

Original Article

Outcome of Surgical and Nonsurgical Methods in the Treatment of Unstable Traumatic Lesions of the Lower Cervical Spine

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Background: One of the important issues in the diagnosis and treatment of patients with trauma to the cervical spine is the stability of injured segment of vertebral column. This study was performed to compare the success rate and capacities of nonsurgical (halo cast) versus surgical management of lower cervical spine injuries.

Methods: Forty patients admitted to hospitals affiliated to Shiraz University of Medical Sciences, Shiraz, Iran with such injuries were divided into two equal groups (halo cast versus surgery). In each group, cases were divided into three categories, based on the type of lesion. The percentage of sagittal subluxation and the degree of sagittal angulation were chosen as the criteria for assessing the treatment outcome; each of these indices was measured on radiographical images, which were recorded at the time of admission and six months later.

Results: Members of both groups showed significant improvements in the measured indices. The amount of correction in subluxation was not significantly different between the two groups; however, surgical approach resulted in a significantly better correction of angulation.

Conclusion: Nonsurgical approach can be an acceptable alternative to surgical correction in selected patients with various lower cervical spine injuries.

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Keywords: Lower cervical spine • outcome • unstable traumatic lesions

Introduction

Spinal column injury, especially at the level of cervical spine, is one of the most common causes of death due to trauma. Timely diagnosis and management of these patients can significantly decrease the associated mortality.¹⁻³ Injury to the cervical spine can result from different mechanisms, including hyperflexion, flexion-rotation, hyperextension, and extension-rotation.⁴⁻⁶ One of the most important issues in the diagnosis and treatment of patients with trauma to the cervical spine is the stability of the injured segment. Stability can be defined from both clinical and radiological aspects.^{7,8} Clinically, stability of vertebral column is defined as the

absence of subluxation and misshaping after the introduction of a physiologic force or during recovery period and the lack of pressure on and injury to neural tissues at the time of trauma or during recovery.⁸ From the radiological point of view, instability is defined as the presence of five out of the following six criteria including destruction of the anterior or posterior part of vertebrae, sagittal angulation $>11^\circ$, sagittal subluxation >3.5 mm, spinal cord injury, nerve root injury or narrowing of the disc space, and significant stress to cervical vertebrae.⁹⁻¹¹

Surgical and nonsurgical methods or a combination of them have been used for almost a century to treat patients with unstable cervical spine lesions. Skull retraction with halo cast was introduced by Crutchfield in 1932. Despite its limitations and the need to hospitalize patients for a relatively long time, it is still widely used as the primary nonsurgical therapy and adjunct treatment to spine surgery. Surgical approach to cervical spine injury aims at realignment of the vertebrae, decompression of the nervous tissue, and providing

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stability for the injured bony spine. It is performed through either an anterior or posterior approach.⁹⁻¹¹

The objective of this study was to compare the success rate and capacities of the nonsurgical vs. surgical approach for management of unstable lower cervical spine lesions and their sequelae.

Patients and Methods

Among those admitted to teaching hospitals affiliated to Shiraz University of Medical Sciences, Shiraz, Iran with the diagnosis of unstable cervical spine injury, 40 patients were selected. All patients had undergone anteroposterior and lateral cervical X-rays, computed tomography (CT), and magnetic resonance imaging (MRI). All patients found to have >3.5 mm subluxation and >11° angulation. None of the patients had an absolute indication for surgical intervention, so both modalities of management could be selected. Presence of hematoma or a portion of bone or disc in the spinal canal absolutely mandates for surgical treatment.

All patients initially underwent cervical traction (5 lb/level) for realignment of the vertebrae. Afterwards, 20 of them were randomly selected for treatment with halo cast (halo group) and the rest for surgical approach (surgery group).

The halo group included 18 males and two females, with the age ranging from 15 – 65 years (mean: 36). The surgery group composed of 17 males and three females, with the age ranging from 18 – 65 years (mean: 37.5). The level of injury both groups is depicted in Table 1.

At the time of admission, the amount of the upper-to-lower subluxation and the degree of sagittal angulations between the involved vertebrae were measured on the radiographical images. To minimize the effect of differing degrees of magnification of radiographical images and anatomical variations, the amount of subluxation was recorded as percentage.

Patients in the halo group underwent treatment with halo cast for three months. Monthly

radiography was performed for each patient during this period. After removal of the cast and three months later, dynamic radiographical studies were repeated. The amount of subluxation and angulation in the last X-ray was compared with those in the initial image obtained at the time of admission.

In the surgery group, the anterior cervical approach was taken for 18 patients and the posterior approach for two. In the anterior approach, patients underwent discectomy, corpectomy, and interbody fusion with iliac graft using plate-screw in 17 and without iliac graft in one. In the posterior approach, sublaminar wiring was used in one and laminar hook in one other patient. Radiographical study was performed after the operation and three months later. The amount of subluxation and angulation in the last X-ray was compared with those in the initial image obtained at the time of admission.

To compare the success rate between the two groups, injuries to the cervical spine were divided into three categories of 1) ligament injury, 2) locked facet with or without posterior element fracture, and 3) fracture of body and subluxation/angulation with or without fracture of the posterior element.

Levene's test was used to determine the equality of variances in both groups. Angulation values were compared using Student's *t*-test. Subluxation data did not have a normal distribution, so Mann-Whitney's U-test was used to compare data of the two groups. In each group, Wilcoxon's test was used to compare angulation and subluxation data before and after treatment. A *P* value <0.05 was considered statistically significant.

Results

In the halo group, most patients suffered from injury at the C3-C4 level. The mean amount of subluxation was 28% and the mean angulation was 15°. In the surgery group, the largest number of patients had injury at the level of C4-C5. The mean amount of subluxation was 27% and the mean angulation was 15°.

Five patients in the halo group belonged to the category 1. The mean subluxation and angulation at the time of admission was 26% and 15°, respectively. These changed to 3% and 5°, six months later (i.e., three months after removal of

Table 1. Level of injury among the halo and surgery groups.

Level of injury	Number of patients	
	Halo	Surgery
C3-C4	10	3
C4-C5	2	8
C5-C6	4	6
C6-C7	3	3
C7-T1	1	0

the halo cast). Seven patients in the surgery group were in category 1. The mean subluxation at the time of admission was 27%, and the mean angulation was 14°. These values changed to 0% and 2°, respectively. Within each group, the decrease in the amount of subluxation and the degree of angulation was significant before and after the treatment. Comparing the results of treatment between the two groups, it was found that although no significant difference was observed regarding the subluxation ($P = 0.202$), the decrease in the degree of angulation was significantly different ($P = 0.010$).

Category 2 included five patients from the halo group, one of whom had a relapse of locked facet after treatment with the halo cast, so surgery was performed to stabilize the vertebra. The other four patients had a change in subluxation from 26% to 3% and in angulation from 16° to 3°.

Seven patients from the surgery group belonged to the category 2, six of whom underwent the anterior and one the posterior approach. In these patients, the mean angulation was decreased from 14° to 2° and the mean subluxation from 28% to 2%. No statistically significant difference was observed in the treatment results between the two groups ($P = 0.755$ for both angulation and subluxation).

Ten patients in the halo group had category 3 disease. One of them experienced a relapse of the subluxation/angulation after the removal of the halo cast. In the other nine patients, the mean subluxation changed from 26% to 6% and the angulation from 14° to 6°. In the surgery group, six patients belonged to the category 3. In these patients, the mean subluxation changed from 24% to 3%, and the mean angulation decreased from 15° to 3°. Statistical analyses of level of improvements in the angulation values revealed that there was a significant difference between the surgery and halo groups ($P < 0.001$). The improvement in subluxation was not significantly different between the two groups ($P = 0.428$).

Discussion

Trauma to the cervical spine can result in different injuries, many of which can have serious sequela and must be managed promptly. Treatment of the cervical spine injuries can be accomplished using both surgical and nonsurgical approaches. Although some lesions necessitate surgical intervention, for others either approach can be

used.⁶⁻⁸

Outcomes and complications of nonsurgical and surgical methods in the management of various cervical spine injuries have been the subject of many studies, some focusing on a specific category of spine injury. Hosssain et al reviewed 104 patients with cervical spine injury managed with halo cast alone or surgery. They found a failure rate of 10% for primary immobilization with halo cast.⁴ The highest rate of failure (15%) occurred in patients with fracture/subluxation. Overall, they concluded that halo cast is an effective nonsurgical treatment for the injured cervical spine at both upper and lower levels.⁴ Vieweg and Schultheiss reviewed 35 relevant studies involving 682 patients with 709 different types of injuries to determine the outcomes after immobilization in a halo vest. Studies were analyzed according to the type of injury and in terms of the treatment outcomes following primary treatment with a halo vest. An overall healing rate of 86% was observed, and they concluded that this treatment continues to be a good alternative to operative stabilization of bone injuries to the upper cervical spine.¹⁰

In subluxation/angulation injuries, which are caused by trauma to ligaments, the lesion tends to be stable, but some increase in the subluxation/angulation with halo cast may be seen.⁸ Cooper et al found that by adjusting the rod connecting the body jacket and the halo ring, the increase in the extent of subluxation during treatment can be arrested and recorrected²; however, Sears and Fazl reported a 75% fusion rate in this type of injury, with additional surgery for those lesions, which are not stabilized enough.⁷ In our study, patients with ligament injury who had been treated with halo cast had a significant correction of their subluxation and angulation; a finding similar to the results observed in those who underwent surgery. In other words, both surgical and nonsurgical approaches were satisfactory regarding the management of ligament injuries. However, the degree of correction of angulation was significantly higher in the surgery compared to the halo group. Since our patients were only followed for six months after trauma, we could not evaluate the clinical significance of the differences observed.

Facet dislocation and locking is a more serious lesion, from the viewpoints of management and neurological complications. Sears and Fazl found a success rate of 44% in the management of locked facet with halo cast.⁷ However, Lifeso and Colucci observed that in this category, the nonoperative

management was uniformly unsuccessful in 32 patients.⁶ In the present study, five patients were treated with halo cast; surgery was performed later on one due to failure of the halo cast to arrest the instability. The other four patients showed an acceptable improvement in both the subluxation and angulation (80% success rate). Statistical analysis showed no significant difference between the two groups regarding the level of improvement. It must be noted that all patients had a unilateral locked facet. Bilateral locked facet results from a more severe trauma to the spine and is expected to be associated with more extensive injury and a higher risk of cord injury. Whether we can apply our findings to those patients with bilateral locked facet who have no absolute indication for surgery, is a matter of further studies.

Management of patients with fractures of vertebrae and subluxation/angulation, is more difficult than other categories. Although many patients ultimately need surgical correction of the spinal lesion, halo cast remains a choice in selected patients. Studies have yielded differing results on this subject. Cooper et al observed an acceptable fusion rate of almost 80% in a series of patients.² The study by Koivikko et al on nine patients with burst fractures showed a higher success rate and more acceptable subluxation correction with surgery compared with halo cast.⁵ Fisher et al found that surgery with anterior approach for teardrop fractures was significantly superior to halo cast for restoring and maintaining sagittal alignment.³ Bucci et al reached the same conclusion in a study on 49 cases.¹ In our study, out of ten patients with complex fracture assigned to the halo group, one required surgery after using halo cast due to failure to stabilize; however, in the other nine patients, an acceptable fusion was accomplished (90%). In the halo group, the correction in subluxation did not significantly differ from the surgery group; however, the amount of correction in the angulation was significantly greater in the surgery group.

In conclusion, although a limited number of patients were included in this study, results indicate a reasonably high success rate for treatment with halo cast compared with surgical correction. The criteria used to compare the two methods were percentage of subluxation, and degree of sagittal angulation, which have been used in other studies as well. The difference in the

correction of angulation between the two groups needs further work to assess its clinical significance. Although it is reasonable to consider surgery as the first step for spinal lesions that look more severe or more unstable, using halo cast can be an acceptable alternative in certain situations, such as the lack of appropriate operative facility. Of course, a larger sample with a longer follow-up period may be required to verify the results of this study for more extensive injuries.

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