

A COMPARATIVE STUDY BETWEEN HARRINGTON INSTRUMENTATION AND PEDICLE SCREW ROD INSTRUMENTATION IN THORACOLUMBAR INJURIES WITH NEUROLOGICAL INVOLVEMENT

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ABSTRACT

BACKGROUND

Spinal cord housed and protected by vertebral column, hence injury to vertebral column endanger the function of spinal cord and half of the spinal column injury associated with spinal cord injury. In our study, we are comparing two method of spinal column fixation in thoracolumbar spinal column injury as incidence of dorsolumbar injuries accounted for 75% of all spine injuries.

MATERIALS AND METHODS

The study was conducted between 25 patients (fixed with Harrington rod retrospective group) and 28 (pedicle screw rod prospective group) with dorsolumbar spine fractures.

RESULTS

In our study, 60% fractures occur T11 to L2. Fall from tree were the common mode of injury in rural population, while in urban area, it were due to road accident followed by fall. Fractures of spine are more common in males as compared to females. Fixation with pedicle screw rod associated fast recovery and did not need any type of brace during postop rehabilitation, complication like implant failure, infection, etc. were less in pedicle screw group.

CONCLUSION

Pedicle screw and rod system is superior to Harrington rod system as it gives three column spine fixation, but it is technically demanding procedure. Although, final neurological recovery did not show any difference with either type of fixation.

KEYWORDS

Pedicle Screws Rod, Harrington Rod, Dorsolumbar Spinal Fractures.

HOW TO CITE THIS ARTICLE: Gaur TNS, Bhargava P. A comparative study between Harrington instrumentation and pedicle screw rod instrumentation in thoracolumbar injuries with neurological involvement. J. Evid. Based Med. Healthc. 2018; 5(1), 64-69. DOI: 10.18410/jebmh/2018/14

BACKGROUND

Spine as said backbone and thus one of the most important part of the body, which is essential for keeping a person erect as well as mobile. It not only gives us the stability, but also protects the electrical system of the body to make a person mobile and flexible. The thoracolumbar junction (T10-L2) is between rigid thoracic spine and mobile lumbar spine, so junction is prone to higher biomechanical stress that is why thoracolumbar junction fracture occur common vertebral column injury.^{1,2}

The goals of thoracolumbar fracture management are to preserve/restore neurological and biomechanical functions of the spine. In spite of development of modern

Financial or Other, Competing Interest: None.

Submission 12-12-2017, Peer Review 22-12-2017,

Acceptance 31-12-2017, Published 01-01-2018.

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DOI: 10.18410/jebmh/2018/14



imaging techniques to understand the biomechanics and improve the diagnostic dilemma, the management of thoracolumbar spine fracture is the most controversial area in the modern spinal surgery. Early fusion with instrumentation is generally accepted treatment method for patients with really unstable fracture and complete neurological deficit. It results in more rapid mobilisation, fewer complications due to prolonged recumbence and lower medical cost.

The optimal treatment for patients with mild and moderate deformity and incomplete neurological deficit and residual spine canal compromise remain largely unknown, while stable spinal fractures without neurological deficit seldom require operative treatment.

We studied 53 patients of thoracolumbar fracture with neurological involvement treated with Harrington's instrumentation and pedicle screw and rod instrumentation. We found that pedicle screw is effective method of reduction and the system requires only one motion segment above and below the fracture site, although pedicle screw fixation is technically more demanding and requires image, although pedicle screw fixation is technically more demanding and

requires image control facility, although it's a less morbid procedure to maintain reduction and leads to pain-free productive life.

MATERIALS AND METHODS

This study was conducted at the Department of Orthopaedics and Traumatology, MGM Medical College, MY Hospital, Indore, in following manner-

1. Criteria for Patient Selection-

Adult (18-60 years) patient with dorsolumbar fracture, non-pathological type with neurological involvement.

2. Plan of Study-

A retrospective study (25) of thoracolumbar injury with neurological involvement treated with Harrington instrumentation at MY Hospital (during June 1999 to 2001).

A prospective study (28) of cases of thoracolumbar injury treated by means of pedicle screw and rod instrumentation (December 2002 to April 2005).

3. Review of Recent Literature-

- Preliminary data consisting of age, sex and occupation.
- Patient study regarding mechanism of injury, neurological symptomatology.
- Radiological evaluation of the injury that included standard anteroposterior and lateral radiograph. Radiological evaluation should include spinal alignment, presence of any rotation or translation, assessment of kyphosis, loss of vertebral height, widened interpedicular distance or interspinous distance.^{3,4,5}
- Detailed neurological examination in the form of sensory, motor, reflexes, bladder and bowel involvement and graded according to modified Frankel (ASIA impairment scale) classification.⁶

Medical Stabilisation at the Time of Admission-

It is observed that if methyl prednisolone given within 3-8 hours of injury and administered over 24-48 hours, better neurological recovery occur.⁷

Surgical Indications⁸

1. Incomplete neurological deficit.
2. Progressive neurological deficit.
3. Spinal cord compression.
4. Fracture dislocation.
5. Kyphosis >30 degrees.
6. Concomitant injuries requires early mobilisation.

Principles of Posterior Short Fixator with Pedicular Screws-

1. Stable internal fixation designed to fulfil the local biomechanical demand.
2. Preservation of blood supply by means of surgery and soft tissue preservation.

3. Anatomic alignment particularly in regard to sagittal plane.
4. Early active pain-free movement of muscles and joints.

Pedicle screws and rods enable three column distraction required for anatomic reduction of fragments.

Techniques of Safe Pedicle Screw Application-

Roy-Camille et al suggested that a pedicle screw should be introduced by drilling the path and then applying the screw. Most American surgeons realised the danger of this approach. They adopted a blunt technique to identify the pedicle and routinely used biplane image intensification during the placement of pedicle screws. The use of taps of gradually increasing diameter to assess the quality of cortical purchase through the isthmus of the pedicle and the use of image intensification to assess the length of the screw necessary to obtain purchase in the vertebral body, but not through the anterior vertebral cortex have become standard procedures for safe screw application resulting in strong fixation. This technique called the funnel technique is now used widely.

- A- The dorsal projection of the pedicle localised under image intensifier.
- B- Point of entry in thoracic spine just below the upper facet joint, 3 mm lateral to the center of joint near the base of transverse process.
Lumbar spine practically at all levels of the long axis of the pedicle pierces the lamina at the intersection of the true line, a vertical line tangential to the lateral border of the superior articular process and horizontal line bisecting the transverse process.
The point of intersection lies in the angle between the superior articular and the base of transverse process.
The entry point made with the help of 90 degrees curve bone awl.
- C- Once the isthmus of the pedicle is directly palpated, a small 2 mm pedicle probe is passed through the isthmus into the vertebral body.
- D- A large (5 mm) probe then is used to enlarge the path through the isthmus of the pedicle.
- E- Small K-wire (55 mm in length) are placed into the probed pedicles as radiographic markers (the anteroposterior and lateral C-arm images confirm the pedicle path. The lateral C-arm images also confirm the length of the screw to be used; the depth of each K-wire is measured after it is removed).
- F- Threads then are cut into the pedicle in all directions-the bottom of the pedicle (in the vertebral body) and the superior, inferior, medial and lateral inner walls of the pedicle.
- H- The screw then is inserted into the pedicle with the screwdriver. The purchase (insertional torque) must progressively increase until final seating.
- I- The anteroposterior and lateral C-arm images confirm proper positioning after all of the screws, rods and connectors are inserted.

RESULTS

In our series, 53 patients of thoracolumbar injuries treated by spinal instrumentation, out of which 25 by Harrington's instrumentation (retrospective group) and 28 by pedicle screw and rod (prospective group). Out of 53, two patients lost due to death. These 2 patients had pre-existing medical illness. The results are found to be comparable to literature.

Average follow up in prospective group is 13 months and in retrospective group, 20 months.

Incidence of injury is found to be more common in young adults and adults (Table 1), especially in males in both groups. This is supported by literature that thoracolumbar injury occur between 20 to 40 years age group men as they are more common involved in outdoor activities.^{9,10}

In most part of India, fall from tree, electric pole or into unprotected well is the commonest mode of injury. Our series also reflects this general trend as majority of the cases were due to fall from height (60%). In developed countries, road traffic accidents (<50%) have overtaken the other mode of injury. In our series we found in Indore region, most of the spinal trauma (40%) in rural population occurred during summer season (April to July).

DISCUSSION

Fall from height associated with flexion type or vertical compression type of injury. In our study, most common type of injury is flexion type followed by vertical compression type of injury. These injuries are associated with anterior and middle column failure as described by Dennis, because fall occurs in flexion and axial loading.

During axial loading, thoracic spine deform in kyphosis in the lumbar spine in lordosis resulting thoracolumbar junction experiences pure compression.

The vulnerability of D12-L1 region is due to the fact that thoracic spine is much stiffer than lumbar spine in sagittal and lateral flexion extension. This reflects the restraining effect of ribcage and relatively thinner discs of thoracic spine.

This is the reason that thoracolumbar region trauma is mostly concentrated at thoracolumbar junction, i.e. more than 60% injury occurs at T11 to L2 vertebra. This trend of injury pattern also confirms at our hospital records.

Literatures show thoracolumbar injuries, 47% associated with other injuries¹¹ and up to 20% of these injury are missed. In our study, this association is much less. In our hospital, most of the patients came from remote areas and could not reach hospital within time. In our study, fracture calcaneum most commonly associated with thoracolumbar junction trauma due to fall from height (Table 5).

On average, Harrington instrumentation at least requires two motion segments above and below fixation from the fracture site, while in pedicle screw fixation requires mostly one motion segment above and below fixation from the fracture site.¹² So, the pedicle screw and rod fixation requires shorter incision for exposure, less blood loss, which is associated with less postoperative morbidity. In our study, time for pedicle screw and rod fixation is 2 hours and 15

minutes and 360 mL blood loss, while Harrington's instrumentation requires 2 hours 30 minutes time and 470 mL blood loss.

Early ambulation is the biggest advantage of surgical stabilisation as nursing care is facilitated (Holdworth and Hardy 1953, Dick 1953, Bardford 1977, Dickson 1978, Meyer 1979). This factor assumes greater significance in a developing country where nursing facilities are often inadequate. As stated by Hanon (1976) and LUQUE (1982), the complications of prolonged recumbency in the form of bedsores, hypostatic pneumonia, etc can thus be prevented.

In our series, the majority of the pressure sores encountered were sacral, which are typically "lying down sores" and can be prevented if the patient is allowed to sit up and postural changing.

The patients treated with the Harrington distraction instrumentation were made to sit with support (Taylor's brace) after 6 weeks, postoperatively. This is because of the fact that although Harrington rods provide vertical compression load bearing, but they do not resist bending, shearing and torsional forces. As a result, if the patient is ambulated earlier, the hooks tend to get displaced leading to implant failure. The incidence of hook cut through is as high as 10%. Although, Dickson and Harrington (1978) have ambulated their patients 2 weeks after the surgery, but the former have used molded plaster jacket or polypropylene brace, and the latter, polypropylene brace in all the cases, which are not used in our series.¹³

In pedicular screw and rod instrumentation, treated patients have enough stable fixation to mobilise early in first weeks. Initially, all were given Taylor's brace, followed to mobilisation of patients according to neurostatus like full weightbearing with caliper, brace or without any support.

KRAG (1986) showed pedicular instrumentation achieved three-dimensional adjustment in eliminating encroachment on the spinal canal. AEBI M (1988) confirms that correction achieved by pedicular screw-rod instrumentation is bettered than Harrington and complication rate is low. ZINDRIK (1987) proved that pedicular screw performs better than hooks or sublaminar wires. They resist not only in flexion and extension, but torsion as well. Also, the pedicle in the dorsolumbar region is large enough to allow easy placement of the screw. He also maintains that rods and plates can be countered to accommodate normal physiological contours. SIMMONS et al (1978) showed transpedicular fixation can selectively distract or compress the segment and prevent further collapse.^{14,15}

Therefore, the view of Guttman and Bedrook that the important determinant of the neural recovery is the extent of damage to the neural tissue at the time of the injury and not the treatment modality used, still hold true to the hilt.¹⁶

In our series, one case of neurologically deteriorated, which is treated by Harrington's instrumentation, otherwise all patients either treated by Harrington or pedicle screw instrumentation having incomplete neurology, neurological recovered at least one Frankel's grade. Although, recovery

rate is faster in prospective group. This is because of good quality of reduction and fixation.

Fletcher D.J., Taddonio R.F., Byne D W et al, incidence of bed sore in spine patients are 7.7%, but in our study, this is quite higher (20%) because of delay in hospitalisation of patient and poor nursing condition. Surgical wound site infection is closely related to bed sore. As bed sore improves, this infection also subside. Deep infection occurred in our series in 1 patient, which required implant removal.

Incidence of implant failure in retrospective group is 12%, which is near to McAfee, PC Bohlman study (7 to

10%). In pedicle screw system, most commonly associated complication is screw malposition 0-42% and most of them are asymptomatic.^{17,18} In our prospective series, two cases of implant cut-out occur.

The advantage of pedicle screw surgical management are immediate mobilisation and earlier rehabilitation and better restoration of sagittal alignment.¹⁹

The disadvantage of surgical management are implant failure, infection, insufficient correction of kyphosis and removal of implant²⁰ are more in prospective group.

Age Group	Male		Female	
	Prospective Group	Retrospective Group	Prospective Group	Retrospective Group
10-19	3	2	1	1
20-29	9	7	2	5
30-39	8	6	1	-
40-49	3	3	-	-
>50	1	1	-	-
Total	24	19	4	6

Table 1. Age and Male-Female Distribution

Mechanism	Prospective Case	Retrospective Case
Fall from height	17	18
Fall of heavy object on back	7	4
RTA	4	3
Total	28	25

Table 2. Mechanism of Injury

Vertebra Involved	Prospective Group	Retrospective Group
D11	1	-
D12	7	10
L1	9	7
L2	2	-
D12 + L12	2	8
D12 + L1 + L2 + L3	1	-
L3	2	-
L4	1	-
L2 + L3	2	-
L3 + L4	1	-
Total	28	25

Table 3. Vertebra Involved in Injury

Type of Injury	Number of Cases in Prospective Group	Number of Cases in Retrospective Group
Flexion	9	9
Extension	1	0
Flexion rotation	3	4
Combination	5	3
Vertical compression	10	9
Total	28	25

Table 4. Types of Injury

Associated Injury	Prospective Group	Retrospective Group
Calcaneum fracture	3	2
Fracture tibia fibula	2	1
Fracture pubic rami	1	0
Head injury	1	0
Blunt trauma abdomen	0	0
Total	7	3

Table 5. Associated Injury

Operation Time	Prospective Group	Retrospective Group
Up to 2 hours	18	8
2 to 3 hours	9	14
>3 hours	1	3
Total	28	25

Table 6. Operation Time

Postoperative Complication	Prospective Group	Retrospective Group
Infection	3	3
Bed sore	5	8
Death	1	1
Implant failure	1	5
Neurological deterioration	0	1
Total	10	18

Table 7. Postoperative Complications

Motion Segment Involved in Fixation	Prospective Group	Retrospective Group
1 above 1 below	26	0
2 above 1 below	1	0
2 above 2 below	1	9
3 above 2 below	-	12
3 above 3 below	-	2
4 above 3 below	-	2
Total	28	25

Table 8. Motion Segment Involved in Fixation

Preoperative Neurology	Number of Case		Follow up Neurology									
			A		B		C		D		E	
	Prospective	Retrospective	P	R	P	R	P	R	P	R	P	R
A	16	13	4	2	2	1	4	6	1	2	5	2
B	8	8	-	-	-	1	4	4	2	2	2	1
C	3	4	-	1	-	-	-	-	2	-	1	3
D	1	0	-	-	-	-	-	-	-	-	1	-
E	0	0	-	-	-	-	-	-	-	-	-	-
Total	28	25	4	3	2	2	8	10	5	4	9	6

Table 9. Neurology According to Frankles Grading⁶

SUMMARY AND CONCLUSION

From this study, we conclude that surgical stabilisation has advantage of return of functional stability of vertebral column, which result-

- a. Early mobilisation of patient out of bed thereby reducing disuse atrophy to a minimum.
- b. Relief of pain experience, while turning on bed.
- c. Diminished incidence of ischial pressure sore.
- d. Avoidance of delayed progressive kyphosis.
- e. Early and better psychological rehabilitation.

Pedicle screw short segment fixation are superior to Harrington instrumentation because-

- 1. Procedure is less morbid, i.e. requires shorter incision and is less time consuming in expert hands.
- 2. Less blood loss as compared to Harrington instrumentation and shorter incision.
- 3. Early smooth postoperative period because pedicle screw and rod fixation is less morbid procedure.
- 4. Mostly requires only one segment fixation above and below the fracture vertebra.
- 5. Provides rigid fixation, so early rehabilitation as compared to Harrington instrumentation.
- 6. Because of good quality of fixation and reduction neurological recovery is faster than Harrington instrumentation.
- 7. As screw resists forces in all direction, i.e. tension, compression and bending, while hook only resists forces that drive the surface of the hook into the bone. So, pedicle screw prevents recurrence of deformity, pain and instability leading to paraplegic to live without the mystery of a deformed painful back.
- 8. Rate of implant failure and infection is much less than Harrington instrumentation.

Although, pedicle screw fixation is technically demanding procedure, requires image intensifier facilities and implant is more costly than Harrington instrumentation, but in benefit of patient, it is better than Harrington instrumentation, but in benefit of patient, it is far better than Harrington instrumentation.

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