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ORIGINAL ARTICLE

Management Outcome of Odontoid Fracture: Conservative vs Surgical Treatment: A Comparative Study

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Abstract

Background: Odontoid fractures are the most common neck bone fractures in elderly patients and form about 10–15% of all cervical spine injuries. There is still no clear agreement on the best treatment — whether to treat with immobilisation (conservative) or surgery, especially in older patients. This study aimed to compare the outcomes of these two treatment methods. **Methods:** This was a bidirectional comparative study conducted at a tertiary care hospital in Chennai, including 76 patients with confirmed odontoid fractures. Patients who underwent conservative treatment (38 patients, using cervical collar or halo) and surgical treatment (38 patients, treated with anterior screw fixation or posterior C1–C2 fusion) were followed up and compared for Outcomes such as fracture healing, new neurological problems, complications, death, hospital and ICU stay, and functional recovery using Neck Disability Index (NDI) and Visual Analogue Scale (VAS). Statistical tests were applied, and $p < 0.05$ was considered significant. **Results:** Fracture healing was much higher in the surgical group (73.3% compared to 26.7%). New neurological problems occurred only in the conservative group. Patients who underwent surgery had longer hospital stay (28.08 ± 9.27 days vs 14.87 ± 4.39 days) and ICU stay (12.95 ± 3.74 days vs 5.18 ± 2.57 days). Complications were more common in the surgical group (75% vs 25%). Death was higher in the conservative group, but this was not statistically significant. Both groups showed improvement in NDI and VAS scores, with slightly better results in the surgical group at one year. Logistic regression did not show any independent factors predicting outcomes. **Conclusion:** Surgical treatment gives better fracture healing and prevents neurological problems, but it has more complications and requires longer hospital stay. Conservative treatment has fewer complications and shorter hospital stay. Treatment should be decided based on patient condition, fracture type, neurological status, and fitness for surgery.

Keywords: Odontoid fracture, Conservative management, Surgical stabilisation, Cervical spine injury, Neck Disability Index

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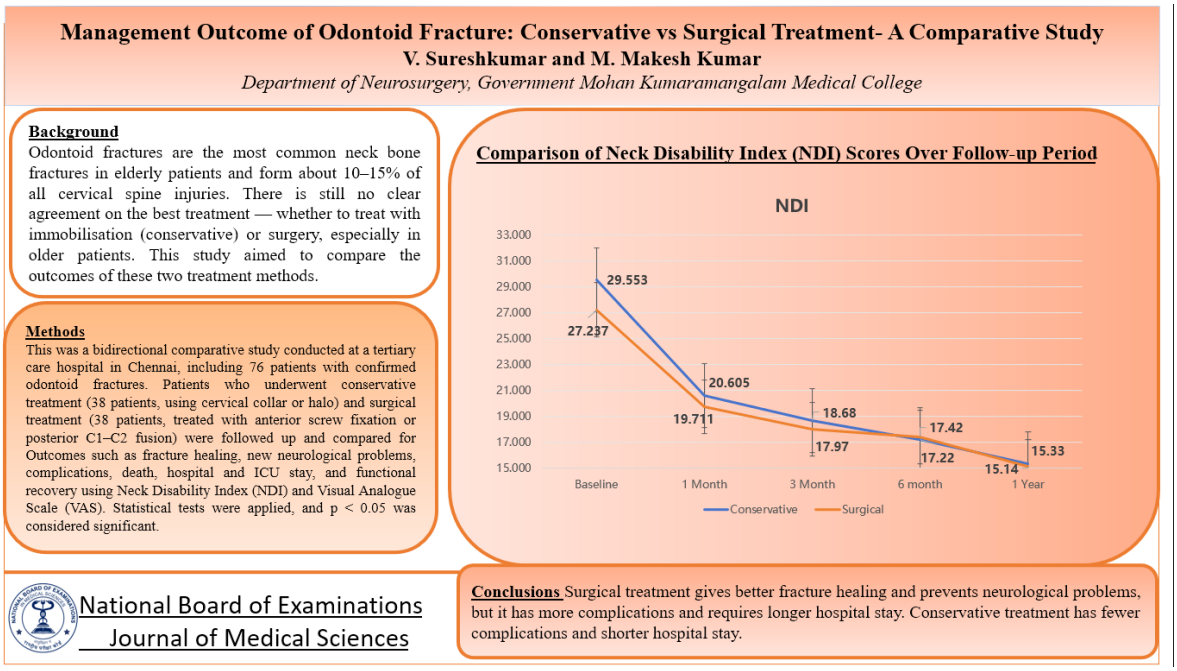
Graphical Abstract



Introduction

Odontoid fractures (fractures of the dens of the axis) are one of the most common neck spine injuries seen in clinical practice. They account for about 10–15% of all cervical spine fractures and up to 20% in people older than 70 years [1]. The odontoid process plays an important role in neck movement, especially rotation between the first and second cervical vertebrae, and its damage can affect both stability and nerve safety.

The Anderson and D'Alonzo classification system divides these fractures into Type I, Type II, and Type III, and it is widely used to guide treatment decisions [2]. Among these, Type II fractures occur at the base of the dens and are the most common. They also have the highest risk of non-healing (non-union), which makes treatment decisions more difficult, especially in elderly patients who often have other medical conditions that increase surgical risk [3].

Conservative treatment mainly involves immobilisation using a rigid cervical collar or a halo-vest. This method is often chosen for elderly patients who are not fit for surgery or for fractures that are not significantly displaced. However, the rate of non-union with conservative treatment is high, ranging from 26% to 67% in Type II fractures. This can lead to complications such as delayed neurological problems, instability between C1 and C2, and long-term neck pain [4-6].

Surgical treatment includes methods such as anterior odontoid screw fixation and posterior C1–C2 fusion techniques (like Harms-Goel screw-rod fixation and transarticular screws). These methods have better fracture healing rates but are associated with risks such as difficulty in swallowing, implant failure, wound infection, blood clots, and longer hospital stay [7-9].

Even though many studies are available, there is still no clear agreement on the best treatment method for odontoid fractures, especially in elderly patients. Many studies have limitations such as small sample sizes, different types of patients,

and varying follow-up periods. Therefore, this study was conducted at Madras Medical College, a tertiary care centre in South India, to compare the outcomes of conservative and surgical treatment in a single group of patients and to help guide better clinical decision-making [10].

Aims and Objectives

Primary Objective

To compare the clinical outcomes — including fracture union rate, secondary neurological deficits, complication profile, and mortality — between conservative and surgical management groups in patients with odontoid fractures.

Secondary Objectives

1. To compare functional recovery using Neck Disability Index (NDI) and Visual Analogue Scale (VAS) scores at baseline, 3 months, 6 months, and 12 months across both groups.
2. To analyse the influence of demographic and clinical variables (age, gender, fracture stability) on treatment selection.
3. To determine independent predictors of treatment outcome using logistic regression analysis.

Materials and Methods

Study Design and Setting

This was a retrospective comparative study conducted in the Department of Neurosurgery at a tertiary care institute in Chennai, Tamil Nadu. The study was carried out over one year (2023–2024).

Study Population

Patients with confirmed odontoid fractures as established by X-ray of the cervical spine, CT scan with fine cuts, or MRI were included of which 40 patients, underwent conservative management - cervical collar or halo and 42 patients underwent surgical treatment with anterior screw fixation or posterior C1–C2 fusion.

Inclusion Criteria

Adult patients aged 18 years and above with odontoid fractures (Type I, II, or III); availability of proper radiological records; available for a minimum follow-up of 12 months; were included in the study by convenient sampling and consent obtained from the patient or legal guardian (in patients with neurological deficits).

Exclusion Criteria

Patients with fractures due to tumors or metastasis; patients with additional atlantoaxial instability needing further surgery; incomplete medical records; patients lost to follow-up before 12 months; and patients who had surgery in another hospital and came only for follow-up.

Treatment Protocol

Conservative treatment included immobilisation using a rigid cervical collar (Philadelphia or Miami-J collar) for Type I, Type III, and mildly displaced Type II fractures. Halo-vest was used for unstable or displaced fractures when surgery was not suitable. Immobilisation was continued for 8 to 12 weeks depending on fracture healing.

Surgical treatment was done under general anaesthesia. Anterior odontoid screw fixation was used for suitable Type II fractures. Posterior C1–C2 fusion (Harms-Goel technique) was done for complex fractures, reverse fracture pattern, or when

conservative treatment failed. A cervical collar was used after surgery for 6 weeks.

Outcome Assessment

Main outcomes included: fracture healing confirmed by CT scan at 6 months, with signs such as bony callus, cortical bridging and reduction in the fracture gap; development of new or worsening neurological problems; complications such as pneumonia, urinary infection, implant failure, wound infection, blood clots, and swallowing difficulty; and in-hospital death.

Functional outcomes were assessed using the Neck Disability Index (NDI) and Visual Analogue Scale (VAS) for pain at baseline, 3 months, 6 months, and 12 months. Duration of hospital stay and ICU stay were also recorded.

Statistical Analysis

Data were analysed using SPSS version 16. Categorical data were analysed using Chi-square test. Continuous data were analysed using independent t-test. Logistic regression was used to identify factors affecting outcomes. A p-value less than 0.05 was considered statistically significant. Results were presented as numbers, percentages, mean values with standard deviation, odds ratios with confidence intervals, and regression values.

Results

A total of 76 patients were included, equally distributed among conservative and surgical groups (38 each). Age showed a significant association with treatment modality, with ≥80 years predominantly managed conservatively (88.5%) and 60–69 years mainly treated surgically (91.3%) ($\chi^2 = 31.117$, $p < 0.001$) (Table 1). Females were more often treated conservatively (62.8%), while males predominantly underwent surgery (66.7%), which was statistically significant ($\chi^2 = 6.481$, $p = 0.011$) (Table 2). Fracture stability did not differ significantly between groups ($p = 0.293$). However, fracture union was significantly higher in the surgical group (73.3% vs 26.7%) ($\chi^2 = 23.213$, $p < 0.001$). Secondary neurological deficits occurred exclusively in the conservative group (100%) ($\chi^2 = 8.941$, $p = 0.003$). Mortality was higher in the conservative group (71.4% vs 28.6%), though not statistically significant ($p = 0.234$). Complications were significantly more frequent in the surgical group (75% vs 25%) ($\chi^2 = 8.769$, $p = 0.003$) (Table 3).

Table 1. Distribution of Study Population According to Age and Treatment Modality

Age	Group		Total	Chi Square Value	p value
	Conservative	Surgical			
≥80 years	23	3	26	31.117	**<0.001***
	88.5%	11.5%	100.0%		
60-69 yrs	2	21	23		
	8.7%	91.3%	100.0%		
70-79 yrs	13	14	27		
	48.1%	51.9%	100.0%		
Total	38	38	76		
	50.0%	50.0%	100.0%		

*p<0.05-Statistical significance

Table 2. Gender-wise Distribution of Patients Based on Treatment Modality

Gender	Group		Total	Chi Square Value	p value
	Conservative	Surgical			
Female	27	16	43	6.481	**0.011***
	62.8%	37.2%	100.0%		
Male	11	22	33		
	33.3%	66.7%	100.0%		
Total	38	38	76		
	50.0%	50.0%	100.0%		

*p<0.05-Statistical significance

Table 3. Comparison of Clinical Outcomes Between Conservative and Surgical Groups

Clinical Parameters	Group		Total	Chi Square Value	p value
	Conservative	Surgical			
Fracture Stability	32	36	68	1.107	0.293
	47.1%	52.9%	100.0%		
Fracture Union	12	33	45	23.213	**<0.001***
	26.7%	73.3%	100.0%		
Secondary Neurological Deficit	8	0	8	8.941	**0.003***
	100.0%	0.0%	100.0%		
Mortality	5	2	7	1.416	0.234
	71.4%	28.6%	100.0%		
Complication	6	18	24	8.769	**0.003***
	25.0%	75.0%	100.0%		

*p<0.05-Statistical significance

The conservative group had fewer complications, mainly pneumonia and urinary infections, whereas the surgical group showed higher rates of pneumonia, hardware failure, wound infection, DVT, dysphagia, and urinary infection (Figure 1). NDI and VAS scores improved progressively in both groups, with slightly better outcomes in the surgical group at one year (Figures 2 and 3). The conservative group had a higher mean age (79.61 ± 6.64 vs 70.32 ± 6.48 years), while hospital stay (28.08 ± 9.27 vs 14.87 ± 4.39 days) and ICU stay (12.95 ± 3.74 vs 5.18 ± 2.57 days) were significantly longer in the surgical group ($p < 0.001$) (Table 4). Logistic regression showed no independent predictors (Table 5).

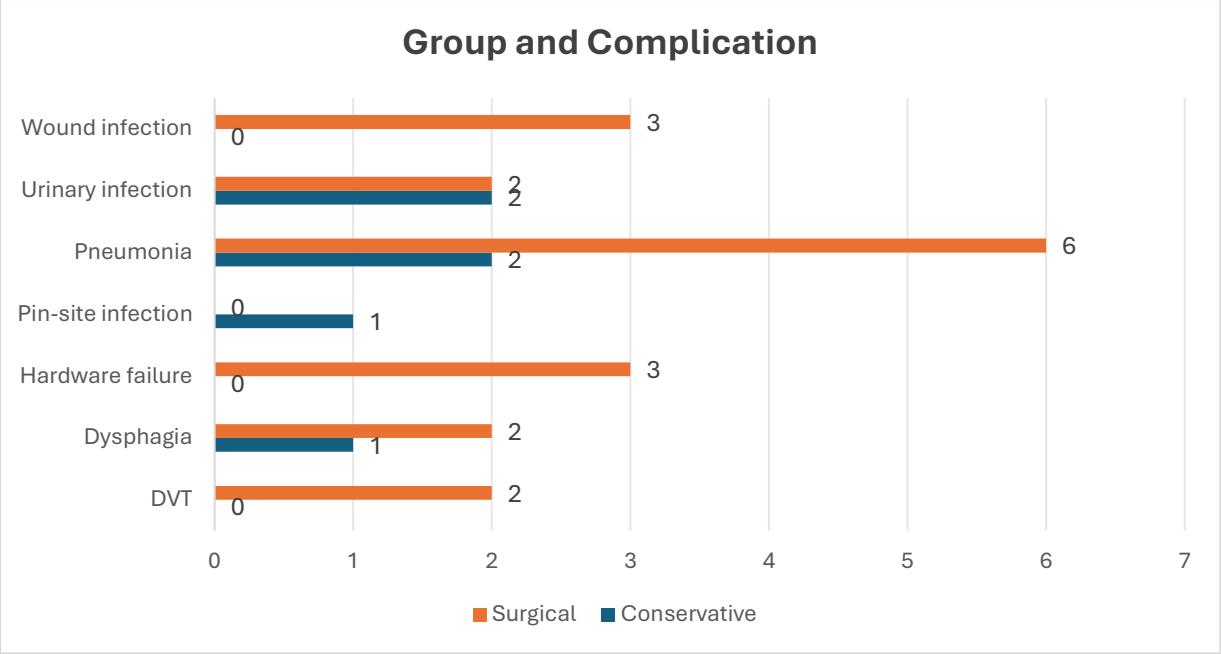


Figure 1. Distribution of Complication Profile in Conservative and Surgical Groups

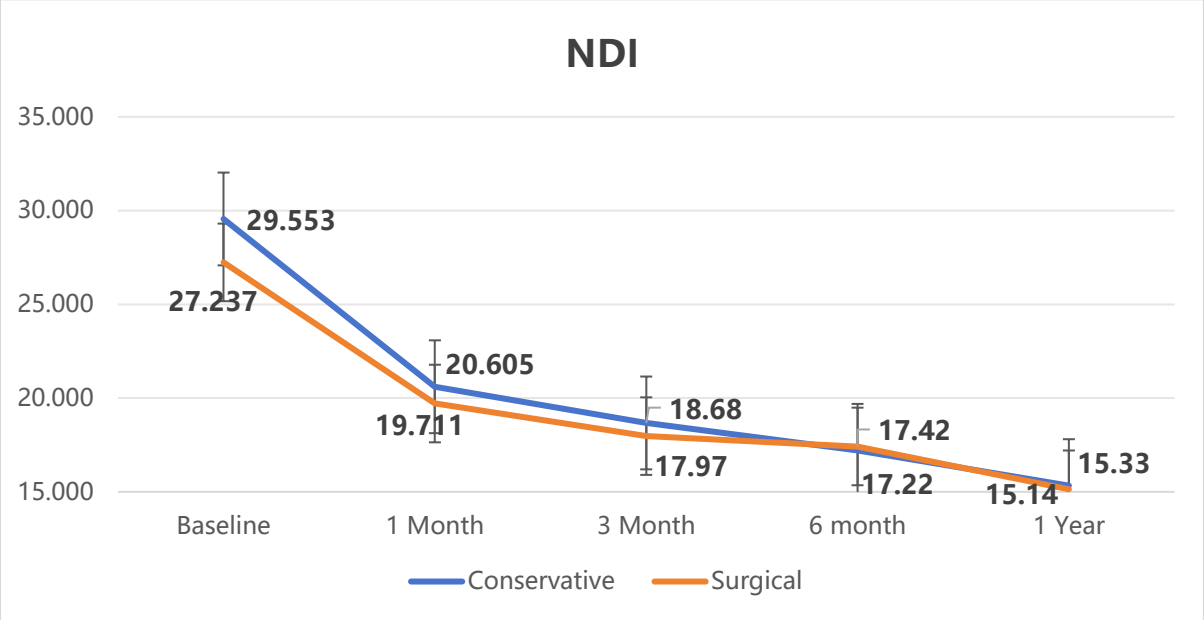


Figure 2. Comparison of Neck Disability Index (NDI) Scores Over Follow-up Period

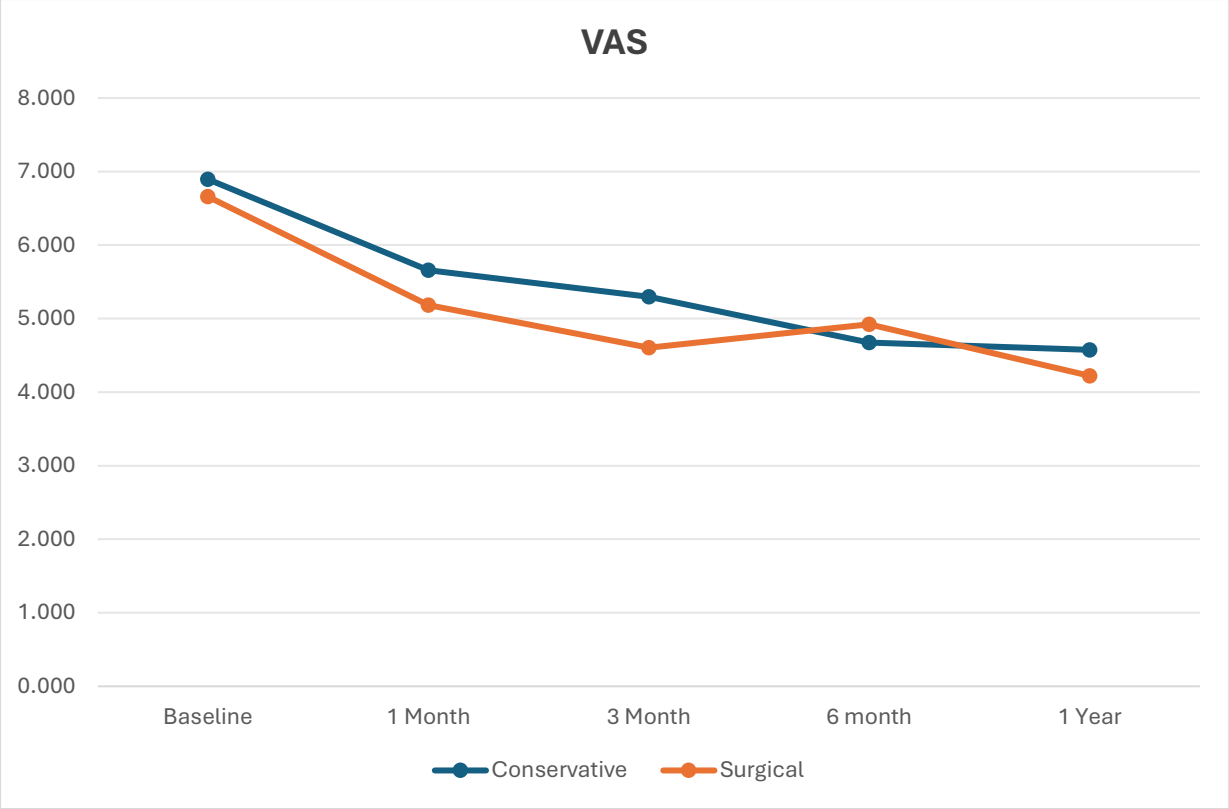


Figure 3. Comparison of Visual Analogue Scale (VAS) Scores Over Follow-up Period

Table 4. Comparison of Continuous Variables (Age, Hospital Stay, ICU Stay) Between Study Groups

Variables	**Group**	**Mean ± SD**	**t value**	**p value**
Age in years	Conservative	79.61±6.64	6.172	**<0.001***
	Surgical	70.32±6.48		
Hospital Stay days	Conservative	14.87±4.39	-7.941	**<0.001***
	Surgical	28.08±9.27		
ICU Stay Days	Conservative	5.18±2.57	-10.548	**<0.001***
	Surgical	12.95±3.74		

*p<0.05-Statistical significance

Table 5. Logistic Regression Analysis of Factors Associated with Treatment Outcomes

Group	**Parameters**	**B**	**S.E.**	**Wald**	**p value**	**OR**	**95% C.I. for EXP(B)**	
							Lower	**Upper**
Conservative	Age in years	-.026	.074	.125	.724	.974	.842	1.126
	Hospital Stay days	-.093	.210	.197	.658	.911	.603	1.376
	ICU Stay Days	.100	.366	.074	.785	1.105	.540	2.262

Surgical	Age in years	-.032	.121	.069	.793	.969	.764	1.228
	Hospital Stay days	.196	.158	1.542	.214	1.217	.893	1.659
	ICU Stay Days	-.327	.533	.375	.540	.721	.254	2.051

Overall, the findings indicate that surgical management is associated with significantly higher fracture union rates and prevention of secondary neurological deficits, albeit at the expense of increased complications and longer hospital and ICU stays. Conservative management, while associated with fewer complications and shorter hospital stay, demonstrated lower union rates and a higher incidence of neurological deterioration.

Discussion

This study compared the outcomes of conservative and surgical treatment of odontoid fractures in 76 patients treated at a tertiary care centre in South India. The results show that surgical treatment gives better fracture healing and protects against neurological problems, while conservative treatment has fewer complications and shorter hospital stay.

The average age was higher in the conservative group (79.61 ± 6.64 years) compared to the surgical group (70.32 ± 6.48 years). This shows that older patients with more health problems are usually treated without surgery due to higher operative risk. This finding is similar to Govind et al. (2022), who reported that age ≥80 years was the main factor for choosing conservative treatment [11]. The higher number of female patients in the conservative group may be due to osteoporosis-related fractures being more common in elderly women, as also reported by Pearson et al. (2016) [12].

Fracture healing was much better in the surgical group (73.3% vs 26.7%; $p < 0.001$). This is in agreement with previous studies. Luksanapruksa et al. (2018) showed in a meta-analysis that surgery leads to better healing rates, especially in Type II fractures [13]. Rocha et al. (2020) also reported similar healing rates (74%) with anterior screw fixation [14]. Poor healing (non-union) can lead to instability and neurological problems later, as shown by Smith et al. (2015), who found worse long-term outcomes in such patients [15].

New neurological problems occurred only in the conservative group ($p = 0.003$). This is an important finding. It may happen due to improper alignment, movement during immobilisation, or instability due to non-union. Patel et al. (2015) also reported that neurological worsening occurred only in conservatively treated patients (14.3%) [6]. Lenarz et al. (2019) similarly found that surgery prevents such neurological complications [16]. The risk of progressive cervical myelopathy from untreated instability is well recognised, and early surgical stabilisation may prevent irreversible cord damage in susceptible patients, as highlighted by Fehlings et al. (2015) [17].

Mortality was higher in the conservative group (71.4% of deaths), but this was not statistically significant ($p = 0.234$). This may be due to older age and more comorbidities in this group rather than the treatment itself. Schoenfeld et al. (2017) also reported no significant difference in

mortality between the two groups after adjusting for age [9]. In geriatric patients undergoing posterior C1-C2 arthrodesis, Molinari et al. (2016) reported acceptable morbidity and mortality outcomes, suggesting that surgical risk can be managed appropriately with careful patient selection [18].

Complications were more common in the surgical group (75% vs 25%; $p = 0.003$). These included problems like implant failure, swallowing difficulty, wound infection, and blood clots. Guo et al. (2018) reported dysphagia in 7.8% of patients after cervical spine surgery [19]. However, infections like pneumonia and urinary infection were seen in both groups, as elderly patients are generally more vulnerable.

Hospital stay (28.08 vs 14.87 days; $p < 0.001$) and ICU stay (12.95 vs 5.18 days; $p < 0.001$) were longer in the surgical group. This is due to surgery, need for monitoring, and management of complications. Elgafy et al. (2015) also reported longer hospital stay and higher costs in surgical patients [7]. Odontoid fractures contribute significantly to the overall burden of traumatic spinal cord injury, and reducing associated complications through optimised treatment pathways remains a priority, as emphasised by Jain et al. (2015) [20].

Both groups showed improvement in functional outcomes (NDI and VAS scores) over one year, but the surgical group had slightly better results. Vaccaro et al. (2013) also found that surgery allows earlier recovery due to better stability and early mobilisation [4].

No independent predictors of outcome were identified in logistic regression analysis. This suggests that outcome depends on multiple factors such as fracture type, patient health, and treatment method, rather than a single factor. Ryken et al. (2013) also reported similar findings [10].

Conclusion

Surgical management of odontoid fractures is associated with higher fracture union rates and a lower risk of secondary neurological deterioration, making it the preferred option in medically fit patients, particularly those with unstable or displaced fractures. However, this benefit comes at the cost of increased complications and longer hospital stay. Conservative management remains a reasonable alternative in elderly or high-risk patients, offering fewer complications but with a higher likelihood of non-union and delayed neurological worsening. From a clinical perspective, treatment should be individualized, balancing fracture characteristics, patient age, comorbidities, neurological status, and surgical fitness to optimize outcomes, especially in resource-limited settings. Further large-scale prospective studies with longer follow-up are needed to establish standardized treatment guidelines.

Limitations

This study was conducted as a retrospective comparative observational study with prospective follow-up, and patients were not randomized to treatment groups. Treatment allocation was based on clinical judgment, including age, fracture characteristics, neurological status, and fitness for surgery, which may introduce selection bias and confounding. Baseline differences in demographic variables, particularly age and gender, were observed between groups and could have influenced outcomes. The study was performed at a

single tertiary care center with a relatively small sample size, which may limit generalizability and reduce the power to detect significant associations. Although fracture healing was assessed using CT-based criteria, the absence of blinded or multiple observer assessment may introduce measurement bias. Mortality was not analyzed based on cause, limiting interpretation of treatment-related outcomes. The follow-up period of 12 months may not adequately capture long-term outcomes such as delayed instability or late neurological deterioration. Detailed analysis of treatment crossover (conversion from conservative to surgical management), including fracture-type-specific indications and duration of prior conservative treatment, was not performed.

Statements and Declaration

Authors' Contributions

VS has contributed to the conceptualization, design of the study, literature search, data acquisition, manuscript editing and review. MMK contributed towards data acquisition Statistical analysis, Manuscript review and editing. VS acted as the corresponding author for this manuscript.

Conflicts of interest

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

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No funding was received for conducting this study.

Human and animal rights

This article does not contain any studies with human participants or animals performed by any of the authors.

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