

Evaluation of the Results of Surgical Management of Traumatic Paraplegia**Subodh Kumar Singh¹, R. N. Suman²**¹Assistant Professor, Department of Orthopaedics, Bhagwan Mahavir Institute of Medical Sciences, Pawapuri, Nalanda, Bihar²Professor, Department of Orthopaedics, Bhagwan Mahavir Institute of Medical Sciences, Pawapuri, Nalanda, Bihar

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Abstract:**Background:** Frequent injuries that can cause severe disability, deformity, and neurological deficiency are thoracolumbar spine fractures. The purpose of the study was to assess the outcomes of surgical treatment for traumatic paraplegia, categorizing the condition as complete or incomplete using Frankel grading.**Methods:** This prospective study was conducted in patients attending outdoor and emergency department of orthopaedics of Bhagwan Mahavir Institute of Medical Sciences, Pawapuri, Nalanda, Bihar with traumatic paraplegia involving the dorsolumbar spine from June 2020 to May 2022. The duration required for the recovery of different functions, such as sensory, motor, bowel, and bladder function, the comparison of early and late decompression, the outcomes of posterolateral fusion, and the amount of time needed for solid bone fusion following surgery, are all significant goals. Four of the 46 patients that were chosen within the minimum 6-month follow-up period after surgery were lost to follow-up. Information gathered from patient records, such as age, gender, length of stay in hospital after injury, Frankel score at the time of admission, MRI results, type of surgery done, postoperative course, neurological status upon release, and most recent follow-up. Analysis of the results did not include patients who were lost to follow-up.**Results:** Eighty percent of patients with partial paraplegia who had decompression within the first week had returned to grade 3 power. In cases of full paraplegia, 11% of patients showed a return to power up to grade 3 within a week following decompression, but no cases showed a recovery to grade 3 power after the second or third week.**Conclusion:** In both total and incomplete paraplegic cases, the earlier surgical decompression following spinal shock recovery occurs, the better the outcome for neurological and bowel/bladder function recovery. Reduction in early decompression is easier, faster, and better than in late decompression. After decompression, motor recovery may last longer than six months.**Keywords:** Spinal Cord Injury, Traumatic Paraplegia, Dorsolumbar Spine, Decompression, Posterior Fixation, Neurological Deficit.

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Introduction

Numerous risks associated with modern living are reflected in various forms of trauma. However, spinal cord injuries that result in paraplegia and quadriplegia are the most incapacitating of all. The topic of spinal cord damage has been discussed for about 4,000 years, when it was first mentioned in Edwin Papyrus' written work. With the exception of attempts to surgically remove the pathology causing the compression, not much progress was made. Research to treat SCI is still ongoing.

Thoracolumbar spine fractures are frequent injuries; 50% of them are unstable and can cause severe impairment, deformity, and neurological deficiency. [1] Men are more likely than women to have thoracolumbar fractures, which peak in

frequency between the ages of 20 and 40 years. [2] Depending on the study, 20-36% of thoracolumbar joint fractures are complicated with neurological damage. The type of fracture determines both the likelihood and severity of a neurological impairment. [3]

For many in the most productive age group, inadequate treatment brought on by a lack of finances results in long-term morbidity damage. Generally speaking, surgery is a safe and efficient way to treat traumatic spine fractures. The sagittal position of facet joints, the lack of the rib cage, and the bigger intervertebral disc all contribute to the lumbar spine's greater flexibility. The considerable size of the neural canal and the higher resilience of

the quadaequina nerve roots account for the comparatively lower incidence of neurological impairment in lumbar fractures. [4]A devastating blow to a person's life, traumatic paraplegia places a heavy financial and social strain on them. After the spine is fixed, the patient receives ongoing care that includes a preventive management plan, coordinated therapy, and multiple family members. By allowing the patient to live an independent life, early surgery and thorough rehabilitation significantly lower the overall morbidity of patients with spinal cord injuries. [5]

Material and Methods

The study was conducted in the department of orthopaedics, Bhagwan Mahavir Institute of Medical Sciences, Pawapuri, Nalanda, Bihar from June 2020 to May 2022. 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.

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.

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 corticocancellous 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.

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. Peri-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 neurological assessment. 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.

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

Patients characteristics	Number
Age (in years)	
16-20	8
21-25	16
26-30	12
31-35	4
6-40	2

Total	42
Sex incidence (n=42)	
Male	Female
32 (72.19%)	10 (23.81%)
Occupation (n=42)	
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=42)	
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. In all cases some return of power was there mostly from grade 3 or grade 4 or grade 5. 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.

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
1 st week	22
2 nd week	12
3 rd week	6
4 th week	2

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

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

Table 5: Motor recovery in complete paraplegia in study subjects

Muscles	Power at presentation	Post- operative	Number of cases
Hipflexors	0	3	7
	0	2	5
Hip	0	2	5
abductors	0	3	7
Quadriceps	0	2	6
	0	3	6
Hamstrings	0	2	8
	0	3	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
1 st week	1
2 nd week	4
3 rd week	8
4 th week	7
5 th week	3
6 th 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
2 nd	3
3 rd	4
4 th	4
5 th	4
6 th	2
8 th	1
10 th	1
12 th	0
16 th	1

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

	Grade3	Grade2	Grade1	Nil
1 st week	80%	20%		
2 nd week	36%	36%	18%	9%
3 rd week	25%	25%	25%	25%

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

	Grade3	Grade2	Grade1	Nil
1 st week	11%	22%	22%	45%
2 nd week		16%	16%	68%
3 rd week			20%	80%

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

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

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

	1 st week	2 nd week	3 rd week	4 th week	Nil
1 st Week		11%	11%		78%
2 nd Week		12%			88%
3 rd 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 resulting 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 intracranial 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 ongoing 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 suggests 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 patient with incomplete paraplegia who had deterioration of 1 grade power post-operatively. The patient was taken back to operation theatre immediately for exploration to find out the pathology for deterioration 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 occur 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 patient's population. Epidemiology and predictors of cervical spine injury in adult's 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 chondroitin's 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 fistula developed. In 9 out of 20 patients of incomplete paraplegia bowel and bladder function got almost normal in 6 months follow up whereas 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.

In spite 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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