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Original Research Article

Analysis of the results of surgical management of traumatic paraplegia

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ABSTRACT

Background: Thoracolumbar spine fractures are common injuries that can result in significant disability, deformity and neurological deficit. Aim of this study was to evaluate the results of surgical management of traumatic paraplegia, complete or incomplete as classified by Frankel scoring.
Methods: A prospective study was conducted in patients attending outdoor and emergency department of orthopaedics of a tertiary care teaching institute in Katihar Medical College, Katihar (Bihar) with traumatic paraplegia involving the dorsolumbar spine. The duration of the study was July 2014 to July 2016. The important objectives are the time for recovery of various functions like sensory, motor and bowel and bladder function, comparison between early and late decompression, results of posterolateral fusion and time taken for solid bony fusion after operation. Cases selected for these studies were those treated surgically between July 2014 to July 2016. Total 46 cases were selected within a minimum of 6 month post-operative follow up of which 4 cases lost in follow up. Data collected from patients records including age, sex, time from injury to hospitalization, initial neurological status as per Frankel score, MRI findings, surgery performed, postoperative course and neurological status at the time of discharge and latest follow up. Patients lost to follow up were not studied for outcome analysis.
Results: When decompression done within 1st week in incomplete paraplegia 80% of the patients showed return of grade 3 power. In complete paraplegia cases, 11% of the patients had return to power upto grade 3 when decompression done within 1 week where no cases return of grade 3 power when decompression done after2nd and 3rd week.
Conclusions: After recovery from spinal shock, the earlier the surgical decompression done, the better the neurological and bowel/bladder function recovery both in complete and incomplete paraplegic cases. Reduction is better and easy and less time consuming in early decompression than in late. Motor recovery can continue for over 6 month after decompression.

Keywords: Spinal cord injury, Traumatic paraplegia, Dorsolumbar spine, Decompression, Posterior fixation, Neurological deficit

INTRODUCTION

Modern lifestyle has its numerous hazards as manifested by different types of trauma. However the most disabling of this is injury of the spinal cord leading to paraplegia and quadriplegia. For almost 4000 years since the first introduction of spinal cord injury in the written document of Edwin papyruses it is still debated. Progress could not be achieved much except the attempts to surgically eliminate the pathology causing the compression. The studies is to correct SCI are on-going. Fractures of thoracolumbar spine are common injuries, 50% of these are unstable and can result in significant disability, deformity and neurological deficit.[1] Thoracolumbar fractures are more frequent in men and the peak incidence is observed between 20 to 40 years.[2] Neurological injury

complicates 20-36% of fractures at thoracolumbar junction in different studies. The chances and extent of neurological deficit depends on the type of fracture.[3] Inadequate treatment due to lack of resources leads to permanent impairment of morbidity of a significant number of individuals in the most productive age group. In general surgical treatment of traumatic spine fractures is safe and effective. The lumbar spine is relatively flexible due to the thicker intervertebral disc, sagittal orientation of facet joints and the absence of rib cage. The relatively lesser incidence of neurological injury in lumbar fractures can be attributed to the large size of the neural canal and the greater resilience of the quada equina nerve roots.[4] Traumatic paraplegia is an unanticipated catastrophe in individual's life, posing a huge economic as well as social burden. The healthcare does not end with fixation of spine and inculcates a programmed rehabilitation and preventive management plan involving multiple personnel family members. Early surgery and comprehensive rehabilitation markedly reduces the overall morbidity of spinal cord injured patients by enabling the patient to lead a independent life.[5] According to National spinal cord injury association of the USA, the most common cause of death after spinal cord injury is respiratory failure, whereas in the past it was renal failure. Mortality rate is higher during the first year after injury than during subsequent year. The monetary cost of this devastating injury has not been calculated accurately, but estimates as high as 4 billion dollars per year in health care costs and lost productivity only in the USA. With the development of regional trauma centers and increased training of paramedics and emergency medical technicians, the chance of survival after severe spinal cord injuries have increased. Overall 85% of patients with a spinal cord injury who survives the first 24 hrs are still alive 10 years later compared with 98% of patients of similar age and sex without spinal cord injury. Since the early 1980s operative treatment has moved to the forefront of fracture management in the spine. Technologies and implants have evolved to provide better results with decrease morbidity and mortality, and current operative management more rapidly returns the patients to work and satisfactory function. In recent review it provides an overview of the epidemiology, biomechanicals, principles, radiological and clinical evaluation, classification and management principles. Literature review of all relevant articles covering thoracolumbar spine fractures with and without neurological deficit was performed. Improved imaging, a better understanding of fracture and implant biomechanics, and the introduction of a variety of new anterior and posterior fixation devices permits surgeons to plan definitive stabilizing procedure for any fracture pattern, allowing rapid mobilization and return to function hence, patients who cannot be mobilized in a cast or brace within a few days of their injury are often more reasonably treated with surgery. So in a developing country like India, our study follow the same approach as being taken all over the world for spinal injuries ,with a logical and document-based activities and with limited resources.

METHODS

The study was conducted in the department of orthopaedics, Katihar Medical College, Katihar (Bihar), India. The duration of the study was July 2014 to July 2016. Institutional Ethics Committee permission was sought before enrollment of study subjects in the above study.

The study participants followed up for 6 months in postoperative period. The cases included in this study were the patients attending outdoor and emergency with traumatic paraplegia involving the dorsolumbar spine.

Pre-operative and post-operative neurological charts (according to Frankel's grade ASIA score (motor and sensory) was maintained with regular assessment for proper post-operative neurological recovery assessment.

Inclusion criteria

The cases with presence of traumatic paraplegia (complete or incomplete) and fulfilled the following criteria, fracture and dislocation of the vertebrae of dorsolumbar spine involving D8 to L5 spine, fractures involving one or maximally two vertebrae and skin condition of the operative field normal patients and party agreed to have a surgical decompression are included in the study.

Exclusion criteria

Patients below 16 years of age, patients unfit for undergoing operation in pre-anaesthetic check-up, patients with head injury or other gross injuries that may preclude undergoing operation, patients with multiple vertebral injuries (>2 vertebrae), injury of the spinal cord and paraplegia with high dorsal spine(above D8), patients presenting late (more than one month after injury) and patients with traumatic paraplegia but without signs of cord compression on MRI (where paraplegia is due to cord edema or myelomalacia) were excluded from the study.

Informed consent was taken after proper counselling and proper pre anaesthetic check-up. The patients were evaluated by X-ray of spine (AP and LAT view) and sometimes CT scan. Due to financial constraint contrast myelography was done in only few cases. In most cases pedicle screw with plate or rod was used and posterior stabilization and posterior fusion with cortico cancellous bone grafts from iliac crest was done. In all cases water bed was used during pre-operative and post-operative period to prevent bed sore. Pre-operative and post-operative neurological charts (according to Frankel's grade and ASIA score (motor and sensory) was

maintained with regular assessment for proper post-operative neurological recovery assessment.[6]

Recovery from spinal shock was noted by using clinical methods like return of bulbocavernous reflex. Direct or indirect decompression was done. In most of the cases laminectomy was done for direct decompression. Decompression was confirmed by using narrow gauge rubber tube. Condition of the spinal cord was detected by direct vision. Any retro- pulsed fragment compressing the cord was taken out.

Pedicle screws were inserted into the proximal and distal stable vertebrae under image intensifier. Then the fracture was stabilized by rods and plates. The pedicle entry point were identified (by intersection method and confirmed by image intensifier guidance) and opened probed all around and the pedicle screw was introduced. Per-operatively, features such as cord pulsation, cord atrophy and lacerations were looked for.

Post operatively, wound healing, amount of drainage, neurological recovery, radiological assessment, time taken ambulation and ultimate recovery were recorded. We used Frankel's grade and ASIA scoring system for pre and post-operative neurlogical assessment.[6]

In all cases long dorso-lumbar brace was given to the patients after removal of stitches at 14th post-operative day. Patients were discharged with advice for follow up.

Follow-up

First follow up was done after 2 week, 2nd follow up after 6 weeks. Then monthly follow up until the radiological sign of solid bony fusion was seen on X-ray. Patients were assessed for neurological recovery and assessment of return of bowel/ bladder function in every follow up. Some case was referred to urosurgery department for management of bladder function problems.

RESULTS

Table 1: Demographic characteristics of the traumatic paraplegia subjects.

Patient characteristics	Number
Age (years)	
16-20	8
21-25	16
26-30	12
31-35	4
36-40	2
Total	42
Sex incidence (N=12)	
Male	**Female**
32 (72.19%)	10 (23.81%)
Occupation (N=12)	
Manual labour	28 (66.67%)
Sedentary worker	10 (23.81%)
Unemployed/housewife	4 (9.52%)

Table 2: Clinical characteristics of the traumatic paraplegia subjects.

Clinical characteristics	Number of patients (N=12)	
Vertebrae involved		
D9	1	
D10	2	
D11	4	
D12	8	
L1	8	
L2	7	
L3	7	
L4	5	
L5	0	
Days elapsed after injury at presentation		
Days		
0-3	28	
4-7	10	
8-11	3	
12-15	0	
16-19	1	
Time of decompression (post injury)		
Days	Complete	Incomplete
0-7	9	5
8-14	8	11
15-21	4	5
Mechanism of injury		
Road accident	18 (42.85%)	
Fall from height	24 (57.14%)	
Paraplegia		
Complete	22 (52.38%)	
Incomplete	20 (47.62%)	
Initial observation (ASIA impairment scale)		
Grade		
A	22 (52.38%)	
B	12 (28.57%)	
C	8 (19.05%)	
D	Nil	
E	Nil	
Classification of fractures		
Types		
True wedge compression	28 (66.67%)	
Burst	10 (23.81%)	
Fracture dislocation	4 (9.52%)	

46 patients in whom posterior stabilization of the spine was done in this institution and followed up for a period ranging from 6 months to 2 years, 4 of 46 patients lost follow up. Remaining 42 patients were considered for the study.

Return of power in incomplete paraplegia

In all cases some return of power was there mostly from grade 3 or grade 4 or grade 5**.**

Return of power in complete paraplegia

Hip flexors within grade 3 and 4, Hip abductors/Quadriceps/Hamstrings within grade 2 and 3, Tibialis anterior/EHL/FHL and Gastrosoleus the power did not return at all.

Stability of implants

We got 3 patients where there was pull-out of the screws completely out of pedicle. In one patient there was loosening of the rod. In all 3 cases these happened within 4 weeks post-operatively. In these patients we had to continue on conservative management and solid bony fusion developed between 12 to 20 weeks.

Table 3: Post-operative sensory recovery (mainly fine touch) in traumatic paraplegia patients.

Onset of sensory recovery	Number of cases
1st week	22
2nd week	12
3rd week	6
4th week	2

Table 4: Onset of motor recovery in incomplete paraplegia in study subjects.

Onset of motor recovery	Number of cases
1st week	10
2nd week	7
3rd week	2
4th week	1

Table 5: Motor recovery in complete paraplegia in study subjects.

Muscles	Power at presentation	Post-operative	Number of cases
Hip flexors	0 0	3 2	7 5
Hip abductors	0 0	2 3	5 7
Quadriceps	0 0	2 3	6 6
Hamstrings	0 0	2 3	8 4
Tibialis anterior	0	0	All
EHL	0	0	All
FHL	0	0	All
Gastro-Soleus	0	0	All

Table 6: Onset of motor recovery in complete paraplegia.

Onset of motor recovery	Number of cases
1st week	1
2nd week	4
3rd week	8
4th week	7
5th week	3
6th week	0

Table 7: Bowel and bladder function recovery.

Complete	Incomplete
Autonomic in all cases	Normal in 9 cases Hesistancy, incomplete in 11 cases

Table 8: Time taken for recovery of bladder function in incomplete paraplegia (weeks).

Time	Weeks
2nd	3
3rd	4
4th	4
5th	4
6th	2
8th	1
10th	1
12th	0
16th	1

Table 9: Comparison among return of muscle power after decompression at different time in incomplete paraplegia.

	Grade 3	Grade 2	Grade 1	Nil
1st week	80%	20%		
2nd week	36%	36%	18%	9%
3rd week	25%	25%	25%	25%

Table 10: Comparison among return of muscle power after decompression at different time in complete paraplegia.

	Grade 3	Grade 2	Grade 1	Nil
1st week	11%	22%	22%	45%
2nd week		16%	16%	68%
3rd week			20%	80%

Table 11: Comparison between onset of sensory recovery after decompression done at different time in incomplete paraplegia.

	1st w	2nd w	3rd w	4th w
1st week	80%	20%		
2nd week	27%	54%	9%	9%
3rd week		25%	50%	25%

Table 12: Comparison between onset of sensory recovery after decompression done at different time in complete paraplegia.

	1st w	2nd w	3rd w	4th w	Nil
1st Week		11%	11%		78%
2nd Week		12%			88%
3rd week				20%	80%

Table 13: Complication in clinical study participants.

Complication	Number of patients
Bed sore	05
Infection	05
Pull out of screws	04
Dural tears	04
Persistent fistula with leakage of urine	03
Morbidity of bone grafts donor site	04
Late back or leg pain	03
Prominence of screw	01
Post-op increase in neuro deficit	01

DISCUSSION

Thoracolumbar junction is the commonest area involved in the spinal injury. Gertzbein had reported 44 burst fractures out of which 30 (68%) were D12 and L1, Viale reported 15 (55%) out of 27 fractures in his around L1. The importance of noting the data is three fold. First this area represents the transition from thoracic kyphosis to lumbar lordosis and the axis of the body passes in front of this junction when the patient is erect. So there is anterior bending moment working at this junction resuting in the maximum stress concentration in this area which may be responsible for implant failure in this junction.[7] Therefore we tried to rigidly stabilized this area which may be responsible for implant failure at this junction. Secondly patients having injury at this level have poor neurological status. This is due to the fact that spinal cord ends at the lower border of L1, any injury involving D12/L1 will directly affect the cord. Thirdly this area represents the transition between relatively stiff thoracic segment and mobile lumbar segments. So we used the segmental fixation so as to keep as motion intact as possible.

Decompression in the spinal injury is one of the most controversial concept. Though the initial may well be the determinant of neurological outcome, the role of decompression has always been debated. Both experimental and clinical findings of Benzel (1986), Dolan (1980), Maiman clearly documented the role of neural decompression in improving neurological outcome.[8-10] The essential key to reduction of intracranal fragments in burst fracture is dictation. So any device used posterior must have large distractive force. The pedicular screw system can provide large amount of distraction. And open up the collapsed anterior segment at specific level by appropriately contouring the rod according to the saggital curvature of the spine. Vaile and et al, also provided evidence that transpedicular decompression in experienced hand is usually able to restore an almost normal cross-section area at the affected level of spinal canal.[11] In our study, decompression was done in patients with >50% collapse of the vertebral body and with canal narrowing, postero laterally by scooping out the retro pulsed bony fragments from the canal as well as pushing some of the fragments anteriorly.

In a study in order to acquire a complete understanding of the spinal cord injury (SCI) one must appreciate the events that comprise its past, present and future. This "trinity of time" for SCI has most interesting past an exciting present and future. This special report traces the path of spinal cord injury from ancient times through the present and provides a optimistic overview promising clinical trials and avenues of basic research. Cord injury consists of the primary contusion, secondary injury due to cellular changes at the injury site and the effects of on-going neural compression. The first mechanism is amenable only to preventive treatment. Intensive investigation for effective agents is underway that may modify the secondary response. The use of methylprednisolone in the immediate post injury phase has been shown to marginally improve outcome in national acute spinal cord injury study investigations, but this improvement has not been substantiated in other studies and its role remains controversial. In our study we have routinely used injection methylprednisolone with a dosage and indication as recommended by NASCIS, but we have not found any neurological improvement with use of methylprednisolone in all of the 22 patients in whom it was used.[12-18]

The clinical outcome of polytrauma patients underwent spine fixation was analysed and correlated both to surgical time (early vs. delayed) and to fixation type (open vs. percutaneous). Early treatment within 72 hours of vertebral fracture in polytrauma patients showed a considerably efficacy in amelioration of clinical outcome. After initial clinical stabilization early radiological diagnosis of thoracic and lumbar spine trauma can be made based on CT scan reconstruction, complemented by an MRI at surgeon's discretion. Using an accepted classification system, such as TLICS surgeons can more consistently choose the best treatment option for patients. Early surgery is recommended for burst fractures with deficit or unstable distraction and rotational injuries e.g. TLICS of 5 or more points, AO B and C fractures. Regarding neurological recovery some amount be it complete or incomplete, be it early or be it sensory or motor or bowel and bladder function, was noticed in all cases as given in Table 3-7. As per report published by Denis, there is improved neurological outcome in effective cord compression after injury, stands for our findings regarding post-operative neurological recovery in spinal injury patients.[19,20]

The biomechanical effects of kyphoplasty on treated and adjacent non treated vertebral bodies. The clinical study suggest that changes in stresses and strains in levels found adjacent to kyphoplasty- treated level are minimal. Curcumin is well known for its antioxidative and anti-inflammatory properties. Curcumin is a polyphenol found in the rhizome of *Curcuma longa*. In this study we evaluate the effects of curcumin on behavioural recovery, glial scar formation, tissue preservation, axonal sprouting, and inflammation after spinal cord injury (SCI) in male wistar rats. Cases of spinal injury where it was treated by surgical management, the onset of sensory recovery was earlier than motor recovery in all cases as in Table 11-12. Almost 75% of the cases showed some amount of sensory recovery within first 5 days of operation. The onset of sensory recovery continued for maximally upto 4th week post-operatively in the cases studied by us. According to Kostuik, persistent neural compression can inhibit neurological recovery and anterior decompression can provide dramatic improvement in many patients.[21]

In present studies patients were divided in three categories:

- Decompression done within 1st week
- Decompression done in 2nd week
- Decompression done in 3rd week

The Stagnara wake up test is still gold standard test to detect gross motor deficit. In our series, we had 1 patients with incomplete paraplegia who had detoriation of 1 grade power post-operatively. The patient was taken back to operation theatre immediately for exploration to find out the pathology for detoriation of power. A block of bone given as a bone graft found to be compressing on the cord and it was taken out. The recovery was uneventful.

Single stage posterior corpectomy and expandable cage placement for treatment of thoracic or lumbar burst fractures. Lumbar burst fractures with greenstick lamina fractures occurs mostly in L2-L4 area. In surgical treatment any reduction manoeuvre will close the greenstick lamina fracture and crush the entrapped neural elements. Therefore it may be better to explore the greenstick lamina fracture whether there is any neural entrapment or not before any reduction manoeuvre is performed. A retrospective study of early magnetic resonance imaging in spinal cord injury without radiological abnormality in adults. Purpose of this study was to describe the clinical and imaging characteristics of patients experiencing blunt spinal trauma without radiological abnormalities but transient or persistent neurological deficit. Computer Tomography alone may clear the cervical spine in obtunded blunt trauma patients with gross movement of all extremities is safe and efficacious if CT cervical spine is negative for injury. Supplemental MRI of cervical spine is needed in this patients population. Epidemiology and predictors of cervical spine injury in adults patients with lowered Glasgow Coma Scale or systolic blood pressure, severe facial fractures, dangerous injury mechanism, male gender and age >35 years are at risk. Contrary to common belief head injury was not predictive for cervical spine involvement. Studies by Bohlman et al, Transfeldt et al, Bradford et al, and others have documented return of neurological function after anterior decompression done more than a year after initial injury.[22-25] For neurological normal patients with unstable spinal injuries and those with non-progressive neurological injuries, we believe that open reduction and internal fixation should be carried out as soon as possible. Mirza et al. in a recent study concluded that patients who sustain acute traumatic injuries to the cervical spine with associated neurological deficit may benefit from cervical decompression and stabilization within 72 hours of injury. Surgery within 72 hours of injury is not associated with a higher complication rate. Early surgery may improve neurological recovery and decrease hospitalisation time in patients with cervical spinal cord injuries.[26] Timing of thoracolumbar spine stabilization in trauma patients impact on neurological outcome and clinical course. A real prospective randomized controlled study. The key issues and unique specific intensive care treatment of adult patients from the trauma surgery prospective. The cornerstones of successful surgical intensive care management are fluid resuscitation transfusion protocol and extracorporeal organ replacement therapies. Percutaneous thoracic pedicle screw fixation is challenging because of the complexity of the spinal anatomy and obscuration of normal surgical landmark by soft tissue. We report a novel percutaneous technique in which intraoperative ISO-C c-arm navigation was used to treat complex spinal fracture.

Combining schwann cell bridge and olfactory-ensheathing glia grafts with chondroitinase promotes locomotor recovery after complete transection of spinal cord. A retrospective review of thoracic and lumbar spinal fractures associated with either skiing or snowboarding over a period of 5 years. The injuries were classified according to the AO comprehensive classification. In addition isolated transverse process fractures and isolated spinous process fractures were included. cervical spine fractures were excluded from this study.

According to Ann S et al and Leandro U, Taniguchi LU et al, in their series of spinal injury, the motor recovery continued for 6 months which in line of our observation.[27-28] In follow up in only the incomplete paraplegic patients, it was possible to change paraplegia since complete sensory recovery was seen in no case of complete paraplegia. This observation supports the findings of the study of Yilmaz et al.[29]

Regarding the return of bowel and bladder function in all the cases this was autonomic in complete paraplegia. In two cases where suprapubic cystostomy was done,

fistulae developed from bladder to anterior abdominal wall. In one patient scrotal fistulae developed. In 9 out of 20 patients of incomplete paraplegia bowel and bladder function got almost normal in 6 months follow up where as rest of the patients developed hesitancy or incontinence. But the bladder sensation returned back in 15 patients (75%) of incomplete paraplegia. According to Burns et al, most patients with paraplegia can regain social continence with appropriate rehabilitative training, urologic care and surveillance.[30]

CONCLUSION

In our series 46 cases of traumatic paraplegia, 22 cases were complete paraplegia and 20 cases were incomplete paraplegia, 4 cases being lost in follow up after analysis of the results we could draw the following conclusions: After recovery from spinal shock, the earlier the surgical decompression done, the better the neurological and bowel/bladder function recovery both in complete and incomplete paraplegic cases. Reduction is better and easy and less time consuming in early decompression than in late. Higher dosages of methylprednisolone are not effective for betterment in the neurological outcome. In early cases indirect decompression is possible, but in late cases direct decompression has to be done. Even with MRI findings of complete transection of cord, some inexplicable sensory recovery took place, which mandates surgical decompression in all cases, be it early or late. Motor recovery can continue for over 6 months after decompression. All follow-up only incomplete injury cases could be converted to higher ASIA scale. Inspite of lack of restoration of vertebral height, neurological recovery can continue. Sensory recovery occurs earlier than motor recovery in all cases. Use of water bed and proper postural care definitely decrease the possibility of bed sore in all paraplegic patients. Bowel and bladder function may return to normal in incomplete paraplegic cases but never in complete paraplegic cases.

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