Comparative Study of Interspinous Wiring and Lateral Mass Fixation in Conjunction with Anterior Fusion in the Treatment of Sub Axial Cervical Spine Trauma

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ABSTRACT
Cervical spine injuries is an important cause of morbidity worldwide, the common causes being fall from height and road traffic accidents. Different techniques are described for the management of severe sub axial spine trauma. For stabilization of two and three column injuries, traditionally surgical fixation is done. While anterior cervical fusion with plating and screwing/corpectomy and CAGE is done anteriorly to stabilize the ventral column, many methods for stabilizing posterior column has been described. In our institution we have regularly followed two methods: either a simple posterior interspinous wiring or lateral mass screw and rod fixation.
58 cases who underwent surgery during three year period were analyzed, 47 cases available for follow up. 23 cases had interspinous wiring and 19 cases lateral mass fixation as posterior procedure along with anterior fusion. Only anterior fixation was done in 16 cases. Comparison of the two procedures in terms of stability and fusion on serial x-rays, complications, surgical time, neurological recovery and cost factor was done. While used in conjunction with anterior fusion, the role of both interspinous wiring and lateral mass fixation are same i.e. to maintain the posterior construct and provide the stability till the anterior fusion is complete. Interspinous wiring is a relatively safe, simple technique even in inexperienced hands. The duration of surgery, blood loss and radiation exposure are less compared to lateral mass fixation.

Keywords: Interspinous wiring, Lateral mass fixation, circumferential fusion.

Introduction
The incidence of traumatic spinal cord injury varies from 13.1 per million in developed countries to 12.7 to 29.7 per million in developing countries. The average age of victims in developed countries varies from 30.7 to 48.5 years whereas in developing countries the average age is below 30 years. Male to female ratio in developed countries varies from 3:1 to 4.3:1. The main cause of traumatic spine injury in developed countries is road traffic accidents followed by falls while in developing countries, falls are the primary cause. In trauma patients, vertebral column injuries occur in about 6% of cases. Patient characteristics like age more than 50, high energy trauma as the mechanism of injury and
presence of head injury adversely affect the survival of patients with traumatic spine injury.\cite{1,6} Prolonged use of external stabilization with collars can result in skin complications. So it is preferable to operate on sub axial cervical spine fractures to stabilize the fracture and improve healing\cite{1}. In subaxial cervical spine fractures involving two or three column injuries, the most stable technique is circumferential fixation\cite{7} The anterior column is stabilized by anterior cervical discectomy or corpectomy with fusion. But for the posterior stabilization, many methods like lateral mass fixation, inter spinous wiring, facet wiring, lateral fixation with plates etc. We try to analyze the effectiveness of the two procedures—Interspinous wiring or Lateral Mass Fixation—when used in conjunction with ventral fusion—in terms of fusion, stability, complications, Surgery time and cost factor

**Materials and Methods**

All patients who underwent circumferential fusion during the three year period from 2013 to 2016 were evaluated.

**Inclusion Criteria**

1. Sub axial cervical spine injury
2. H/o trauma
3. two or three column injury
4. Facet dislocation with unilateral or bilateral locking
5. Single motion segment
6. Posterior elements intact in patients undergoing interspinous wiring.

**Exclusion Criteria:** Patients without subluxation, multiple motion segments involved and those cases requiring multiple level constructs, pathological fractures

All patients were evaluated with initial X-ray cervical spine followed by CT scan cervical spine and head, MRI cervical spine. Traction was applied in a good number of cases. Those cases not reduced under skull traction had to undergo posterior approach, reduction and fixation by either lateral mass fixation or interspinous wiring. Some patients with significant anterior compression with disc material had to undergo initial anterior procedure. Some cases with reduction under traction underwent anterior cervical discectomy with fusion and fixation with anterior cervical plates and screws, followed by philadelphia collar for 3 months. All other cases underwent circumferential fixation. anterior cervical discectomy or corpectomy, fusion with iliac crest graft or titanium cage filled with bone graft and fixation with titanium plates and screws. Posterior stabilization was done with either lateral mass screw rod fixation or interspinous wiring with titanium wires. For lateral mass fixation, we used 3.5 mm screws by Magerl’s technique.

Post operatively the patients were put on hard cervical collar for two weeks and started mobilization depending on the patient’s neurological status and post-operative X-ray. Patients were followed up two weeks after discharge and again at 3 months and 6 months. X-rays were repeated during each visit to look for any malalignment, graft displacement, wire breakage, screw pull out, recurrent subluxation or loss of sagittal alignment. Assessment of neurological status was done using the American Spinal Injury Association(ASIA) Scale pre- and postoperatively and during follow up\cite{8}. Stability and fusion was assessed in X-rays by\cite{1} absence of translation between the vertebra on flexion extension images\cite{2} absence of hardware loosening \cite{3} absence of motion between contiguous spinous process on flexion—extension X-rays.\cite{9}

Information regarding the following were collected and tabulated: Age/sex ,Mechanism of injury, Level of subluxation Cord injury, Neurological deficits in case of cord injury and neurological improvement was recorded in ASIA chart, Reduction to traction, Type of posterior procedure, Operative time, Complications, Improvement on follow up, Achievement of fusion, The role of traction in achieving reduction was analyzed. A comparison was drawn between interspinous wiring and lateral mass fixation based on information collected.
Results
Total of 58 patients ranging from 20 years to 75 years with a mean age of 42.7 years, 56 males and 2 females underwent surgery for severe sub axial cervical spine trauma during the study period. 11 patients expired of which 9 expired during the first two weeks and 2 after 3 months. Fall from height was the major cause of injury in 37 cases (63.7%), road traffic accidents in 17 cases (29.3%) and heavy objects falling on head in 4 cases (6.9%). (chart 1). C3-4 in 4 cases, C4-5 in 8 cases, C5-6 in 22 cases, C6-7 in 21 cases and C7-D1 in 3 cases were involved (chart 2). 16 cases underwent anterior fusion alone following reduction by skull traction of which 4 patients expired. 42 cases underwent circumferential fusion with interspinous wiring as the posterior procedure in 23 cases (3 expired) and lateral mass fixation in 19 cases (4 expired). 47 cases were available for follow up. The average duration of surgery in circumferential fusion when lateral mass fixation is used is 5 to 5½ hours whereas it is 4 to 4½ hours in interspinous wiring. Blood loss is significantly less in interspinous wiring. 16 cases in interspinous group showed neurological improvement in ASIA score, the rest remain same. In lateral mass fixation group, 12 cases showed improvement while others static. No significant operative complication was observed in interspinous wiring but one case of root injury and one case of lateral mass fracture in the lateral mass fixation group. In those cases where only anterior fusion was done, recurrent subluxation occurred in one patient and had to undergo a revision surgery and circumferential fixation. Follow up dynamic x-rays showed stability and fusion in all cases of circumferential fusion in both the procedures.

Chart 1. Causes of Trauma: Total 58 patients

Chart 2. Levels of Trauma: Total 58 patients

Chart 3 Total 47 patients available for follow up

The major causes of death in patients were respiratory tract infection, ventilator associated pneumonia and sepsis. Two patients developed refractory hypotension and cardiac arrest.
In those cases where anterior fusion alone was performed, the patients had to be kept on collar immobilization for 2 months and hence collar related skin excoriations and skin infections were seen in majority of patients. The cost of titanium wire for interspinous wiring is 1000 rupees whereas that for lateral mass fixation is around 20,000 rupees in addition to the cost of anterior fixation.

Discussion
For the management of severe cervical spine injury involving anterior and posterior columns, in those with unilateral or bilateral facet dislocations, circumferential fixation is the most stable technique. \[7\] But it requires prolonged surgical time and is associated with significant morbidity and blood loss. Some cases of facet dislocation which are reduced by traction, there is a tendency to fix anteriorly alone. Many authors have described this closed traction, rapid realignment followed by surgical stabilization with a view that early reduction gives high chance of neurological recovery. \[7,10\]. But in cases with traumatic disc protrusion, this can be hazardous. Hence Eismont et al proposed that before any such attempt, MRI should be done to rule out traumatic disc protrusion \[11\].

Whether posterior stabilization which allows the disrupted posterior tension band to be reestablished alone is sufficient is again a matter of debate. Elgaffy et al described the development of segmental kyphosis in some cases treated by posterior fixation alone like wiring. Cervical spine injuries with bilateral facet dislocations indicate severe and unstable injury and it requires dorsal supplemental instrumentation even if reduction and stabilization is achieved through anterior approach. Some authors have described that in bilateral facet dislocations treated by anterior approach alone, the redislocation rate is unacceptable \[12\]. So bilateral

Fig 1. C4-5 traumatic subluxation with locking CT and MRI

Fig 2. Posterior wiring + Anterior fusion follow up

Fig 3. Lateral Mass Fixation + Anterior fusion-Follow up

Fig 4. Anterior Fixation alone and recurrent subluxation
facet dislocation needs posterior unlocking, stabilization of posterior column by any acceptable technique followed by anterior fixation by graft at the level of disc space.
The management of unilateral facet dislocation in a neurologically intact patient is an area of debate. Many people practice halo vest or collar immobilization without open or closed reduction. But the incidence of recurrent instability and chronic pain in more than 50% of patients suggests reconsideration of this approach [13]. Some group suggests skeletal traction and anterior approach alone. In a series by Henriques the reoperation rate in such patients was 5.9% [14]. Shapiro et al described posterior wiring and facet wiring with iliac crest graft and in 22 cases of unilateral facet dislocation treated by his procedure, one had resubluxation which required anterior cervical fusion with plates [16]. This again suggests that anterior fusion with posterior augmentation by any procedure is the most stable one in comparison with anterior alone or posterior alone procedures.

Benzel in 1989 published an article where posterior interspinous wiring and fusion was used in 50 cases where graft rom iliac crest was placed on medial lamina to achieve fusion posteriorly. He descried it as a simple and straightforward procedure [17].

We use anterior cervical fusion with iliac crest graft or cage filled with graft and fixation with plates and screws in all the cases of sub axial cervical spine injuries with subluxation. About one third of the cases reduced by closed reduction with traction underwent anterior procedure alone. The remaining two third of the patients underwent posterior procedure either interspinous wiring or lateral mass fixation along with anterior fusion.

Posterior interspinous wiring, first described by Hadra in 1891 for the treatment of Potts spine has played a major role in cervical spine stabilization [18]. Rogers in 1942 gave a detailed description of the procedure [19] which was modified time to time by Abdu and Bohlman (triple-wiring), White hill, et al., Benzel and Kesterson, and Murphy and Southwick. Inter spinous wiring restores the posterior tension band reconstruct but does not prevent lateral bending and rotation [15]. Posterior cervical wiring requires that the posterior bony ring is preserved i.e., lamina, facet, and spine. The technique we follow involves; after reduction of the facet, a burr hole drilled transversely at the base of the upper spinous process and the lower spinous process. A braided titanium wire or cable is passed through the burr holes and tightened to keep the facet and lamina in anatomical position. The procedure is relatively safe and does not cause any injury to nerve roots, dura or vessels. It is cost effective too.

However posterior cervical interspinous wiring today has a very limited role in fixation of the subaxial spine, after the introduction of plates and screws, usually as an adjunct to other fixation constructs [8].

Lateral mass fixation with screws, first described by Roy-Camellie in 1964 has recently been the mainstay of posterior fixation of subaxial spine [18]. It was later modified by magerl, Louis and Anderson.

We commonly use the Mageri’s technique where the entry point is 1 mm medial and 1 mm cephalad to the Centre of the lateral mass directed 25 degrees laterally and parallel to the overlying facet joint cranially. 18mm long bicorticate screw is preferred while in Roy –camellie 14 mm screw is used [15]. Misplacement of the screws can cause injury to vertebral artery and the nerve root. Screw loosening and pull out are also described [15,20]. Moreover it is a technically demanding procedure using c-arm intensifier with about 92.5 fsec [11].

Conclusion
While used in conjunction with anterior fusion, the role of both interspinous wiring and lateral mass fixation are same ie to maintain the posterior construct and provide the stability till the anterior fusion is complete. Interspinous wiring is a relatively safe, simple technique even in inexperienced hands. The duration of surgery, blood loss and radiation exposure are less
compared to lateral mass fixation. The cost of implant is about 1000 rupees in wiring compared to 30,000 rupees in lateral mass fixation. The chance of complications like injury to vertebral artery and nerve roots is less with wiring and hence better safety profile. The chance of implant failure like screw pullout is less in wiring. But unlike lateral mass fixation, it does not provide stability in lateral flexion and rotation and has a limited role in cases where the spinous process and lamina are fractured.

References
1. Comparison Of Lateral Mass Screw Fixation Technique And Hartshill Rectangle Technique In The Treatment Of Sub-Axial Cervical Spine FracturesMohit KM, DNB Orth, Ajay CS, DNB Orth, Shashikant NN, DNB OrthMalaysian Orthopaedic Journal 2012 Vol 6 No 4
2. Epidemiology of Traumatic Spinal Cord Injury :Comparisons Between Developed and Developing Countries Wen-Ta Chiu, MD, PhD, Hsiao-Chiao Lin, MPH, Carlos Lam, MD, MPH, Shu-Fen Chu, MSc, Yung-Hsiao Chiang, MD, PhD, and Shin-Han Tsai, MD, PhDAsia-Pacific Journal of Public Health Volume 22 Number 1 January 2010 9-18
3. Shingu H, Ikata T, Katoh S, Akatsu T. Spinal cord injuries in Japan: a nationwide epidemiological survey in 1990. Paraplegia. 1994;32:3-8.
4. Ravaud JF, Delcey M, Desert JF. The Tetrafigap Survey on the long-term outcome of tetraplegic spinal cord injured persons, part II: demographic characteristics and initial cause of injury. Spinal Cord. 2000;38:164-172.
5. Pickett GE, Campos-Benitez M, Keller JL, Dug gal N. Epidemiology of traumatic spinal cord injury in Canada. Spine. 2006;31:799-805.
6. Blackmore CC, Emerson SS, Mann FA, et al. Cervical spine imaging in patients with trauma: determination of fracture risk to optimize use. Radiology 1999; 211(3): 759-65.
7. EdwardC. Benzel Spine Surgery Techniques, Complication avoidance and Management, 3rd Edition; chapter 64, sub axial cervical spine injuries
8. ASIA. Standards for Neurological Classification of Spinal Injury. Chicago: American Spinal Injury Association; 1996.
9. Farey ID, McAffee PC, Davis RF, Long DM. Pseudoarthrosis of the cervical spine after anterior arthrodesis. J Bone Joint Surg Am. 1990; 72: 1171-7.
10. Cotler JM, Herbison GJ, Nasuti JF, et al: Closed reduction of traumatic cervical spine dislocation using traction weights up to 140 pounds. Spine (Phil a Pa 1976) 18:386–390, 1993.
11. Eismont FJ, Arean MJ, Green BA: Extrusion of an intervertebral disc associated with traumatic subluxation or dislocation of cervical facets: case report. J Bone Joint Surg [Am] 73:1555–1560, 1991
12. Razack N, Green BA, Levi AD: The management of traumatic cervical bilateral facet fracture-dislocations with unicortical anterior plates.J Spinal Disord 13:374–381, 2000.
13. Rabb CH, Lopez J, Beauchamp K, et al: Unilateral cervical facet fractures with subluxation: injury patterns and treatment. J Spinal Disord Tech 20:416–422, 2007.
14. Henriques T, Olerud C, Bergman A, et al: Distractive flexion injuries of the subaxial cervical spine treated with anterior plate alone. J Spinal Disord Tech 17:1–7, 2004.
15. Ghori A, Le H V, Makanji H, et al. (October 01, 2015) Posterior Fixation Techniques in the Subaxial Cervical Spine. Cureus 7(10): e338. DOI 10.7759/ cureus.338
16. Outcome of 51 cases of unilateral locked cervical facets: interspinous braided cable
for lateral mass plate fusion compared with interspinous wire and facet wiring with iliac crest. Shapiro S, Snyder W, Kaufman K, Abel T. J Neurosurg. 1999 Jul;91(1 Suppl):19-24.

17. Posterior cervical interspinous wiring and compression for mid to lower cervical spine injuries: Benzel E C, Kesterson L. Journal of Neurosurgery 1989 June, 70(6); 893-9

18. Roy-Camille R, Saillant G, Mazel C: Internal fixation of the unstable cervical spine by aposteriorosteosynthesis with plates and screws. The Cervical Spine, 2nd ed. Sherk HH, Dunn HJ, Eismont FJ, Fielding JW, Long DM, Ono K, Penning L, Raynor R (ed): JB Lippincott, Philadelphia; 1989. 390–403.

19. Hadra BE: Wiring the spinous processes in Pott’s disease. Trans Am Orthop Assoc. 1891,14:206210.

20. O’Brien MF: Surgical anatomy of the cervical spine. Spinal Deformities: The Comprehensive Text. DeWald RL, Arlet V, Carl AL, O’Brien MF (ed): Thieme Medical Publishers, Inc, NewYork, NY; 2003. 33–45.