ROLE OF MOSS MIAMI SPINAL SYSTEM IN TRAUMATIC UNSTABLE THORACOLUMBAR SPINE: A STUDY OF 50 CASES

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BACKGROUND: The goals of treatment of spinal injuries are to realign the spine, obtain and maintain spinal stability and to prevent or minimize 'secondary neurological injury.' AIMS: To evaluate the role of Moss Miami pedicle screw fixation in decreasing the deformity and bony union in spinal injuries and to see the neurological recovery and functional outcome of the operated cases of traumatic unstable thoracolumbar spine. SETTINGS AND DESIGN: Prospective study in a tertiary care referral Postgraduate Institute of Medical Sciences. MATERIALS AND METHODS: Fifty patients (48 males and 2 females with mean age of 29.68 years) having traumatic insult to the thoracolumbar spine of less than two weeks duration resulting in unstable fracture/subluxation or dislocation with incomplete or complete neurological deficit were included in the study. Spine was fixed with Moss Miami Spinal System. RESULTS AND CONCLUSION: Roadside accidents (40%) and fall from height (36%) were the most common mode of injury. There was clustering of trauma around the thoracolumbar junction i.e.D12 and L1 levels(42%). Mean kyphotic deformity preoperatively was 19 degree and postoperatively it was 3 degree. Majority of the patients recovered 1 or 2 grades of power according to ASIA Scale. The results were evaluated on the basis of neurological, radiological and functional outcome and were excellent and good in 84% cases and poor in 16% cases. Faulty screw placement in 6, nut loosening in 4, and implant pullout in 2, bursitis over implant in 3 and loss of correction in 6 were the complications related to the system. Moss Miami pedicle screw system provides stable, reliable, truly segmental construct, helps in immediate rehabilitation of patients suffering from traumatic unstable thoracolumbar spine.

Fracture • spine • Moss Miami Spinal System

INTRODUCTION

Fractures and dislocations of the spine are serious injuries that mostly occur in productive age group people. The management and evaluation of these types of injuries have changed tremendously over the last decade with improvement of imaging technologies and spinal instrumentation [1].The goals of treatment of spinal injuries are to realign the spine, obtain and maintain spinal stability and to prevent or minimize 'secondary neurological injury' [1].

Numerous internal fixation devices have been developed for the treatment of unstable thoracolumbar spine fracture. Boucher introduced pedicle screw fixation of the spine in the1950s. Significant advances by Roy Camille, Steffee, Krag, Luque and the others in biomechanical design and placement technique have led to a rapid increase in the use of pedicle screw fixation systems.2-6 Several problems existing with multiple hook-screw-rod systems became evident and the development of Moss Miami spinal instrumentation had the initial goals of solving the problems posed by the existing systems. Advantages like low profile of the implant, minimum number of implants and instruments, easy to apply closure system and avoidance of damage to bio-mechanically important structures and stable and 360 degree fusion without anterior access are some of the advantages which make Moss Miami spinal system a better choice in the management of the patients with thoracolumbar instability[7].

We carried out the study to evaluate the role of Moss Miami pedicle screw fixation in decreasing the deformity and bony union in spinal injuries and to see the

neurological recovery and functional outcome of the operated cases of traumatic unstable thoracolumbar spine.

Method

Between July 2001 to December, 2005 a total of fifty patients having traumatic insult to the thoracolumbar spine of less than two weeks duration resulting in unstable fracture/subluxation or dislocation with incomplete or complete neurological deficit were included in the study. Criteria for the instability of the thoracolumbar injuries observed during the study:

- Loss of vertebral body height by more than 50%
- Kyphotic deformity of 20 degrees or more
- Progressive neurological deficit
- Involvement of two of the Denis' three columns
- White and Panjabi score more than 5

Patients on reporting to the Accident & Emergency department were assessed for the vital signs (pulse, blood pressure, respiratory rate), followed by general physical examination and examination of the whole body under good light for other associated injuries, if present. A detailed history regarding date and time of injury, time elapsed since injury, mode of injury, involuntary passage of urine or faeces, type of first aid/treatment received, mode of transport used after injury, was recorded.

Neurological exam

A complete neurological examination of the patient (sensory as well as motor) was done. Neurological assessment was done using the American Spinal Injury Association score. Patients having neurological deficit were carefully turned to right or left lateral position and examined for anal wink reflex, tone of anal sphincter and sensation in the perianal area to determine the completeness of the lesion. The examination was repeated after twenty four to forty eight hours to look for any signs of improvement. The neurological status was assessed according to American Spinal Injury Association Impairment Scale (ASIA Score for motor and sensory examination, and ASIA Impairment Scale for the patients with spinal cord injury) which is a modification of the classification first described by Frankel et al.[8] In the case of patients having associated injuries, the consultant's recommendations were accepted and executed.

Roentogram

After the patient's condition was stable and initial clinical assessment was done, the patient was sent for radiological investigation. Roentgenograms of the dorsolumbar spine - Anteroposterior and Lateral views were taken. Radiological assessment of the injury to the spine was done. Specialized investigations like CT and MRI scan were also done as and when required. The patients and the attendants were informed about the type of injury, and the possible options.

Surgical technique

The surgery was performed as an elective procedure as early as possible. After induction of general anaesthesia, patient was positioned prone over a specially made cushioned wooden frame, which enables flexion/extension of the dorsolumbar spine while reducing a fracture/ subluxation or a dislocation. Caution was taken to keep the abdomen free thereby reducing the pressure over the inferior vena cava to facilitate the venous return, reducing pressure in the vertebral and perivertebral venous plexus, and thus reducing intraoperative blood loss.

Fracture site anatomy was studied with the help of x-rays and C-arm. A midline posterior approach was adapted. The fracture site was identified and subluxation /dislocation if present, was reduced using distraction through Moss-Miami instrumentation. To reduce persistent fracture dislocations where two vertebral bodies were impacted against each other (and we were unable to reduce these through pedicle screw instrumentation), decompression was done at the required levels unilaterally or bilaterally as necessary and the following technique was then used.

First the spinous processes of the vertebrae were firmly held by a Kocher clamp at the fracture level and the kyphosis at the fracture level was increased by applying traction to the spinous processes with the attached clamps while the assistant held the patient's trunk from the sides and pulled it upwards. This maneuver reduced almost all the fracture dislocations except for the few cases which necessitated a facetectomy of the caudad vertebrae and the facets of the cephalad vertebrae were levered out to reduce the dislocation. The retropulsed bony fragments were scooped out to ensure that nothing compressed the cord anteriorly and the remaining bony fragments were pushed anteriorly with the help of dissector. In some of the cases where cord was compressed by the posterior elements of the vertebrae decompression was achieved by doing laminectomy. Adequacy of the decompression was checked by looking for the pulsations in the dural sac as well as by gently passing a blunt probe in the spinal canal of the superior and the

inferior vertebrae. The status of the cord was noted whether contused, lacerated or completely transected. This was followed by short segment stabilization using Moss-Miami instrumentation under C-arm.

Postoperative follow-up and rehabilitation

Patients were encouraged in sitting with a supporting brace on as early as permissible by the strength of the construct and the stability of the fixation obtained. The brace used in the study was a full size steel jacket i.e. thoracolumbosacral orthosis (TLSO brace). Postoperative neurological assessment was done at the first week of surgery, after one month and then after six months from the surgery. Assessment was done using ASIA Score for motor and sensory examination as well as ASIA Impairment Scale. In patients with partial recovery walking was encouraged by providing walking aid in the form of calipers.

Results

There were 50 patients, two female and 48 males, with age distribution between 18 yrs to 55 yrs. Twenty-eight patients were between 25 to 40 yrs, 16 were less than 25 yrs and 6 were more than 40 yrs old and the mean age was 29.68 years. The most common cause of the thoracolumbar spinal injuries observed was roadside accidents (40%) followed by fall from height. Amongst the roadside accidents, most common cause was motorcycle accidents. Another significant cause found was injuries by bull-cart while doing agricultural work. Table 1 shows mode of trauma in present series.

There was clustering of trauma around the thoracolumbar junction i.e. D12 and L1 levels (42%). Table 2 shows injury level in the present series.

Twenty-four patients were having burst/wedge fractures and 26 having subluxation/dislocation. The most common level of the fracture dislocation observed was D11-D12.

There were only eight patients who had associated injuries. The average in-patient period was 27 days. Mean time interval between injury and surgery was 7 days; shortest time interval was 3 days and the longest one of 12 days after the injury.

Deformity correction

Deformity in sagittal plane was measured by kyphotic angle. Kyphotic angle was measured using Cobb method. Table 3 shows pre operative & post-operative kyphotic deformity in the patients. The average preoperative kyphotic angle was 19 degrees. The average postoperative kyphotic angle was 3 degrees; the average correction of 16 degrees was achieved and there was average loss of correction of 2 degrees in six-month follow up period.

Neurological status (according to ASIA Impairment Scale) at the end of six months is shown in table 4.

Functional results

The results were evaluated on the basis of neurological, radiological and functional outcome. The final results were excellent &good in 84%cases and poor in 16% cases.

Complication

We had faulty screw placement in 6 cases, nut loosening in 4, and implant pullout in 2, bursitis over implant in 3 and loss of correction in 6 cases. Four patients developed bedsores, 6 had urinary tract infection and 2 patient developed periurethral fistula.

Discussion

Recognizing the nature of the injury resulting in spinal instability and the associated morbidity is the first step toward the appropriate treatment of the patients with thoracolumbar injuries. Meticulous clinical examination including the neurological examination based on objective finding and categorization of the injury severity is essential to allow comparisons, guide treatment, and determine prognosis. As excellent results have been shown possible with conservative treatment [9], the controversy regarding conservative versus surgical treatment of thoracolumbar fractures still persists. However, surgical intervention for spinal realignment, canal reconstruction and decompression can be expected to relieve ongoing neural compression and correction of deformity, thus preventing secondary neurological injury and providing better chances for neurological recovery.

We assessed the neurological status according to the American Spinal Injury Association standards (ASIA Motor Score, ASIA Sensory Score and ASIA Impairment Scale) and majority of patients (72 % of the total number) in our study were having complete neurological deficit i.e. ASIA Impairment Scale A. Since the required ASIA elements have better reproducibility, they constitute a minimal data set desirable in all spinal injury patients for accurate communication, particularly for the clinical studies. However, most other studies conducted have used the Frankel grading in assessing the neurological status of the patients.

We classified the fracture according to the Dennis three-column classification and found 48% of the total patients having unstable burst fracture and 52 % having fracture dislocation. In studies by Weyns et al[10] out of 93, twenty patients had fracture dislocation and rest having unstable burst fractures. A study of 180 cases by Lesoin et al[11] showed that 40 patients had subluxation /dislocation and in 15 patients there was co-occurrence of subluxation /dislocation and comminuted fracture. The type of fracture determination is important as it influences the urgency of treatment and the type of treatment.

During the surgery we did not observe any major intraoperative complication. However, reduction of the fracture or the dislocation was problematic and difficult to achieve in patients in whom surgery was delayed for more than a week due to one or the other reason. We found that in these patients reduction achieved was unstable and forceful maintenance of the reduction while doing fixation of the spine led to implant failure with loss of the per-operative correction achieved.

In the present study, we found the implant satisfactory in obviating the deformity and maintaining the achieved correction. The average correction of 16 degrees was achieved and there was average loss of 2 degrees in six months follow up in our study. In a study Esses et al.[12] had the average preoperative kyphotic angle of 18.2 degrees and average post operative 3.5 degrees, Carl et al[13] reported average improvement of 7.3 degrees in kyphosis postoperatively and average loss of correction of 6.5 degrees at follow up examination, thus only one degree of correction was attained. A study by McNamara et el[14] showed the average progression of kyphosis by 8.7 degrees in the operated cases from postoperative period to the final follow up. In the present study progression of kyphosis by only 2 degrees in postoperative period may be due to delayed ambulation of the patients and use of braces, thus allowing for proper spinal stabilization and fracture consolidation.

In the present study patients showed clustering of the spinal injuries at D12 or L1 level. Other studies also show clustering of thoracolumbar trauma around D12 and L1. Weyns et al[10] showed 60% injuries over D12-L1, Viale et al[13] 55% 15and Carl et al 82% 13at D12-L1 junction. The increased affliction of the thoracolumbar junction in the trauma can be due to more than one specific reason. Firstly this is the most mobile segment as compare to the any other segment of the thoracolumbar region. Secondly this area represents the transition from the normal thoracic kyphosis to the lumbar lordosis. Furthermore patients having injuries at this level has poor neurological status due to fact that the spinal cord usually ends at the lower border of L1 or the upper border of the L2, and spinal cord and conus medullaris show poor neurological recovery as compared to cauda equina which almost behaves as do peripheral nerves.

The patients having incomplete lesions of the spinal cord i.e. ASIA Impairment scale B and above (C, D and E) showed neurological improvement by at least one or more grades, whereas in patients with complete lesion of the spinal cord chances of neurological improvement were poor. In our study, the majority of the patients had severe neurological deficit (36 out of 50 i.e. 72% of the total patients were evaluated as ASIA A). This explains a comparatively lesser number of patients with complete neurological recovery in our study (only 8% of the patients showed complete neurological recovery)

A number of complications have been reported for transpedicular spinal fixation. Whitecloud et al noted the overall complication rate to be as high as 45%, although most of the complications were minor in nature. Blumenthal et al noted an overall complication rate of 6% with the Wiltse pedicle screw system16. Major complications in our series were-- improper screw placement, nut loosening, loss of correction and instrumental bursitis.

The poor neurological recovery in our study was that related to the fact that the patients with massive cord injuries including complete cord transactions, cord lacerations and nerve root avulsions resulting in severe neurological deficit were included in our study (72 % of the total patients were having ASIA Impairment A and 52 % of the total patients were having fracture dislocations). The neurological recovery in these patients would have been the same no matter what kind of treatment might be given. Our objective of the spinal surgery in these patients was deformity correction and early rehabilitation and thus obviating the complications of prolonged recumbency and we find the result in this respect encouraging.

Hence transpedicular screw fixation by Moss Miami pedicle screw system provides stable, reliable, truly segmental construct, helps in immediate rehabilitation of patients suffering from traumatic unstable thoracolumbar spine.

Mode of injury	Number of patients	Proportion (%)
Road side accident	20	40
• motor cycle accident	12	24
• hit by a moving vehicle	8	16
Fall from height	18	36
Injury by bullock-cart	8	16
Others	4	8
• Burial under sand	2	4
• Log of wood onto back	2	4

Table 1: mode of injury to the spine

Fracture level	No. of patients	Proportion (%)
D12	8	16
L1	8	16
L2	0	0
L3	2	4
Multiple fractures		
D11 and D12	2	4
D12 and L1	4	8
Fracture dislocations		
D11-D12	10	20
D12-L1	8	16
L1-L2	8	16

Table 2: level of vertebral fracture

Kyphotic Deformity (in Degrees)	Pre-operative Number of patients (%)	Post-operative Number of patients(%)
1-10	6(12%)	31(62%)
11-20	24(48%)	12(24%)
21-30	14(28%)	4(8%)
>30	6(12%)	3(6%)

Table 3: comparison of pre-operative and post-operative kyphotic deformity

Preoperative		Post-operative				
		A	B	C	D	E
A	36	20	14	2	-	-
B	10	-	-	8	2	-
C	4	-	-	-	-	4
D	0	-	-	-	-	-
E	0	-	-	-	-	-

Table 4: Preoperative and post-operative neurological status according to ASIA

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COMMENT

Once again, the authors have published a paper which describes an innovative and aggressive approach to the treatment of severe spinal cord trauma. Traditionally, the surgical treatment of such injuries, when unstable, has been the more invasive anterior vertebrectomy and fusion techniques, sometimes including posterior stabilization as well.

In this paper, the authors, using the Miami-Moss system, have utilized a posterior approach, employing pedicle screw and rod fixation, to reduce major traumatic deformities and stabilize the spine; this resulting in results comparable to some series involving the more invasive approaches.

In this study, a relatively small series of patients with severe spinal trauma, involving neurological deficit and significant instability, was treated surgically using the methods described in the article, and the results of treatment are shown to be quite favorable, considering the severity of the injuries. This approach, thusfar, has not been extensively studied.1,2

My one concern is the description of the "scooping out" of bone fragments which may be present in the spinal canal, this necessitating traction on the dural sac with its contents of nerve roots and, at the thoracolumbar level (a common location for these injuries), the spinal cord (conus medullaris). When available, the use of monitoring parameters, such as somatosensory evoked potentials (SSEP), should be encouraged.

The authors are to be commended for their work with these often tragic cases, and this work should serve as a stimulus for more research in this vital area.

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