Article published online: 2024-06-04

Research Article

Comparison of Anterior versus Posterior Fixation in Traumatic Subaxial Cervical Spine Subluxation in Terms of Intraoperative Blood Loss, Surgical Time, and Length of Hospital Stay: A Prospective Observational Study

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Indian J Neurotrauma

Abstract

Objective The aim of this study was to compare the outcome of anterior versus posterior fixation for traumatic subaxial cervical spine subluxation in terms of mean intraoperative blood loss, surgical time, and length of hospital stay.

Materials and Methods A prospective observational study was conducted from August 25, 2022 to August 24, 2023 at the Department of Neurosurgery, Punjab Institute of Neurosciences, Lahore, Pakistan, including 60 patients (30 in each group) fulfilling the inclusion criteria. Group A had anterior cervical fixation, while group B underwent posterior cervical fixation. Patients were monitored for intraoperative blood loss, surgical time, and length of hospital stay. All the results were collected and recorded on a proforma.

Results The mean age of the patients in group A was 45.40 ± 3.75 years and that in group B was 45.50 ± 4.13 years. In all, 48.8% ($n = 21$) were males and 52.9% ($n = 9$) were females in group A, while 51.2% ($n = 22$) were males and 47.1% ($n = 8$) were females in group B. The mean intraoperative blood loss was 71.60 ± 0.77 mL in group A and 101.76 ± 0.85 mL in group B. The mean surgical time was 72.73 ± 0.98 minutes in group A and 94.73 ± 0.58 minutes in group B. The mean length of hospital stay was 7.63 ± 0.55 days in group A and 12.80 ± 0.71 days in group B.

Conclusion It was concluded that the anterior approach is better than the posterior approach for traumatic subaxial cervical subluxation spine in terms of low blood loss, less surgical time, and reduced hospital stay.

Keywords
- spinal injuries
- surgical blood loss
- hospital stay
- operative time

Introduction

The cervical spine is the segment of the spine most vulnerable to injury due to its structure and flexibility. Although cervical spine injuries are infrequent, they can cause considerable and long-term impairment.[1,2] A cervical spine injury can be traumatic or nontraumatic. Blunt trauma, diving accidents, falls, motor vehicle accidents, penetrating injuries, or sports-related injuries are the most prevalent causes of traumatic cervical spine injuries. Nontraumatic causes include compression fractures caused by osteoporosis, arthritis, or malignancy, as well as spinal cord inflammation. Cervical

DOI https://doi.org/10.1055/s-0044-1786688.
ISSN 0973-0508.

Thieme Medical and Scientific Publishers Pvt. Ltd., A-12, 2nd Floor, Sector 2, Noida-201301 UP, India

spine flexion, extension, and rotation can all cause cervical spine injury.[3] The first step in treatment is to decompress the neuronal components. This is best conducted by traction, which is often done using tongs, and may assist in neurologic rehabilitation. In the cases where fracture reduction is not possible, either an anterior or a posterior approach is used to treat the patient.

The cervical spinal column is separated into two sections: anterior and posterior. The vertebral bodies are found in the anterior column, whereas the spinal cord and spinous processes are found in the posterior column. When an injury affects both the anterior and posterior columns, it is deemed unstable.[4] Radiological investigations, including plain radiographs of the cervical spine in anteroposterior, lateral, oblique, and open mouth views with a computed tomographic (CT) scan and magnetic resonance imaging (MRI) of the cervical spine, are performed. Radiology helps assess the stability of the cervical spine.[5] Cervical spine subluxation is initially managed by close reduction and the neurology of the patient is continuously monitored. This approach can minimize cervical fracture-dislocation injuries in up to 80% of patients. If neurology deteriorates, this merits open reduction. The most common reason for the deterioration of neurology after closed reduction is the cervical disk material's rupture. The disk herniations can be ruled out on MRI and it is advisable to get an MRI before opting for any intervention. Open reduction techniques include anterior reduction and instrumentation or posterior reduction and instrumentation and a combined approach.[6,7]

Many breakthroughs have been made in the surgical treatment of patients with an unstable cervical spine, including the use of instruments to impart immediate stabilization and maintain alignment to encourage fusion. Anterior cervical plating is currently a routine procedure. Posterolateral mass screw and plate or rod constructs have grown in favor, and in vitro studies have shown them to be biomechanically superior to previous techniques.[8] An anterior approach is typically employed in cases of spinal cord compression caused by retropulsed bone fragments or disk herniation.[9] A posterior approach is frequently used if the patient has posterior ligamentous disruption without dislocation or irreducible locked facets in fracture-dislocation.[10] However, there are clinical circumstances when there are no obvious requirements for either an anterior or a posterior approach. Reducible dislocations or reducible unstable fractures that fail following mobilization are examples of such circumstances. Wiring, laminar screw fixation, lateral mass screw fixation, and pedicle screw fixation are surgical options for posterior subaxial spine stabilization.[11]

In a study conducted by Ren et al, the posterior approach group had greater blood loss (102.4 ± 18.5 vs. 71.5 ± 14.6 mL; $p < 0.001$) and longer surgical times (93.0 ± 11.3 vs. 72.1 ± 9.2 minutes; $p < 0.001$) compared with the anterior approach group. The posterior approach group had considerably longer hospital stays than the anterior approach group (13.4 ± 2.3 vs. 8.6 ± 1.5 days; $p < 0.001$).[12] As there is a paucity of data in the literature to date, our study may add to the national and international literature and help us instigate a treatment regimen more suitable to our local population.

Materials and Methods

Study Design

This is a prospective observational study.

Study Setting

The study was conducted at the Department of Neurosurgery, Punjab Institute of Neurosciences, Lahore, Pakistan.

Study Duration

The duration of the study was 1 year (August 25, 2022 to August 24, 2023).

Sampling Technique

The sampling technique employed in this study was nonprobability consecutive sampling.

Sample Size

The sample size of 60 (30 in each group) was calculated with 95% confidence interval (CI) and 80% power of test, and expected blood loss, surgical time, and length of hospital stay in the posterior versus anterior approach were taken with reference to the study by Ren et al.[12]

Sample Selection

Inclusion Criteria

- Patients aged 18 to 60 years from both genders.
- Patient with traumatic injury from C3 to C7.
- Posttraumatic subaxial cervical spine subluxation.
- Subaxial cervical spine injury classification (SLIC) score ≥ 4.

Exclusion Criteria

- Pathological fractures.
- Posttraumatic ruptured disc.
- Previous spine surgery.
- Irreducible locked facets.
- Comorbidities.
- Osteoporotic spine.
- Lateral mass fractures of vertebrae above or below the level of injury.
- Multiple injury levels.
- Polytrauma.

Data Collection Procedure

After approval from the ethical review board, 60 patients (30 in each group) fulfilling the inclusion criteria were enrolled in this study. Written and informed consents were taken from each patient. The demographic information was recorded on a proforma. A proper history and neurological examination were performed. The subaxial cervical spine subluxation diagnosis was made based on history, examination, X-rays, CT, and MRI of the cervical spine. The patients were divided into two groups: A and B. Group A patients had anterior cervical fixation, while group B patients underwent posterior cervical fixation. An experienced neurosurgeon executed all surgical procedures on the elective list. A single shot broad-spectrum antibiotic (intravenously) was given to all the patients at induction and general anesthesia was administered. All patients received injection Ketorolac (30 mg) at the time of induction. The analgesia was repeated every 8 hours postsurgery. All the patients were monitored for intraoperative blood loss and surgical time. Postoperatively, they were shifted to a high-dependency unit with a cervical collar. The length of hospital stay was calculated. All the results were collected and recorded on the proforma.

Data Analysis Procedure

All the data were entered and analyzed by using Statistical Package for Social Sciences (SPSS) version 24. Quantitative data like age, body mass index (BMI), blood loss, surgical time, and length of hospital stay were presented by the mean and standard deviation (SD). Qualitative data like gender were presented by frequency and percentages. Outcome in both the groups were compared by *t*-test. Stratification was done based on age, gender, and BMI to see its effect on the outcome variable, that is, intraoperative blood loss, surgical time, and length of hospital stay. The *t*-test was performed and a *p*-value $\leq$0.05 was considered as significant.

Results

Age distribution of the patients showed that out of 60 patients (30 in each group), 0% ($n = 0$) were in the age group of 18 to 35 years and 51.7% ($n = 30$) were in the age group of 36 to 60 years in the anterior cervical fixation group and 100% ($n = 20$) were in the age group of 18 to 35 years and 48.3% ($n = 28$) were in the age group of 36 to 60 years in the posterior cervical fixation group. The mean age of the anterior cervical fixation group was 45.40 ± 3.75 years and the mean age of the posterior cervical fixation group was 45.50 ± 4.13 years (►**Table 1**).

Gender distribution showed that 48.8% ($n = 21$) were males in the anterior cervical fixation group and 52.9% ($n = 9$) were females, whereas 51.2% ($n = 22$) were males and 47.1% ($n = 8$) females in the posterior cervical fixation group (►**Table 1**).

The BMI was 26.86 ± 7.37 kg/m^2 in group A and 28.24 ± 3.18 kg/m^2 in group B (►**Table 1**). The mean intraoperative blood loss was 71.60 ± 0.77 mL in group A and 101.76 ± 0.85 mL in group B (►**Table 1**). The mean surgical time was 72.73 ± 0.98 minutes in group A and 94.73 ± 0.58 minutes in group B (►**Table 1**). The mean length of hospital stay was 7.63 ± 0.55 days in group A and 12.80 ± 0.71 days in group B (►**Table 1**).

Both the groups were compared for mean blood loss, surgical time, and length of hospital stay. The data were stratified for age, gender, and BMI, which showed significant results ($p \leq 0.001$; ►**Tables 2–4**).

Discussion

The cervical spine is the most prevalent site of spinal cord injuries, occurring in 3% of all blunt traumas and generally resulting in severe cervical spinal cord injury.[13,14] The most prevalent location of damage is the subaxial cervical spine, with approximately 50% of injuries occurring between C5 and C7.[15] Unilateral and bilateral facet dislocation is another typical finding in cervical spine injuries.[16] Decompression of the neuronal components is the first step in treatment. Cervical traction is one of the most efficient methods for alleviating neurological symptoms in patients.[17] Surgical intervention is required for cervical spine reconstruction, preservation of the spinal cord and nerve roots, and restoration of cervical alignment and spine stability.[18] Surgical approaches for individuals with subaxial cervical injuries are controversial among surgeons. Cervical spine fractures and displacements are now treated using the anterior, posterior, or combination techniques. So far, numerous studies have shown conflicting results about the benefits and drawbacks of each of the aforementioned procedures.[17,18]

Table 1 Variables in both the groups in the study

Variables		Groups		Total ($n = 60$)
		A ($n = 30$)	B ($n = 30$)	
Age (y)	18–35	0 (0%)	2 (6.67%)	2 (3.33%)
	36–60	30 (100%)	28 (93.33%)	58 (96.67%)
	Mean ± SD	45.40 ± 3.75	45.50 ± 4.13	–
Gender	Male	21 (70%)	22 (73.33%)	43 (71.67%)
	Female	9 (30%)	8 (26.67%)	17 (28.33%)
Mean BMI (kg/m^2)		26.86 ± 7.37	28.24 ± 3.18	–
Mean blood loss (mL)		71.60 ± 0.77	101.76 ± 0.85	–
Mean surgical time (min)		72.73 ± 0.98	94.73 ± 0.58	–
Mean hospital stay (d)		7.63 ± 0.55	12.80 ± 0.71	–

Abbreviations: BMI, body mass index; SD, standard deviation.

Table 2 Stratification results by using independent sample *t*-test for intraoperative blood loss in both groups with respect to age, gender, and BMI

Blood loss with respect to		Groups	No. of patients	Mean ± SD	*p*-value
Age (y)	18–35	A	0	–	–
		B	2	102.50 ± 0.71	
	36–60	A	30	71.60 ± 0.77	<0.001
		B	28	101.71 ± 0.85	
Gender	Male	A	21	71.71 ± 0.78	<0.001
		B	22	101.63 ± 0.78	
	Female	A	9	71.33 ± 0.71	<0.001
		B	8	102.12 ± 0.99	
BMI (kg/m^2)	17–25	A	14	71.64 ± 0.84	<0.001
		B	3	102.33 ± 0.57	
	>25	A	16	71.56 ± 0.72	<0.001
		B	27	101.70 ± 0.86	

Abbreviations: BMI, body mass index; SD, standard deviation.

Table 3 Stratification results by using independent sample *t*-test for surgical time in both the groups with respect to age, gender, and BMI

Surgical time with respect to		Groups	No. of patients	Mean ± SD	*p*-value
Age (y)	18–35	A	0	–	–
		B	2	95.00 ± 0.00	
	36–60	A	30	72.73 ± 0.98	<0.001
		B	28	94.71 ± 0.59	
Gender	Male	A	21	72.66 ± 0.96	<0.001
		B	22	94.72 ± 0.55	
	Female	A	9	72.88 ± 1.05	<0.001
		B	8	94.75 ± 0.71	
BMI (kg/m^2)	17–25	A	14	72.92 ± 1.07	<0.001
		B	3	95.33 ± 0.57	
	>25	A	16	72.56 ± 0.89	<0.001
		B	27	94.66 ± 0.55	

Abbreviations: BMI, body mass index; SD, standard deviation.

Table 4 Stratification results by using independent sample *t*-test for length of hospital stay in both the groups with respect to age, gender and BMI

Hospital stay with respect to		Groups	No. of patients	Mean ± SD	*p*-value
Age (y)	18–35	A	0	–	–
		B	2	12.50 ± 0.71	
	36–60	A	30	7.63 ± 0.55	<0.001
		B	28	12.82 ± 0.72	
Gender	Male	A	21	7.71 ± 0.56	<0.001
		B	22	12.77 ± 0.68	
	Female	A	9	7.44 ± 0.52	<0.001
		B	8	12.87 ± 0.83	
BMI (kg/m^2)	17–25	A	14	7.57 ± 0.51	<0.001
		B	3	12.33 ± 0.57	
	>25	A	16	7.68 ± 0.60	<0.001
		B	27	12.85 ± 0.72	

Abbreviations: BMI, body mass index; SD, standard deviation.

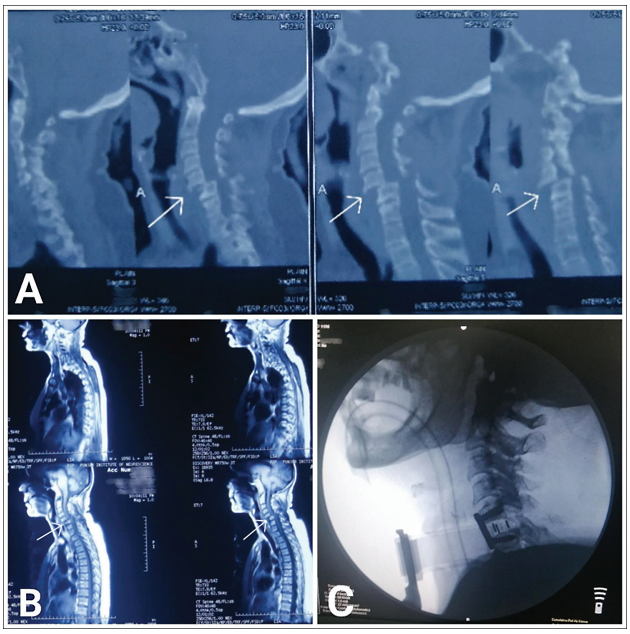

Fig. 1 (**A**) Sagittal cervical spine computed tomography (CT) scan showing C5 and C6 traumatic subluxation. (**B**) Sagittal T1 weighted magnetic resonance imaging (MRI). (**C**) Intraoperative fluoroscopic image of anterior cervical fixation. (White arrow points C4, C5 subluxation).

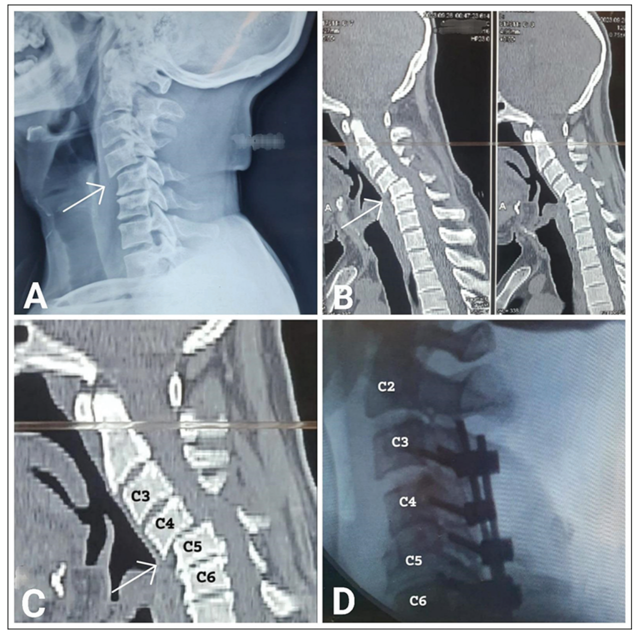

Fig. 3 (**A**) X-ray cervical spine lateral view showing C4 and C5 traumatic subluxation. (**B,C**) Sagittal cervical spine computed tomography (CT) scan of the same patient. (**D**) Intraoperative fluoroscopic image showing posterior cervical fixation. (White arrow points C4, C5 subluxation).

In the current study, we compared the outcomes in terms of the mean intraoperative blood loss, surgical time, and length of hospital stay between anterior fixation and posterior fixation for traumatic subaxial cervical spine subluxation. Both the fixation techniques and cases are shown in ►**Figs. 1–3**. We found that the mean age of the anterior cervical fixation group was 45.40 ± 3.75 years and that of the posterior cervical fixation group was 45.50 ± 4.13 years. BMI was $26.86 \pm 7.37\,kg/m^2$ in the anterior cervical fixation group and $28.24 \pm 3.18\,kg/m^2$ in the posterior cervical fixation group. Intraoperative blood loss was 71.60 ± 0.77 mL in the anterior cervical fixation group and 101.76 ± 0.85 mL in the posterior cervical fixation group, surgical time was 72.73 ± 0.98 minutes in the anterior cervical fixation group and 94.73 ± 0.58 minutes in the posterior cervical fixation group, length of hospital stay was 7.63 ± 0.55 days in the anterior cervical fixation group and 12.80 ± 0.71 days in the posterior cervical fixation group. Both the groups were compared for mean blood loss, surgical time, and length of hospital stay, and the poststratification results showed significant results ($p < 0.001$).

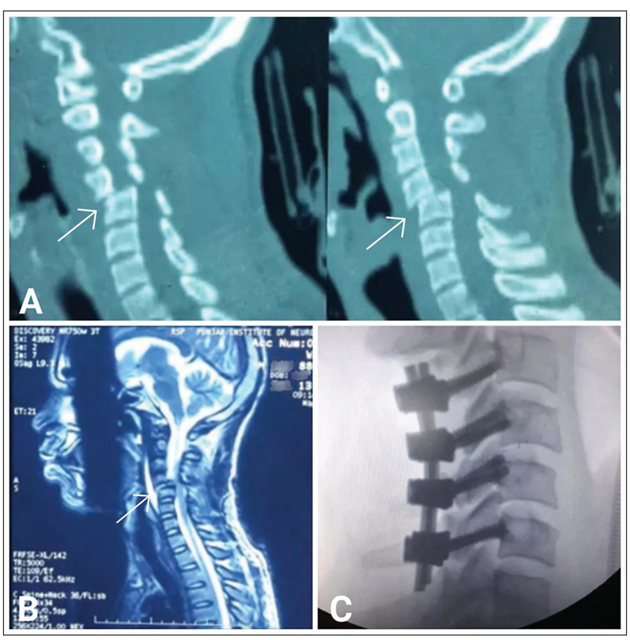

Fig. 2 (**A**) Sagittal cervical spine computed tomography (CT) scan showing C4 and C5 traumatic subluxation. (**B**) Sagittal T2-weighted magnetic resonance imaging (MRI). (**C**) Intraoperative fluoroscopic image of posterior cervical fixation. (White arrow points C4, C5 subluxation).

Each year, 150,000 persons in North America suffer from cervical spinal injuries,[19] and a considerable percentage of these patients acquire neurological disorders. As a result, it is critical to manage these patients to get the best possible outcome. A study looked at the clinical and radiological results of subaxial cervical spine injuries treated with surgery. During the 7-year study period (2011–2017), 72 patients satisfied the inclusion criteria, the majority of whom were males in their 40s. Furthermore, the most prevalent cause of subaxial cervical spine injuries was a motor vehicle accident. As previously stated, C5–C7 was a common site of subaxial injuries,[15] and in our study, this area was also frequently the site of fracture and dislocation. Approximately half of the patients had surgery with the anterior approach. Complications and the length of hospital stay following surgery were similar for all approaches. Significantly higher death rates were linked to a combined approach during a single round of surgery; however, none of these deaths were brought on by the procedure. Nevertheless, no correlation found between the type of approach and the length of hospital stay or the frequency of complications; as a result, the type of surgical approach cannot be held responsible for this notable discrepancy. The American Spinal Injury Association (ASIA) impairment score showed no discernible variation across the approaches. Moreover, there was no correlation between the kind of approach and instrument-related factors according to follow-up X-ray imaging. Nevertheless, their study showed that the posterior approach had the highest lordosis correction. At two rounds, the posterior approach showed a higher rate of loss of correction, whereas the combined approach showed a lower rate.[20]

Surgical approaches for individuals with subaxial cervical injuries are controversial among surgeons. Cervical decompression, reconstruction, and stabilization are all factors that may assist the surgeon in determining the best approach.[21] Since Robinson and Smith initially detailed their technique 60 years ago, the usage of an anterior approach has expanded, and it is now one of the most popular spine procedures.[22] In comparison to the posterior approach, this form of therapy restores normal stiffness in flexion, extension, rotation, and axial loading.[17]

Do Koh et al[23] demonstrated in a biomechanical study that posterior plating with interbody grafting was better to anterior plating for stabilizing one-level flexion-distraction injury or burst injury. Ianuzzi et al[24] highlighted in another biomechanical study that anterior, posterior, and mixed single-level constructions restored stability; nevertheless, differences in the construct are still unclear. Lins et al[18] compared the surgical therapy of traumatic cervical facet dislocation to the approach type. Furthermore, they discovered that both anterior and posterior approaches may be employed for cervical facet dislocation, with none being superior to the other; as a consequence, surgeons can conduct both procedures as well as combination approaches. Toh et al[25] investigated the radiological and neurological consequences of burst fractures or teardrop dislocation fractures in the middle and lower cervical spine at the same time. They examined 31 patients and determined that for subaxial burst fractures or teardrop dislocation fractures, the anterior approach was preferred. Similarly, Kwon et al[26] evaluated the result of unilateral subaxial facet fracture, dislocation, or fracture-dislocation, and concluded that all methods were efficacious and had similar outcomes. They also discovered that the anterior approach resulted in reduced postoperative discomfort, wound complications, and a greater rate of fusion.

Brodke et al[17] investigated the anterior and posterior approaches for cervical spinal cord injuries and found no statistically significant difference in neurological improvement between the two techniques. Also, there was no statistically significant relationship between fusion status and kyphosis improvement. As a result, they concluded that an anterior or posterior approach might be used to stabilize the unstable cervical spine; moreover, the selection could be determined on the surgeon's preference, particular indications, and patient conditions. Dvorak et al[27] published a review article titled "The surgical approach to subaxial cervical spine injuries: an evidence-based algorithm based on the SLIC classification system." The SLIC classification can identify patients who can be handled nonsurgically; as a result, they released several algorithms that can assist surgeons in making judgments about which technique to use based on the SLIC system components.

In the treatment of patients with cervical spinal cord injuries and unstable cervical spines, there are no strong data that support the anterior or posterior approach. Both the anterior and posterior techniques of gaining stability and performing a fusion have an appeal, but for different reasons. There is less muscle splitting and simpler dissection anteriorly. According to some, the patient tolerates it better postoperatively. The anterior column can be directly repaired. Furthermore, most cervical spine surgeons are familiar with the technique and anatomy. In the laboratory, the biomechanical strength favors the posterior approach and assures anatomical reduction of the facet joints.[28,29] The decision as to whether to approach from the front or back is often clear-cut and dependent on the pathology present. In general, an anterior approach is necessary to effectively decompress the spinal cord if there is a disk herniation. Dislocated facets that cannot be reduced by closed means may need a posterior approach for open reduction. Burst fractures frequently necessitate anterior decompression. Ligamentous instability can be addressed using either method.[30] The combined anterior and posterior approach is reserved for select instances and can be conducted as a single surgery or in stages.[31] At follow-up, anterior and posterior surgeries were associated with comparable neck impairment and overall quality of life, while anterior surgery was linked with better patient satisfaction and reduced infection rates.[32] Posterior cervical fixation necessitates a greater number of fused segments in individuals with reducible cervical subaxial dislocations and fractures. Shorter operating time and reduced blood loss correspond with anterior surgery. For this subset of patients, anterior instrumentation with interbody grafts may be the first line of therapy. If radiographs after anterior instrumentation show failure, posterior surgery is necessary.[33] A single posterior approach with open reduction and pedicle screw fixation can result in satisfactory clinical and radiological results for subaxial cervical dislocations after a short follow-up time. Although an initial attempt at closed reduction is preferable after cervical dislocation, for patients for whom closed reduction is not an appropriate intervention, an immediate and single-stage posterior approach with open reduction and pedicle screw fixation with or without posterolateral removal of traumatically herniated disk particle is one treatment option.[34]

Limitations and Future Recommendations

The shortcomings of our study are primarily due to its limited sample size. For improved findings, we advise larger sample sizes and longer follow-up periods in future studies.

Conclusion

According to our study the anterior approach is better than the posterior approach for traumatic subaxial cervical spine subluxation as it is associated with low blood loss, decreased surgical time, and reduced length of hospital stay.

Funding
None.

Conflict of interest
None declared.

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