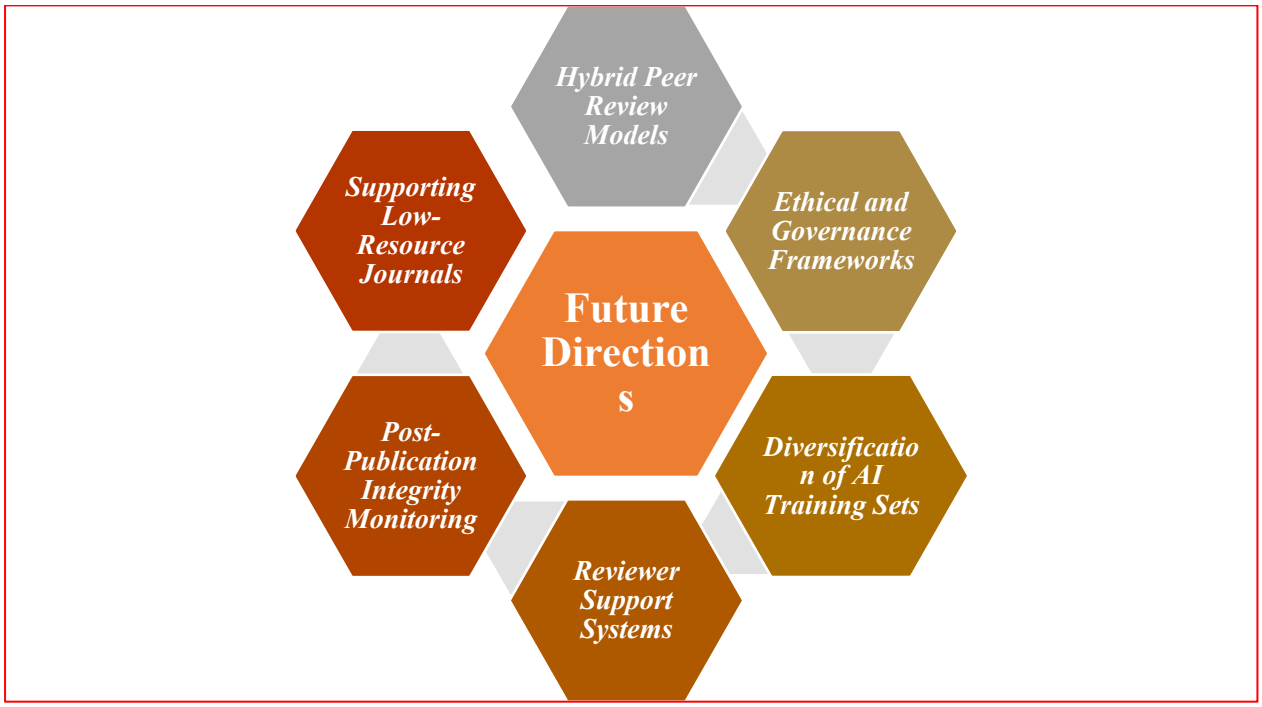

Figure 1. Future Directions in the Use of AI for Peer Review of Scientific Articles

Hybrid Peer Review Models

AI can produce structured "pre-review checklists" summarising technical findings such as similarity scores, statistical anomalies, or image duplication, allowing reviewers to concentrate on higher-level critique. Preliminary reports from ICLR 2024 suggested that AI involvement may influence review outcomes: at ICLR 2024, 15.8% of reviews were AI-assisted, and these reviews gave higher scores in 53.4% of cases, resulting in approximately a 4.9 percentage point increase in acceptance probability for manuscripts using AI assistance [26]. Such data remain preliminary and require validation across multiple venues before generalisation; however, such findings highlight both potential and risks of integrating AI into evaluative processes.

Ethical and Governance Frameworks

Journals are increasingly recognising the need for AI policies. According to publisher policy reviews conducted in 2023, among the top 100 journals, 70% had formal policies on using generative AI, with nearly 95% prohibiting AI as an author. However, only 43–45% mandated disclosure of AI use, and policy details varied widely across publishers [24]. Several analyses of publisher guidelines indicate that harmonised, transparent guidelines are critical to ensure consistency and protect research integrity.

Diversification of AI Training Sets

Most current AI tools are disproportionately trained on English-language, high-impact literature, which risks amplifying systemic biases. A recent survey 2025, (pre-print) suggested that ChatGPT accounted for 77% of AI use in academic writing, with 51% applied to readability improvement and 22% to grammar correction, particularly among non-native English authors [28]. Findings are preliminary and not yet peer-reviewed; however, they suggest that expanding training datasets to incorporate multilingual and regionally diverse scholarship will help AI tools serve the global scientific community more equitably.

Reviewer Support Systems

Beyond technical screening, AI can augment reviewer capacity by curating relevant resources, providing literature summaries, and flagging methodological checklists. Such systems could strengthen review depth while leaving judgment of novelty, rigour, and significance firmly in human hands.

Post-Publication Integrity Monitoring

AI also offers opportunities for ongoing oversight after publication. Automated tools can detect image duplication, identify contradictory datasets, and flag undeclared conflicts of interest, providing an additional safeguard when combined with traditional post-publication peer review. This ongoing surveillance could significantly improve the reliability of the scientific record.

Supporting Low-Resource Journals

In regions or journals with limited editorial infrastructure, AI can serve as a technical ally, screening for plagiarism, formatting issues, or reference errors. Nevertheless, human oversight remains essential to avoid over-reliance on automated systems and ensure editorial decisions reflect scholarly merit rather than algorithmic gatekeeping.

Taken together, these future directions emphasise that AI should serve as a tool to support, not replace, human expertise. The peer review ecosystem can evolve toward greater efficiency, equity, and integrity by adopting hybrid models, building governance frameworks, addressing systemic biases, and extending support to low-resource journals.

Conclusion

Several chances exist to improve editorial efficiency through integrating AI in peer review, especially in increasing submission quantities and reducing delays. The workload for human reviewers can be reduced by using AI systems to automate various tasks, including plagiarism detection and document formatting. Notwithstanding these developments, human expertise, context, and ethical judgment are still required for critical research evaluation, highlighting AI's limitations in completely replacing human reviewers. The review promotes a well-rounded strategy in which AI aids editorial procedures, enabling quicker judgments while maintaining the integrity and legitimacy of scientific publishing. In the end, maintaining the strict standards for disseminating high-quality research requires keeping human interaction at the centre of peer review.

Statements and Declarations

Ethics Approval and Consent to Participate: Not applicable. This manuscript is a narrative review and did not involve human participants or animals

Consent for Publication

Not applicable.

Availability of Data and Materials

No primary data were generated or analyzed for this manuscript.

Competing Interests

The author(s) declare no competing interests.

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Author's contribution

Both authors have equally contributed to conceptualization, literature review, manuscript preparation, edits and final approval

Use of AI tools

The authors have used Grammarly for English editing and improving the manuscript's readability, but have rechecked its final contents and take full responsibility.

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CASE REPORT

Intrathoracic Extrapleural Hydatid Cyst with Intraspinal Extension Mimicking a Dumbbell Tumour

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Abstract

Hydatid cystic disease or Echinococcosis is endemic in the Mediterranean countries, Middle and Central Asia, South America, Iceland, Australia, New Zealand, and northern and eastern Africa. However, it is unusual in northern Europe and America. Echinococcosis Granulosus or E. Multilocularis causes this zoonotic disease. Humans are accidental hosts of this zoonosis, and transmission occurs through ingesting parasite eggs in contaminated food. Here we present a 22-year-old male who had an Intrathoracic, extra pleural and extradural hydatid cyst, which mimicked a dumbbell tumour and was successfully managed with simultaneous posterior approach laminectomy with thoracotomy.

Keywords: Hydatid cyst, Echinococcosis, Dumbbell Tumor, Spinal canal, Intervertebral foramen

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Introduction

Mediastinal hydatid cyst with spinal canal extension is a very rare form of Echinococcosis that can mimic various mediastinal cystic lesions. Spinal hydatidosis occurs in less than 1% of cases of Echinococcosis. This case highlights a mediastinal hydatid cyst extending into the spinal canal, mimicking a dumbbell tumour. Humans are accidental hosts of this zoonosis. Transmission occurs through ingestion of parasite eggs in contaminated food. Echinococcus Granulosus or E. Multilocularis may cause it. E. Granulosus is more common, benign and encapsulated, whereas E. Multilocularis is a rare, non-capsulated, and malignant form. Hydatid disease is commonly harboured in the lungs and liver, but it may also occur in other sites. The rarity of such presentations emphasizes the need to include hydatid disease in differential diagnoses, especially in endemic areas. If it is not managed early, it can lead to severe neurologic compromise. The mainstay of treatment is surgical excision with anthelmintic medication [1].

Case Presentation

Here we present a 22-year-old male who had an Intrathoracic, extra pleural and extradural hydatid cyst, which mimicked a dumbbell tumour and was successfully managed with simultaneous posterior approach laminectomy with thoracotomy. A previously healthy, 22-year-old male patient without a family history of any neurological diseases presented with complaints of radicular pain over the upper back radiating to the right anterolateral chest wall for three months, associated with tingling and occasional numbness. There was no history of bowel and bladder incontinence, trauma, weight loss, or fever. Physical examination revealed that the straight leg raise test was pain-free, all four limbs were normal concerning bulk, tone, power, reflexes and sensations, and chest expansion was 5 cm. without any noticeable paraspinal fullness, vertebral tenderness or muscle spasm. Chest X-ray showed a paravertebral opacity close to the right side's 4^{th} and 5^{th} thoracic vertebrae (Figure 1). Hence, it was decided to do further radiological investigations. A contrast-enhanced computerized tomography (CECT) scan of the thoracic region was done, and it showed an intrathoracic dumbbell-shaped mass. For better visualization and to define its spinal relation, Magnetic resonance imaging (MRI) was done, and it revealed a well-defined abnormal signal intensity cystic lesion 51mm x 53 mm x 22 mm seen along the 5^{th} rib in the right paravertebral location, causing scalloping of rib medially and extending into the right T4-T5 neural foramina without compression of the spinal cord (Figure 2 A & B). The lesion was hyper-intense on T2 and short tau inversion recovery (STIR) and hypo-intense on the T1 weighted image of MRI. Whole spine screening revealed no other lesion, and the patient was planned for laminectomy followed by right posterolateral thoracotomy, keeping a possible diagnosis of dumbbell schwannoma due to the presence of radicular symptoms. Under general anaesthesia and in a prone position, T5 right hemilaminectomy was started. Still, on the table, we found a cystic lesion protruding into the canal without any attachment to the nerve root. On careful aspiration, it revealed clear fluid and a pearly white membrane popping out of the cavity, which led to a suspicion of a hydatid

cyst on gross appearance. The intraoperative frozen section confirmed this diagnosis. As all daughter cysts could not be retrieved through this route and due to intrathoracic extension, we thoroughly washed and packed this cavity with 3% hypertonic saline for scolicidal action. After completion of this procedure, we proceeded with right posterolateral thoracotomy through the 4th space and found the pleura and lung to be intact, and the cyst was totally extrapleural (Figure 3A). The pleura opened, residual daughter cysts were removed, and communication with the spinal cavity was packed with 3 per cent hypertonic saline (Figure 3 B & C). After putting the chest tube, thoracotomy closure was done, and he was smoothly extubated on the table. The postoperative course was uneventful. The symptoms were relieved entirely following surgery. Histopathological examination y of the excised cyst confirmed the diagnosis of a hydatid cyst (Figure 3 D). He was discharged on the 7th postoperative day with healthy wounds. At the discharge, Tablet Albendazole 15mg/kg daily orally in two divided doses was started, and planned to be continued with periodic assessments. Follow-up visit at the three months has revealed no loco-regional recurrence and normal liver function enzyme status.

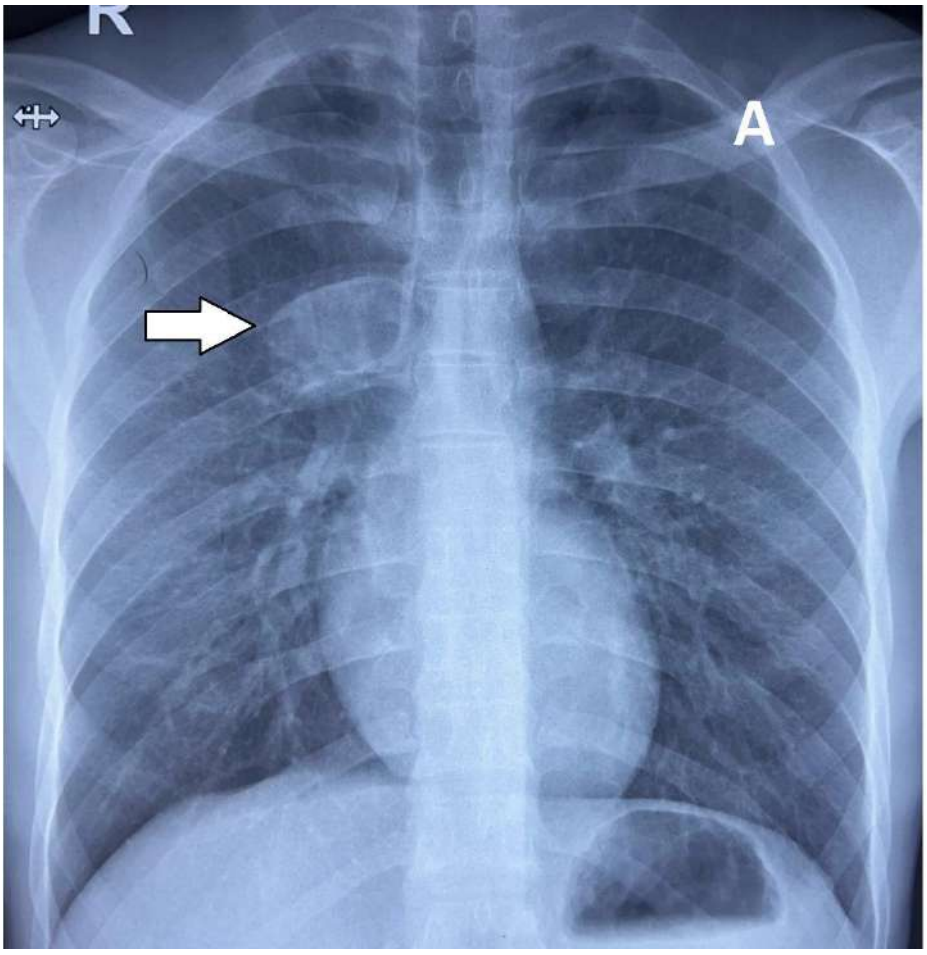

Figure 1. Preoperative Chest X-ray PA view showing paravertebral opacity (marked by arrow).

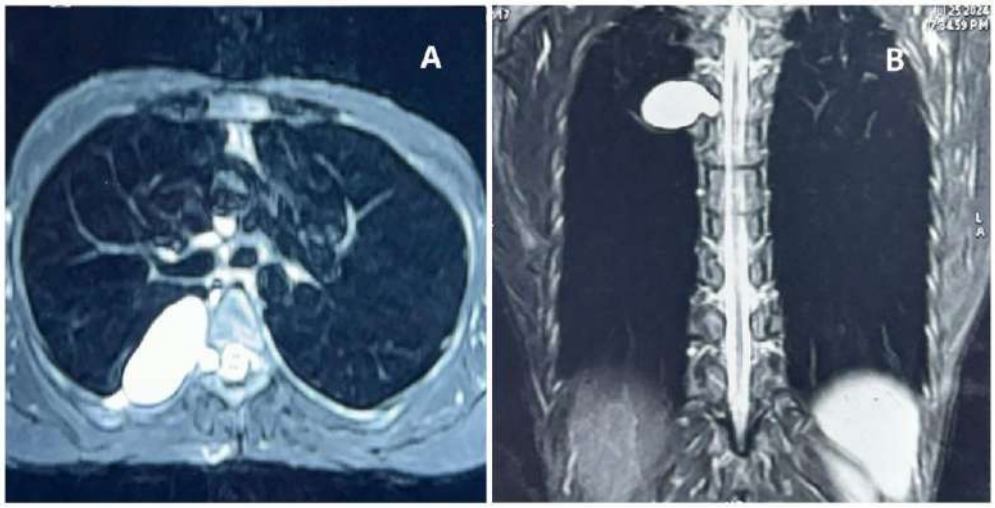

Figure 2. **A:** Coronal T2-weighted Magnetic resonance imaging showing well-defined abnormal signal intensity cystic lesion 51mm x 53 mm x 22 mm seen along 5th rib in right paravertebral location extending into right T4-T5 neural foramina without spinal cord compression. **B:** Axial T2-weighted Magnetic resonance imaging showing well-defined abnormal signal intensity cystic lesion 51mm x 53 mm x 22 mm seen along 5th rib in right paravertebral location extending into right T4-T5 Neural foramina without spinal cord compression.

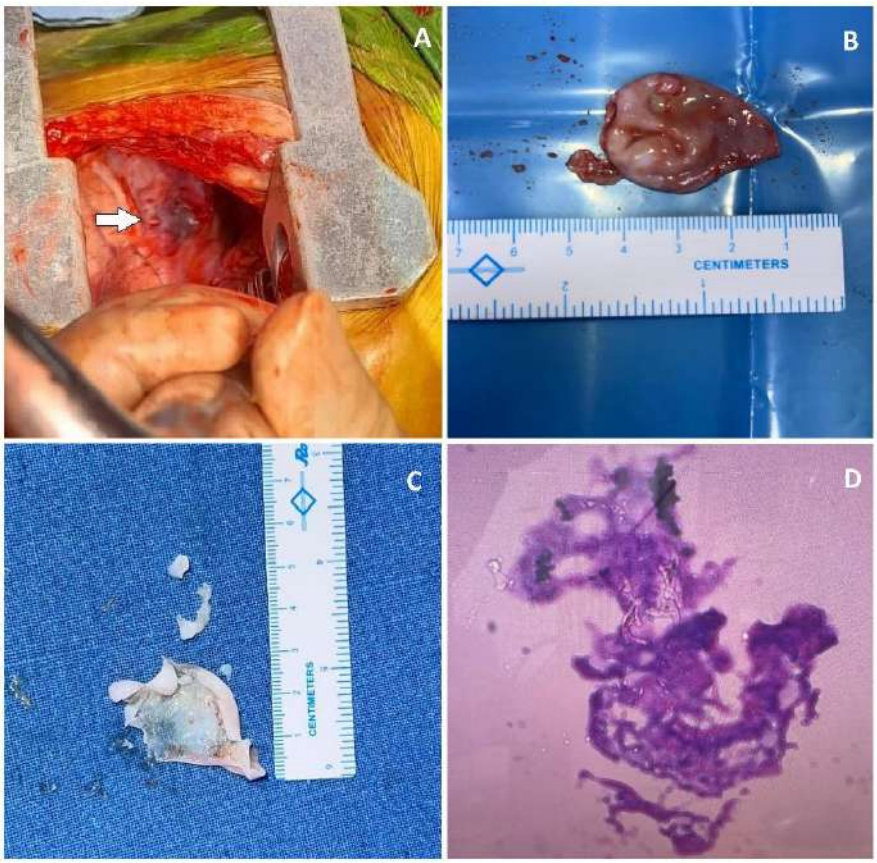

Figure 3. **A:** Intraoperative image showing intact pleura and extrapleural cyst. **B** and **C:** Excised specimen showing daughter cysts with laminated membrane. **D:** Histopathology shows occasional hooklets embedded in fibro collagenous tissue, which suggests a hydatid cyst.

Discussion

Most dumbbell tumors are benign in nature and of neurogenic origin in 90% cases as schwannoma, neurofibroma, ganglioneuroma, and neuroblastoma with schwannomas. Spinal hydatidosis occurs in less than 01% of cases of *Echinococcosis*. Among these, completely extradural hydatid cyst very rarely occurs. Benzagmout *et al*. reported the first transthoracic excision of a para-spinal hydatid cyst [2]. In 90% of cases, these cysts are extradural and usually affect the dorsal vertebra [3]. Spinal involvement can be secondary to liver or lung hydatid or rarely primary, as in our case. Primary paravertebral hydatid without any other foci is explained by porto-vertebral venous shunts theory [4]. Spinal hydatidosis can present with paraparesis (62%), radicular pain (55%), numbness or sensory less (36%), paraplegia (26%) and sphincter disturbance (30%). Imaging and serological tests can be used in diagnosis. Echinococcus IgG has high specificity and low sensitivity. Computed tomography can be used for any lytic lesions or vertebral involvement. MRI is the gold standard in radiological investigation. Braithwaite and Lees classified spinal hydatid cysts into five radiological types: intramedullary, intradural-extramedullary, extradural, hydatid osseous cyst of vertebrae, and paravertebral lesions extending to spinal structures. Advanced imaging, particularly MRI, demonstrates the cyst's nature and intraspinal impact. Hydatid cyst shows cerebrospinal fluid-like intensity in MRI. CT scans complemented MRI findings by detailing bone involvement. Hydatid disease should have a high degree of suspicion in endemic areas. Multiloculated cysts with hypointense T1 weighted MRI and hyperintense T2 weighted MRI favoured our diagnosis towards hydatid cyst [5]. The correlation between imaging findings and intraoperative discoveries offers an area for further exploration. A hydatid cyst can occur in different sizes and shapes, which may mimic benign and even malignant neoplasms and may create diagnostic challenges in those cases. Especially in the musculoskeletal system and in this region, differentiating these lesions from malignancies such as schwannomas or neuroblastomas is a bit tricky [6].

For managing thoracic dumbbell tumors ultimate aim is to remove both the intraspinal and the extraspinal tumor mass. A combined approach firstly, a posterior laminectomy by a neurosurgeon, followed by a postero-lateral thoracotomy method avoids the risk of bleeding from remnant tumor tissue and compression of the spinal cord. Also, leakage of cerebrospinal fluid and damage to the spinal cord can be easily visualized before thoracotomy by this approach. Hence the standard surgical approach often involved decompression (laminectomy) and resection of intraspinal extended mass with or without spinal stabilization followed by thoracic excision. As the standard management of Hydatid disease is the surgical removal of the cyst along with all daughter cysts coupled with anthelminthic therapy. There are isolated case reports of similar type of presentation [7,8]. Albendazole and Mebendazole both can be used with. However, Albendazole is the preferred drug of choice and is crucial to prevent recurrence, as observed in similar cases [9]. It should be kept in mind that both of these drugs are teratogenic and embryotoxic, and both may cause alterations in liver function and

haematological adverse reactions. The complete blood picture and liver enzyme titre should be assessed monthly during follow-up.

Conclusion

The rarity of such presentations emphasizes the need to include hydatid disease in differential diagnoses, especially in endemic areas. The surgical approach is definitive management and may be individualized based on imaging. Our case has unusual clinical and radiological presentation, so we used simultaneous combined both posterior and anterior approaches with successful outcomes.

Most tumors are benign, neurogenic tumors, with schwannoma, neurofibroma, ganglioneuroma, and neuroblastoma with schwannomas accounting for 90% of all dumbbell tumors

Statements and Declarations

Conflicts of interest

The authors declare that they do not have conflict of interest.

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CASE REPORT

A Case Report of Atypical Presentation of Abdominal Tuberculosis with Concurrent Broad Ligament Cyst: Laparoscopy as a Diagnostic Tool

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Abstract

Background: Abdominal tuberculosis (TB) continues to be important health concern in India. The diagnosis is often challenging because of its non-specific presentation. Conventional laboratory and microbiological methods are usually time consuming and requires a high clinical index of suspicion. Laparoscopy with biopsy is an efficient tool for rapid and accurate diagnosis of abdominal tuberculosis. We aimed to demonstrate the effectiveness of laparoscopy in diagnosing a case of abdominal tuberculosis presented as ovarian cyst. **Case presentation:** A 22 year young female presented to our surgery outdoor clinic with history of abdominal pain lasting for 4 months. Her laboratory tests were unremarkable including a normal CA 125 with raised ESR. A CT scan was performed which revealed a cystic mass in left ovary. Considering the possibility of pelvic cyst and abdominal TB, a diagnostic laparoscopy was performed. At laparoscopy, adhesions or fibrinous networks between liver and peritonium, enlarged mesenteric lymph nodes and ascites were seen along with left broad ligament cyst with left atrophied ovarian tissue. She underwent left sided salplingo-oopherectomy with resection of cyst with biopsy from mesenteric nodes and peritoneal aspiration. The histopathological diagnosis from lymph nodes during the procedure confirmed as chronic granulomatous inflammation with casesous necrosis favouring tuberculosis. The peritoneal aspirate shows a raised ADA and positive CBNAAT for MTB further confirmed the diagnosis. She was started with standard antitubercular drugs. Postoperatively, she recovered uneventfully and responded well to the ATT therapy. **Conclusion:** In cases of chronic abdominal pain, a significant clinical suspicion is necessary keeping abdominal TB as an important differential diagnosis. Laparoscopy with biopsy is an effective tool for early diagnosis of abdominal tuberculosis.

Keywords: Tuberculosis (TB), diagnostic laparoscopy (DL), anti-tubercular therapy (ATT), Adenosine deaminase (ADA)

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Introduction

Tuberculosis (TB) is a major global health problem, mainly affecting the developing nations [1,2]. It remains one of the top ten leading cause of death worldwide [3]. TB caused by mycobacterium tuberculosis, generally affect the lungs but it can also involve other organs of body termed as extrapulmonary TB [4]. Abdominal TB is one of the most common forms of extrapulmonary TB accounting for 1-2% of all cases of tuberculosis [5]. It affects gastrointestinal tract, lymph nodes, peritoneum and solid organs [6]. The presentation of abdominal TB is generally non-specific and may mimics various clinical conditions like inflammatory bowel disease, abdominal malignancies, colitis, gynecological tumors or malignancies [7]. Early and accurate diagnosis of Abdominal TB remains a great challenge due to its non-specific presentation and lack of characteristic laboratory features. Even radiological imaging like ultrasound and CT scan, in many instances fail to reach the definite diagnosis accurately [8].

Particularly in countries with high burden of tuberculosis, strong evidence of clinical suspicion is required. When a patient presents with unexplained abdominal pain or other suspected features of abdominal TB, laparoscopy offers to early and accurate diagnosis [9]. Occasionally, a pelvic mass may present along with abdominal tuberculosis making the diagnosis further more challenging [10,11].

In our case, we established the diagnosis of abdominal tuberculosis in a young female with the help of laparoscopy who initially presented as a case of ovarian cyst.

Case presentation

A 22 year young female presented to surgery outdoor clinic with a history of dull aching pain abdomen for 4 months. Pain was non-radiating in nature and was associated with vomiting sometimes. There was no history of fever, significant weight loss or night sweats. She denied any urinary symptoms or altered bowel habits. There was no history of pulmonary tuberculosis or close contacts in the past.

On admission; she had a temperature of 98.6 F, a heart rate of 98 per minute, blood pressure of 110/72 mmHg and respiratory rate of 18 per minute. Her general examination was normal and there was no evidence of any systemic lymphadenopathy. On per abdomen examination, patient didn't have any distension present with no palpable lump. Shifting dullness was also absent.

Initially, her ultrasound of whole abdomen and pelvis revealed a large pelvic cyst of size 20.3cm*15cm with non visualistion of left ovary likely suggestive of cystadenoma with normal right ovary. An abdominal CT scan of the patient suggestive of large well defined homogenous hypodense cystic lesion of size 11. 5cm*22cm*23.7cm with minimally enhancing thin peripheral wall involving lower abdomen and upper part of pelvis possibly arising from left ovary with non-visualization of left ovary separately likely suggestive of left ovarian cystadenoma. Right ovary appears normal with no evidence of any mesenteric lymphadenopathy, peritoneal or omental thickening or ascites (Figure 1). On further workup, CA 125 was found to be 2.1U/ml (normal < 30 U/ml).

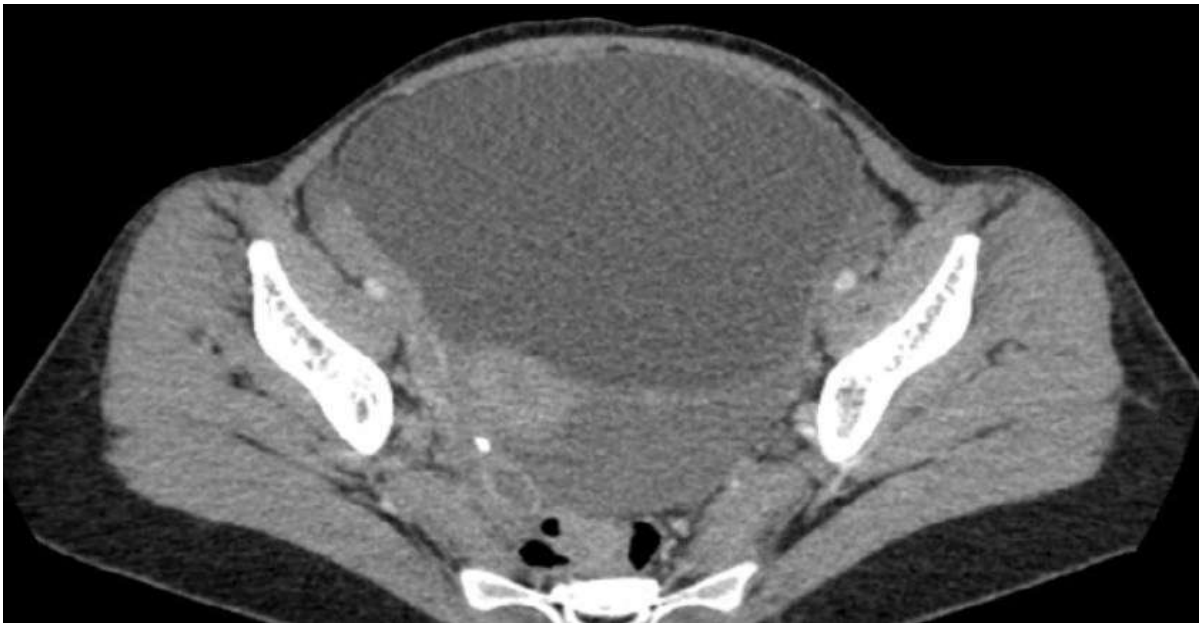

Figure 1. CECT abdomen shows hypodense cystic lesion of size 11. 5cm*22cm*23. 7cm with minimally enhancing thin peripheral wall involving lower abdomen and upper part of pelvis possibly arising from left ovary

Ancillary tests done in support of tuberculosis like mantoux test,chest xray (CXR), QuantiFERON-TB Gold were also normal except a mild rise of ESR, 36mm/hr (normal 20 mm/hr in females).

On the basis of history, clinical examination, laboratory investigation and radiological imaging features possible diagnosis of pelvic cyst was suspected.

She was planned for diagnostic laparoscopy. During the procedure, macroscopic visualization of the abdominal cavity and pelvis with adnexa was done. Intraoperatively, characteristic features of abdominal tuberculosis, in the form of dense adhesions and fibrinous networks between liver and peritoneum, mild ascites in paracolic gutters and pelvis and enlarged mesenteric lymph nodes in distal ileum were present. Encysted fluid in left sided broad ligament with left atrophied and diseased ovarian tissue were also present (Figures 2A-C).

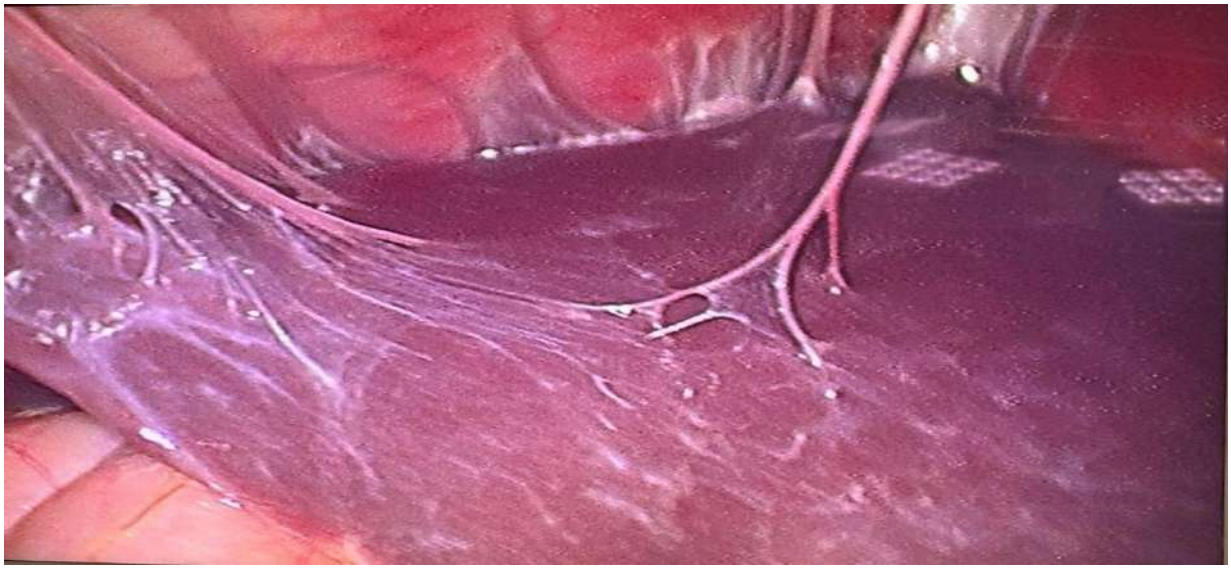

Figure 2A. Diagnostic laparoscopy shows dense adhesions and fibrinous networks between liver and peritoneum

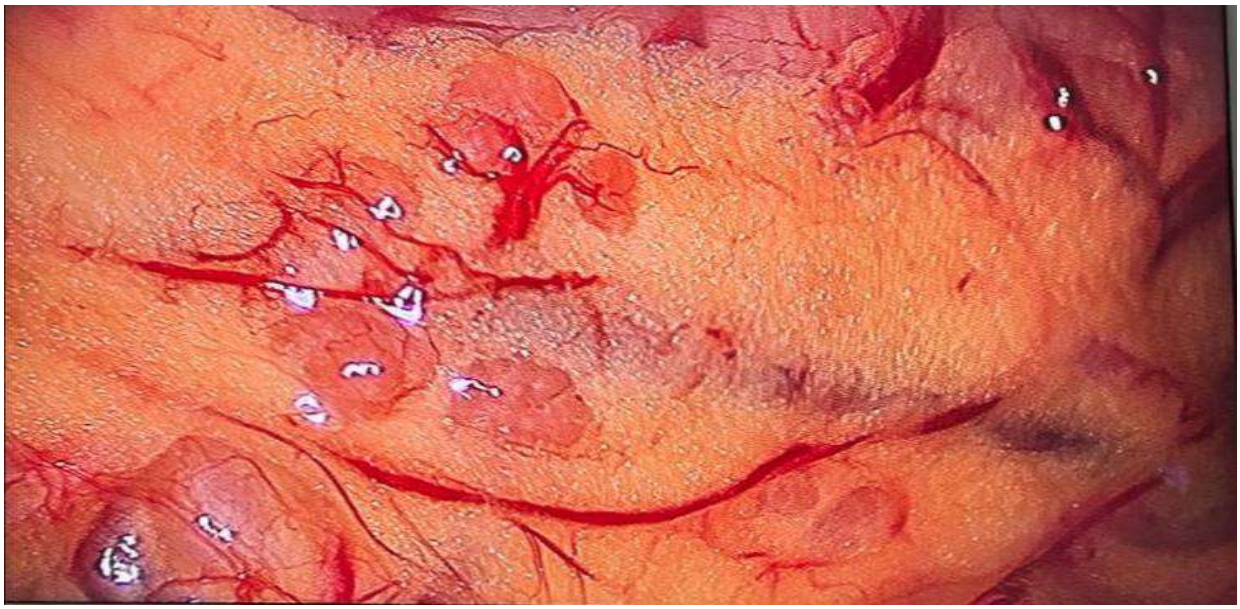

Figure 2B. Diagnostic laparoscopy shows multiple enlarged mesenteric lymph nodes

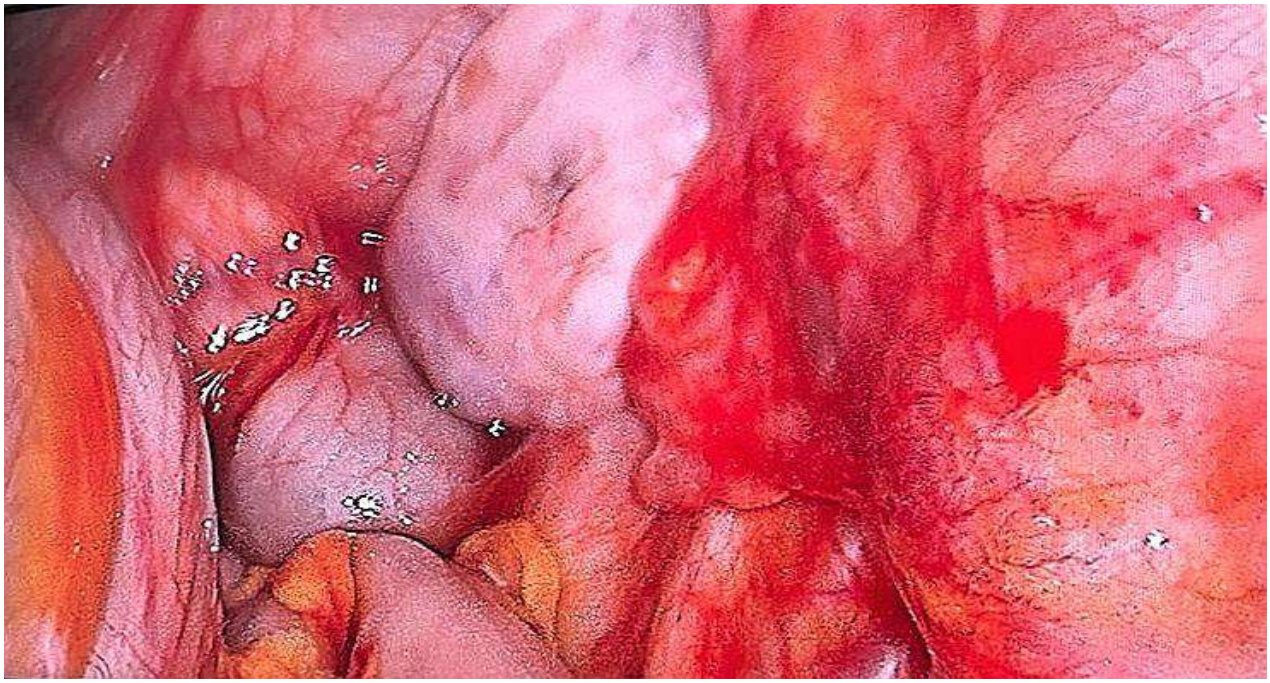

Figure 2C. Diagnostic laparoscopy shows encysted fluid in left sided broad ligament with left atrophied ovarian tissue.

She underwent left sided salpingo-oopherectomy with resection of the cyst and a biopsy from mesenteric lymph nodes was also done along with aspiration of peritoneal fluid for Adenosine deaminase (ADA) analysis, Acid fast bacilli (AFB) staining and Cartridge based Nucleic Acid Amplification Test (CBNAAT) for mycobacterium bacilli. Fluid AFB and liquid culture were found to be negative. Peritoneal fluid CBNAAT was positive for Mycobacterium tuberculosis with no Rifampicin resistance. An elevated level of ADA (60U/L) was found in peritoneal fluid.

Histopathology examination (HPE) of mesenteric lymph nodes established the presence of epithelial granulomas, Langhans giant cells with central necrosis suggestive of chronic granulomatous lesion with caseous necrosis consistent with tuberculosis (Figure 3).

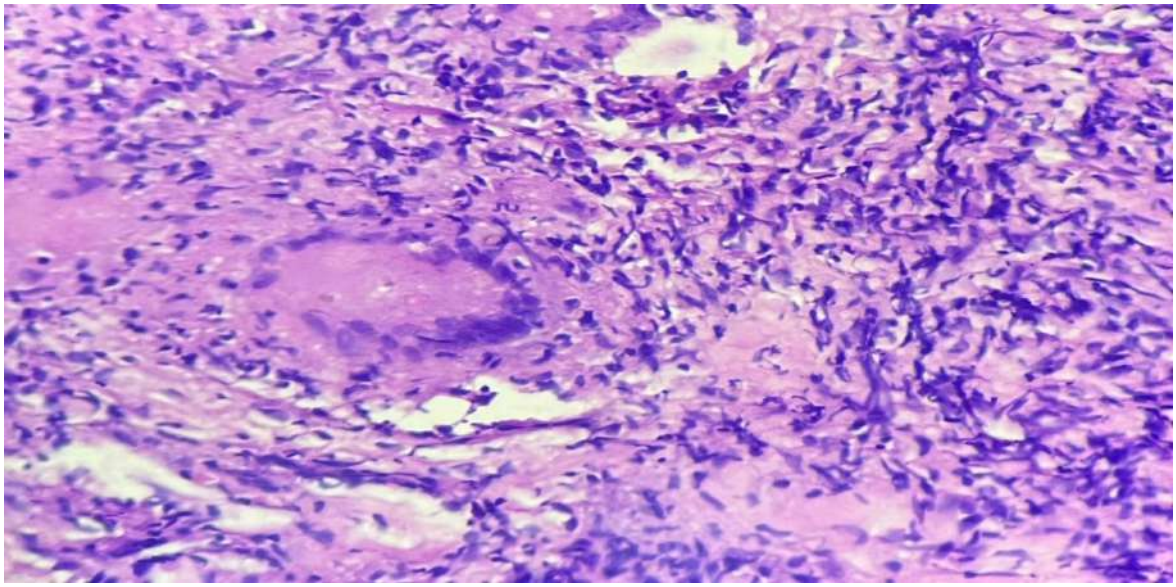

Figure 3: HPE of mesenteric lymph nodes shows the presence of epithelial granulomas, Langhans Giant cells with central necrosis

Hence on the basis of laparoscopic findings and histopatholgy, the patient was finally diagnosed as a case of abdominal tuberculosis with coexisting left sided broad ligament cyst. She was started on category I anti-tubercular drugs (Rifampicin;10 mg/kg/day, Isoniazid;5mg/kg/day, Ethanbutol;15-20mg/kg/day and Pyrazinamide;20-25mg/kg/day) as per her body weight from post op day 1 onwards. Post operative period was uneventful and she was discharged on postoperative day 2. Anti-tubercular drug therapy were continued. Currently the patient is under regular follow up and she responded well to anti-tubercular medications. During 3 follow up, patient clinical response in the form of improvement of symptoms of pain, increased appetite with increased oral intake and general well being.

Discussion

Tuberculosis continues to be a global public health menace which threatens health security [12]. In countries with low socioeconomic status, poor hygiene and high prevalence of HIV coinfection, abdominal tuberculosis is still a matter of concern with great effect on public health increasing overall morbidity and mortality [13]. Abdominal TB can be spread by four different routes. It includes hematogenous spread from a lung focus, or consumption of contaminated milk or food products infected with bacilli, or via lymphatics or through direct spread [14].

The presentation of abdominal TB are very non-specific which includes vague symptoms like abdominal pain of acute or chronic in nature, nausea and vomiting, fever, weight loss, night sweats, altered bowel habits, abdominal distension with or without ascites [15]. Its varied presentation often mimics with other gastrointestinal diseases like IBD, malignancy, abdominal lymphoma or gynecological tumors or malignancies [16]. Interestingly, our patient had both abdominal tuberculosis coexisting with pelvic cyst.

The diagnostic challenges represented due to its varied presentation increases the delay in diagnosis of abdominal TB leading to high mortality and

morbidity. Several criteria included for diagnosing abdominal TB are a)positive Acid-fast bacilli (AFB) smear on Ziehl-Neelsen staining or culture in peritoneal fluid b)histological features of caseating granuloma c)CBNAAT positive in peritoneal fluid d)typical presentation of kochs abdomen and good response to anti-tubercular treatment [17, 18]. Mantoux test is still not outdated and continues to be widely used in many developing countries with low specificity and negative predictive value [19]. There is very low positive rate (<3%) of AFB smear test from peritoneal aspirate due to its paucibacillary nature [20]. The culture of M. TB bacilli takes a long time of 2-6 weeks making an unnecessary delay in diagnosis of the disease [2,21].

Radiological diagnostic modalities like ultrasound and CT scan are able to detect ascites, thickened bowel loops, enlarged mesenteric lymph nodes. However, these are non-specific and can mimics other abdominal pathologies [8,22]. Remarkably, In our case neither ultrasound nor CT scan suggest these features which was later visualized by laparoscopy.

Adenosine deaminase (ADA) level in peritoneal fluid is a very emerging investigation with high sensitivity and specificity [23]. In our case the ADA value was 60 (>33 was taken as cut off value) [24,25] which is suggestive of abdominal tuberculosis. Cartridge based Nucleic Acid Amplification Test (CBNAAT) for extrapulmonary TB specimens like ascitic fluid is also an emerging molecular assay with high sensitivity (100%) [26]. In our case, the peritoneal fluid aspirate sent for CBNAAT was found to be positive for MTB which further confirmed the diagnosis of abdominal TB. CA125 level measurement in abdominal tuberculosis is also nonspecific. Many conditions can elevated CA125 like endometriosis ,pelvic inflammatory disease, uterine fibroids, liver disease, and pregnancy [15].

Laparoscopy with tissue biopsy is the gold standard method in diagnosing abdominal tuberculosis with a very high diagnostic yield [27-31]. The characteristic features on diagnostic laparoscopy for diagnosing peritoneal TB are yellowish/whitish nodules or tubercles scattred over peritonium, adhesions or violin strings, omental thickening, abdominal cocoon, mesenteric thickening or enlarged mesenteric lymph nodes [31]. The patient in this case report on diagnostic laparoscopy had characteristic lesions in the form of adhesions/fibronectin networks between liver and peritonium, multiple enlarged mesenteric lymph nodes with mild ascites favoring the diagnosis of intra-abdominal tuberculosis. Another advantage of laparoscopy is the early diagnosis of abdominal tuberculosis compared to traditional microbiogical culture methods which generally yield results in 2-6 weeks [32]. This early diagnosis helps in avoidance of dreadful complications such as intestinal perforation specially in fibronectin type of peritoneal tuberculosis [33].

This case emphasize the importance of considering abdominal tuberculosis as one of the differentials for non-specific abdominal pain particularly in a young age group in endemic countries like India. It also underscores the role of laparoscopy with biopsy as a rapid and accurate diagnostic tool for diagnosing abdominal tuberculosis and thereby decreasing overall morbidity and mortality.

Conclusion

In cases of suspected abdominal TB with non-specific presentation, laparoscopy with biopsy is an effective tool for early diagnosis. Appropriate treatment can be started with anti-tubercular drugs to decrease morbidity and mortality.

Conflict of interests

The authors declare that they have no conflict of interest.

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Informed Consent

Written and informed consent was obtained from the patient prior to the study.

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