

Correlation between Interpedicular Distance to Severity Of Thoracolumbar Spine Burst Fractures – A Prospective Study

Dr. Tanaji C. Patil¹, Dr. Ajay S. Chandanwale¹, Dr. Amit Kale¹, Dr. Vishal Patil¹,
Dr. Ujjwal Wankhade^{1*}

Byramjee Jeejeebhoy Government Medical College And Sassoon General Hospital, Pune.¹

Introduction: Burst fractures resulting from axial compression with rupture of the anterior and medial structures of the vertebral body with retropulsion of a bone fragment into the spinal canal and an increase in the interpedicular distance account for more than half of all thoracolumbar fractures which often cause neurologic deficits.

Objective: To study correlation between interpedicular distance and the severity of thoracolumbar burst fractures on neurological outcome with respect to Time from injury to presentation, neurological assessment at presentation, grading of patients according to Frankel grading, imaging of patient with the help of X-rays, CT scan and MRI, interpedicular distance of burst fracture vertebra preoperatively and post operatively.

Materials and methods: In our study, 60 patients with thoracolumbar spine burst fractures with neurodeficits were investigated with respect to preoperative and post operative interpedicular distance and were treated with posterior pedicular screw fixation from August 2012 to August 2013 with a follow up period of at least 6 months.

Results: Our study found that 28 patient's Computed tomography (CT scan) showed change in preoperative and postoperative interpedicular distance while 32 patients had no change in interpedicular distance postoperatively. Among patients showing a change in interpedicular distance (n=28), 8 (28.57%) cases showed neurological recovery while 20 (71.43%) patients did not have any neurological recovery at latest follow up. While among 32 patients who did not have any change in interpedicular distance, 14 (43.75%) patients had neurological improvement while 18(56.25%) patients did not show any neurological improvement in Frankel grading at latest follow up. The P value for correlation between interpedicular distance and severity of thoracolumbar burst fractures in relation to neurological outcome is 0.38 (Chi square test = 0.74) i.e. >0.05 hence the neurological outcome is not statistically significant with changes in interpedicular distance.

Conclusion: To conclude, our prospective study of 60 thoracolumbar burst fractures, proposes that change in an interpedicular distance is not significantly correlated with neurological outcome in thoracolumbar burst fractures. The initial neurological damage at moment of impact is the major factor on which the final neurological outcome depends.

Keywords: Burst fracture, Interpedicular distance, Posterior instrumentation, Thoracolumbar region, neurological deficits

I. Introduction

Reports of trauma to the thoracolumbar spine with associated neurologic injury were described as early as 3000 BC in the Edwin Smith Papyrus. Hippocrates distinguished spinal fractures with and without neurological deficit. Patients with paralysis would usually die. Spinal fractures without paralysis were treated by distraction, manual reduction and rest in supine position¹. With the introduction of motorized vehicles and greater exposure to high energy blunt trauma, the occurrence of thoracolumbar fractures and dislocations has increased substantially. Recent data have indicated that motorcycle accidents are associated with a greater chance of severe and multiple level spinal column injury than other types of vehicular trauma.²

Approximately 90% of all spinal fractures occur in the thoracic and lumbar spines. The two primary areas of concern relate to spinal column stability and neurologic status. As with other spine trauma, thoracolumbar injuries occur most frequently in male patients between 15 and 29 yrs of age.² Indeed, an undiagnosed spine injury or a sub optimally managed spine injury can result in a neurologic deficit that may permanently impair a patient's function and quality of life and in some cases may even involve the risk of death.

Burst fractures (**Figure 1**) account for more than half of all thoracolumbar fractures which often cause a neurologic deficit and present a significant economic burden to the family and society^{3,4,5}. Thoracolumbar burst fractures result from axial compression with rupture of the anterior and medial structures of the vertebral body with retropulsion of a bone fragment into the spinal canal and an increase in the interpedicular distance. This region is a common site for injuries with frequencies ranging from 10 to 45%^{6,7,8}. This type of injury occurs frequently in young individuals of productive age and results from high-energy trauma. It may be associated

with other injuries such as fractures at other levels of the spine or in limbs or the pelvis and chest and abdominal injuries⁹.

Around 90% of all spinal fractures occur between T11 and L4 and around 14 to 17% are classified as burst fractures. This region is sensitive to injury for three reasons: loss of the stabilization provided by the ribs and thoracic musculature; the transition from kyphotic thoracic curvature to lordotic lumbar curvature; and the change in orientation of the joint facets from coronal in the thoracic spine to sagittal in the lumbar spine. The management of thoracolumbar fractures remains controversial. Advocates of operative management of thoracolumbar fractures cite the potential for decompression of spinal cord and conus, restoration of spinal alignment and earlier mobilization with early rehabilitation as the compelling reasons for their approach. Advocates of the non-operative approach counter with clinical evidence of similar neurologic recovery while avoiding potential complications of spinal surgery. Over the past two decades the treatment has evolved from conservative to operative management. Operative management has shown to increase the chances of returning the patient to a useful and productive life.^{10,11}

This particular study helps to derive correlation between interpedicular distance to severity of thoracolumbar spine burst fracture among sixty burst fracture cases on neurological outcome.

Aims and Objectives

To study correlation between interpedicular distance and the severity of thoracolumbar burst fractures on neurological out come with respect to

- Time from injury to presentation.
- Neurological assessment at presentation.
- Grading of patients according to Frankel grading.¹²
- Imaging of patient with the help of X-rays, CT scan, and MRI.
- Interpedicular distance of burst fracture vertebra preoperatively and post operatively.

II. Materials and Methods

In our study, 60 patients with thoracolumbar spine burst fractures with neurodeficits were investigated with respect to preoperative and post operative interpedicular distance and were treated with posterior pedicular screw fixation from August 2012 to August 2013 with a follow up period of at least 6 months.

Inclusion Criteria:

Following patients presenting with the following criteria were included in our study:

- Fractures involving vertebrae D1 to L5.
- Single level fractures.
- Patients presenting with neurodeficits at presentation.

Exclusion criteria:

Following patients were excluded from our study:

- Multiple level fractures.
- Patients having preexisting neurological disorders.
- Patients with no neurodeficits at presentation.

Time of CT imaging in management of Burst fractures of thoracolumbar spine:

- At the time of admission.
- One week postoperatively.
- Six months postoperatively.

All sixty patients were initially evaluated in emergency department of a tertiary care hospital and were managed on basis of principles of advanced trauma life support. All patients were evaluated for neurological examination using Frankel grading scale, radiological investigations like X-rays, Computed tomography scan (CT scan) and Magnetic resonance imaging (MRI), routine hematological investigations for operative management. All burst fractures were managed by posterior pedicle screw fixation, ligamentotaxis and decompression surgery with fusion (**Figure 2 & 3**). All patients were followed up for atleast 6 months through clinical examinations & radiographic investigations

III. Results

In our study of sixty patients of thoracolumbar spine burst fractures were admitted in orthopaedics ward and were treated with posterior instrumentation. The series was evaluated for sex and age distribution, mode of injury, level of injury, type of injury, decompression done, neurological function, blood loss, complications, duration of hospitalisation, pain at followup and interpedicular distances preoperatively and postoperatively with the help of computed tomography scan at the time.

Our study of 60 patients included 50 (83.3%) males and 10 (16.7%) females with male to female ratio 5:1. The mean age for patients were 32.3 years for traumatic thoracolumbar burst fractures with maximum patients in a range of 30 to 40 years. In this study of 60 patients, there were 40 (67.7%) patients with mode of injury fall from height, 18 (30%) patients with mode of injury RTA and 2 (3.3%) patients with fall from train. In all majority cases involved thoracolumbar junction that is D12-L1. The most commonly involved vertebrae were D12 and L1, the percentage involvement being 60% that is 36 cases of 60 cases followed by D11 and L2 involvement.

There were 4 (6.7%) patients who were operated within 2 days of injury, 16 patients (26.67%) were operated within 3-4 days of injury, 36 patients (60%) were operated within 5-7 days of injury, 4 (6.7%) were operated more than 7 days after injury owing to surgical fitness of patients. Our particular study comprised of 26 (43.33%) patients who had concomitant injuries requiring medical attention, majority formed by lower limb fractures 8 (13%) followed by head injury 6 (10%). The average blood loss calculated was 230 ml with no patient requiring postoperative blood transfusions.

Neurological assessment was done by Frankel's grading. The preoperative neurological function was compared to that in the post-operative follow up period in relation to interpedicular distance. Interpedicular distance was measured with help of computed tomography preoperatively and postoperatively (**Figure 4 & 5**) and relationship of neurological recovery was ascertained in patients with changes in interpedicular distance and patients without change in interpedicular distance postoperatively. Eventually we found that 28 patient's Computed tomography (CT scan) showed change in preoperative and postoperative interpedicular distance while 32 patients had no change in interpedicular distance postoperatively. Among patients showing a change in interpedicular distance (n=28), 8 (28.57%) cases showed neurological recovery while 20 (71.43%) patients did not have any neurological recovery at latest follow up. While among 32 patients who did not have any change in interpedicular distance, 14 (43.75%) patients had neurological improvement while 18 (56.25%) patients did not show any neurological improvement in Frankel grading at latest follow up. (Table no.1). The P value for correlation between interpedicular distance and severity of thoracolumbar burst fractures in relation to neurological outcome is 0.38 (Chi square test = 0.74) i.e. >0.05 hence the neurological outcome is not statistically significant with changes in interpedicular distance. Thus, result of study indicates that neurological outcome does not vary with changes in interpedicular distance. Pain at follow up was graded according to Guttman scale¹³ as follows-. **Mild pain** – Intermittent, minimal, relieved by rest, not interfered with activities. **Moderate pain** - Intermittent, moderate distress relieved by salicylates, occasional interference with activities. **Severe pain**-Continuous severe distress not relieved by rest or analgesics, all activities interfered with. In the present study, 8 patients had Mild degree of pain while 1 patient had severe pain.

In our study of 60 patients, we had complications in 7 (11.67%) patients of which we had 4 (6.67%) patients with urinary infection, 1 (1.67%) with superficial wound infection, 2 (3.33%) with superficial bed sore. Mean postoperative hospital stay for patient was 5 days ranging from 4 to 10 days. Rehabilitation of patients was assessed according to the mobility of the patient at the end of twenty four weeks using the aids. (Table 2)

IV. Discussion

The present study focuses on a series of sixty patients of thoracolumbar burst fractures treated with posterior spinal instrumentation. Males formed the majority of the population (n=50, 83.33%) because of the force involved in high risk jobs. In the current series there were ten (16.7%) female patients and out of which four patients had fall from height while remaining met with road traffic accident. In the present series, 80% (n=48) of the patients were below 40 years of age and 40% (n=24) were below 30 years. The possible explanation for this observation seems to be high risk situations in which these types of injuries are seen involve the younger population. The mean age in this series was 32.23 years. According to Gertzbein et al¹⁴, multicentre study showed male preponderance which corresponds with our study but their peak age was found to be less than thirty years of age.

Fall from height was the most common mode of injury followed by motor vehicle accident. Fall from height may be the most common cause due to absence of safety gear in the construction workers as well as negligence on the part of the workers. Most of these patients' unskilled manual labourers' with low literacy level and understanding. Also implies the importance of safety nets and other equipments for avoiding such injuries. According to the studies of Gertzbein et al, Riggins et al and Calenoff et al^{14,15,16} most common mode

of injuries were fall from height which corresponds to our study. Other modes of injury were road traffic accidents, sport related injuries and gunshot wounds.

In our study of 60 patients, the Level of injury in the study included D7,D9,D10,D11,D12,L1,L2. Majority cases showed involvement at thoracolumbar junction that is D12-L1. The most commonly involved vertebrae were D12 and L1 ,the percentage involvement being 60% that is 36 of 60 cases. According to the White and Panjabi and Vialle et^{17,18} al most common site for thoracolumbar burst fractures were D11 to L2 due to considerable anatomic differences between thoracic and lumbar segments which corresponds with our study.

In present study, there were 4 (6.7%) patients were operated within 2 days of injury, 16 patients (26.67%) were operated within 3-4 days of injury, 36 patients(60%) were operated within 5-7 days of injury, 4 (6.7%) were operated more than 7 days after injury.

According to Chipman et al¹⁹, even though early surgery did not provide any additional improvement in terms of postoperative neurological status. Patients that were treated less than three days after sustaining their fractures exhibited fewer complications. This corresponds well with our study.

In our study patients there were 6 (10%) patients with coexistent head injuries, 4 (7%) patient with coexistent chest, 4 patients (7%) with abdominal injury, 4 (7%) with upper limb and 8 (13%) with lower limb injuries. According to Saboe, Reid and Davis study²⁰, associated injuries with Spine trauma included head injury, Chest injury or Long bones fracture mostcommonly which relates with our study well.

The average blood loss in our study was around 230 ml for posterior instrumentation. In study of Zhang et al (2013)²¹, average blood loss was around 240 ml which nearly corresponds with our study.

As per the results of our study, 28 patients in whom interpedicular distances were changed, 8 patients showed change in neurological recovery with 1 grade improvement as per Frankel grading and 20 patients showed no change in neurological recovery. 32 patients in whom interpedicular distances were not changed, 14 patients showed change in neurological recovery with grade 1 improvement as per Frankel grading and 18 patients showed no change in neurological recovery. After applying tests of significance the value as per Chi Square test DF 0.74 and probability tests, the p value calculated was 0.38 which is not statistically significant. The results of our study indicate that the neurological outcome is not altered with change in interpedicular distance.

As per various studies published in literature- Aebi et al²² in 1987 published a study of 30 patients of dorsolumbar burst fractures of which 25 were D12 to L2; of all operated patients with posterior stabilization none showed an improvement of more than 1 Frankel grade. Crutcher et al²³ in 1991 published a study of 44 patients of dorsolumbar burst fractures of which 30 were D12 to L2; of all operated patients with posterior stabilization none showed an improvement of more than 1 Frankel grade. Huler et al²⁴ in 1991 published a study of 44 patients of dorsolumbar burst fractures; of all operated patients with posterior stabilization none showed an improvement of more than 1 Frankel grade. Marti Garin et al²⁵ in 1992 published a study of 21 patients of dorsolumbar burst fractures of which 11 were of D12 to L2 level, of all operated patients with posterior stabilization 5 showed an improvement of 2 Frankel grade and 4 did not show any improvement and 2 showed 1 grade improvement.

However, Caffero MF, Avangi²⁶ in 2012 February found significant correlation between Interpedicular distance and percentage of narrowing of spinal canal. Interpedicular distance was significantly increased in patients with neurological deficit and in patients with lamina fractures and concluded that interpedicular distance measured from plain radiograph proved to be reliable instrument to assess narrowing of spinal canal and neurological deficits and lamina fractures.

Residual pain assessment in our patients revealed that 8 (13.3%) patients had mild residual pain in overall of patents. In a study by Seybold et al²⁷ and Siebenga et al²⁸ showed range of 12.8 to 19% of residual pain in posterior instrumented patients while comparing their functional outcome which agrees with our study.

In our study of 60 patients, 6 (10%) remained bed ridden, 46 (76.7%) were rehabilitated on wheelchair, 4 (6.67%) on walker and 4 (6.67%) on two crutches. In study of G Merathi et al in 2000²⁹, showed that most of the patients were rehabilitated with wheelchair followed by with walker and crutches which corresponds with our study. The largest retrospective trial done by T.O Boerger, D.Limb and A .Dickson³⁰ in 2000, 60 studies done in the last 30 years were considered and the outcome was evaluated retrospectively which summarizes that clinical and laboratory experience indicates that the neurological damage in thoracolumbar burst fractures occurs at the precise moment of injury. Geometrical parameters of compromise of the canal do not relate to the initial neurological deficit nor is there any evidence that operative clearance helps the neurological situation; it may make it worse. If, nonetheless, surgical treatment is employed, since it is not 'necessary' for neurological reasons, the patient should be adequately counselled the assumption that apparent embarrassment of the spinal cord on the basis of a CT scan can be improved surgically, is without foundation.

V. Conclusion

To conclude, our prospective study of 60 thoracolumbar burst fractures, proposes that change in an interpedicular distance is not significantly correlated with neurological outcome in thoracolumbar bursts

fractures .The initial neurological damage at moment of impact is the major factor on which the final neurological outcome depends. Geometrical parameters of compromise of the canal do not relate to the initial neurological deficit nor is there any evidence that operative clearance helps the neurological situation.

References

- [1]. Memmert M 1999 Ein Versuch, die Geschichte der Wirbelsäulenchirurgie zu rekonstruieren. In: Memmert M, Memmert G (eds) Die Wirbelsäule in der Anschauung. Spurensuche in Kunst, Geschichte und Sprache. Springer-Verlag, Berlin Heidelberg, pp 247-270.
- [2]. Robertson A, Branfoot T, Barlow I F et al. Spinal injury patterns resulting from car and motorcycle accidents. *Spine* 2002;27:2825-2830.
- [3]. Davidoff G, Roth E, Morris J, et al Assessment of closed head injuries in trauma related spinal cord injury. *Paraplegia* 1986;24(2):97-104.
- [4]. Vaccaro AR, Ans HS, Lin S et al. Non contiguous injuries of the spine. *J Spinal Disord* 1992;5(3):320-329.
- [5]. Burney RE, Maio RF, Maynard AS et al. Incidence, characteristics and outcome of spinal cord injury at trauma centres in North America. *Arch Surg* 1993;128(5):596-599.
- [6]. Denis F. The three column spine and its significance in the classification of acute thoracolumbar spinal injuries. *Spine (Phila Pa 1976)*, 1983;8(8):817-31
- [7]. Kraemer WJ, Schemitsch EH, Lever J, McBroom RJ, Mckee MD, Waddell JP. Functional outcome of thoracolumbar burst fractures without neurological deficit. *J Orthop Trauma*, 1996;10(8):541-4.
- [8]. Thomas KC, Bailey CS, Drorak MF, Kwon B, Fisher C. Comparison of operative and non operative treatment of thoracolumbar burst fractures in patients without neurological deficits : Systematic review. *J Neurosurg Spine*, 2006 ;4(5) :351-8.
- [9]. Knight RO, Stornelli DP, Chan DP, Devanny JR, Jackson KV. Comparison of operative versus non operative treatment of lumbar burst fractures. *Clin Orthop Relat Res*. 1993;(293): 112-21.
- [10]. Tator CH, Duncan EG, Emonds VE, et al. Neurologic recovery, mortality and stay after acute spinal cord injury associated with changes in management .*Paraplegia* 1995;33(5):254-262.
- [11]. Kelly RP, Whitesides TE et al. Treatment of lumbodorsal fracture dislocation. *Ann Surg* 1968;167:705.
- [12]. Furlan JC, Fehlings MG, Tator CH, Davis AM. Motor and sensory assessment of patients in clinical trials for pharmacological therapy of acute spinal cord injury : psychometric properties of the ASIA standards. *J Neurotrauma*. 2008;25:1273-1301
- [13]. Guttman L 1976 Disturbances of sensibility. In: Guttman L (ed): *Spinal Cord injuries*. 2 nd edn. Blackwell Scientific Publications, London, p.283.
- [14]. Gertzbein S. Scoliosis Research society .Multicenter spine fracture study. *Spine* 1992; 17:528 -540.
- [15]. Riggins RS, Kraus JF: The risk of neurologic damage with fractures of the vertebrae. *J Trauma* 17:126-133, 1977.
- [16]. Calenoff L, Chessare JW, Rogers LF: Multiple level spinal injuries: Importance of early recognition. *Am J Roentgenol* 130:665-669, 1978.
- [17]. White AA , Panjabi MM: The basic kinematics of the human spine. A review of past and current knowledge. *Spine* 3: 12-20, 1978.
- [18]. Vaillat R, Levassor N, Rillardovic M et al. Radiographic analysis of the sagittal alignment and balance of the spine in asymptomatic subjects. *J Bone Joint Surg Am* 87:260-67, 2005.
- [19]. Chipman JG, Deuser WE, Beilman GJ. Early surgery for thoracolumbar spine injuries decreases complications. *J Trauma* 56:52-57, 2004.
- [20]. Saboe LA, Reid DC, Davis LA, et al. Spine trauma and associated injuries. *J Trauma* 31: 43-48, 1991.
- [21]. Zhang L, Zou J, Gan M, Shi J, Li J, Yang H. Treatment of thoracolumbar burst fractures: Short segment pedicle instrumentation versus kyphoplasty. *Acta Orthop Belg* 79 :718 -725, 2013.
- [22]. Aebi M, Etter C, Kehl T, Thalgott J. Stabilization of the lower thoracic and lumbar spine with the internal spinal skeletal fixation system. *Spine* 1987; 12:544-51.
- [23]. Crutcher JP Jr, Anderson PA, King HA, Montesano PX. Indirect spinal canal decompression in patients with thoracolumbar burst fractures treated by posterior distraction rods. *J Spinal Disord* 1991;4:39-48.
- [24]. Huler RJ, Esses SI, Botsford DJ. Work status after posterior fixation of unstable but neurologically intact burst fractures of thoracolumbar spine. *Paraplegia* 1991;29:600-6.
- [25]. Marti Garin D, Villanueva Leal C, Bago Granell J. Stabilisation of the lower thoracic and lumbar spine with the internal spinal skeletal fixation system and a cross-linkage system: first results of treatment. *Acta Orthop Belg* 1992;58:36-42.
- [26]. Caffaro MF, Avangi O. Can the interpedicular distance reliably assess severity of thoracolumbar burst fractures? *Spine (Phila Pa 1976)* 15 ; 37 (4): 231-6, 2012.
- [27]. Seybold EA, Sweeny LA, Frederickson BE, et al. Functional outcome of low lumbar burst fractures. Multicentre review of operative and non operative treatment of L3-L5. *Spine* 24:2154-2161, 1999.
- [28]. Seibanga J, Leferink VJ, Segers MJ, et al. Treatment of traumatic thoracolumbar spine fractures: A multicenter prospective randomized study of operative versus non surgical treatment. *Spine* 31: 2881-2890, 2006.
- [29]. Marathi G, Sarchi P, Ferrarin M, Pedotti, Veicsteinas A. Paraplegic adaptation to assisted walking: energy expenditure during wheelchair versus orthosis use. *University of Brescia, Italy; Spinal Cord* (2000) 38, 37-44.
- [30]. Boerger TO, Limb D, Dickson RA. Does 'canal clearance' affect neurological outcome after thoracolumbar burst fractures? *J Bone Joint Surg (Br)* 82:629-635.

Tables and Image



Figure 1 – Anteroposterior and lateral radiographs showing L1 Burst fracture

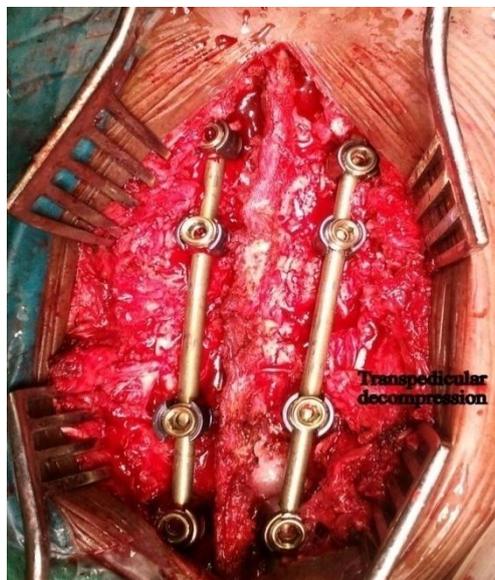


Figure 2 – Posterior Spinal instrumentation with Transpedicular decompression



Figure 3 – Postsurgical anteroposterior and lateral radiographs

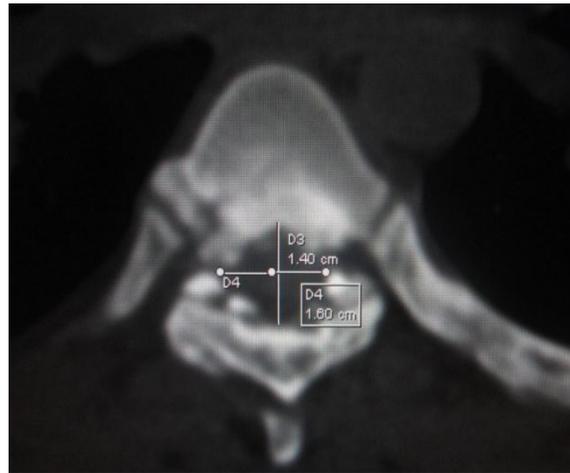


Figure 4 –Interpedicular distance measurement on CT scan preoperatively

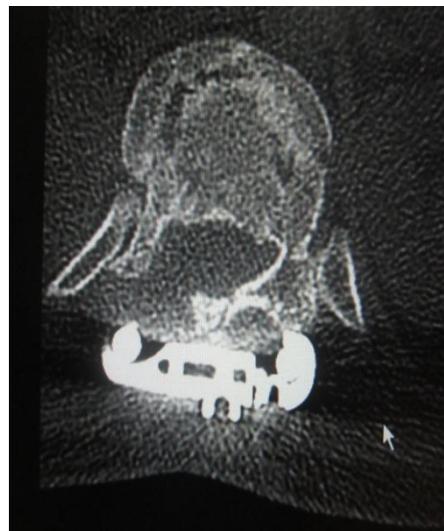


Figure 5 – Postoperative CT scan Interpedicular distance measurement

Interpedicular distance	Neurological Improvement	No Neurological Improvement	Total
Change	08 (28.57%)	20 (71.43%)	28
No changes	14 (43.75%)	18 (56.25%)	32
Total	22	38	60

Table no 1. – Correlation of interpedicular distance to neurological recovery in 60 patients.

Rehabilitation Mode	No of cases	Percent
Bedridden	6	10.0
Wheel Chair	46	76.7
Crutches Mobilisation	4	6.7
Adjustable Walker Ambulation	4	6.7
Total	60	100.0

Table no. 2 – Statistics of mode of rehabilitation at latest follow up.