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Dr. TC Premkumar
Senior Assistant professor, department of orthopaedics and traumatology, Madurai medical college, Madurai, Tamil Nadu, India

Dr. MN Karthi
Senior Assistant professor, department of orthopaedics and traumatology, Madurai medical college, Madurai, Tamil Nadu, India

Correspondence
Dr. TC Premkumar
Senior Assistant professor, department of orthopaedics and traumatology, Madurai medical college, Madurai, Tamil Nadu, India

A prospective study on radiological and functional outcome in dorsolumbar burst fractures treated with dorsal instrumentation and transpedicular bone grafting

Dr. TC Premkumar and Dr. MN Karthi

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Abstract
Background: Dorsolumbar spine fractures are one of the most common cause of traumatic paraplegia and paraparesis with or without bladder and bowel involvement in younger individual. This is one of the controversial areas in modern spine surgery and continues to evolve.
Aim: To analyse the radiological and functional outcome in patients with dorsolumbar burst fractures treated with dorsal instrumentation and transpedicular bone grafting.
Material and Methods: 21 patients (20males and 1 female) admitted in govt rajaji hospital, Madurai medical college with dorsolumbar burst fracture with TLICS score more than 5 included in this study. All the patients were treated with dorsal instrumentation and transpedicular bone grafting and posterior decompression if neurological deficit present. Patients were followed up and assessed for functional outcome with denis pain pain scale and denis work scale, neurological outcome by ASIA scale and radiological outcome by anterior wedge angle, anterior height, posterior height, kyphotic angle.
Results: 21 patients (20 males, 1 female) with history of fall from height (86%) and RTA (14%)with TLICS of more than 5 (score 5:16patients, score 6:1patient, score 7:2 patients, score 8:2 patients) were included in the study. 57.1% of patients were 20-40years old. On follow up 2 patients improved from ASIA B to ASIA C and 1patient from ASIA C to ASIA D. among 21 cases, mean Anterior Wedge Angle (AWA) was 18.04° pre operatively which was corrected to 9.42° and on follow up, mean AWA was 10.14°. Mean Anterior Height (AH) was 64.09% pre operatively which was improved to 83.66% and on follow up, mean Anterior Height was 78.57%. Mean Posterior Height (PH) was 83.90% pre operatively which was improved to 93.80% and on follow up, mean Posterior Height was 92.33%. Mean Kyphotic angle was 8.85° pre operatively which was corrected to 5.42° and on follow up, mean Kyphotic angle was 6.38°.
Conclusion: dorsolumbar burst fractures treated with dorsal instrumentation and transpedicular bone grafting facilitate early mobilisation of patients and achieving stable, pain free spinal column and preventing the late vertebral collapse, loss of kyphosis correction and instrumentation failure.

Keywords: dorsolumbar burst fracture, tranpedicular bone grafting, tricalcium phosphate

Introduction
Background
The dorsolumbar junction is a unique one because of its anatomy and biomechanical environment. Dorsolumbar spine fractures are one of the most common cause of traumatic paraplegia and paraparesis with or without bladder and bowel involvement. These fractures occur most commonly in younger individual. 90% of all spinal fractures occur in the thoracic and lumbar spine. Most common presentation of thoracic and lumbar injuries are within the level between T11 and L1. It has major functional, psychosocial, medical and financial effects on the injured person, family and society.
The treatment modalities are conservative therapy and surgery. Surgery includes either posterior reduction and instrumentation or anterior decompression and instrumentation or combined. This is one of the controversial areas in modern spine surgery and continues to evolve. Posterior instrumentation is most commonly done procedure. Most of the dorsolumbar burst fractures are unstable requiring surgical spinal stabilization to maintain the anatomical

reduction and stability and to promote the early bony fusion, early mobilisation. So now-a-days most of the dorsolumbar fractures are treated surgically to allow early mobilisation and protection against neurological injury when the patient is ambulant and to prevent the complications of bed rest.

During the past 20 years, the field of spine surgery has seen a dramatic increase in the operative management. The development of biomechanically sound instrumentation to provide stable internal fixation, so it has changed the concepts of patient management.

Posterior short segment pedicle screw fixation with pedicle screw at the fractured vertebra was done. Although the early clinical results of this surgery are usually satisfactory, progressive kyphosis and a high failure rate of the pedicle screws remain a concern. Failure of the anterior column support is the main cause of hardware failure. Anterior column support by anterior approach has its own risks and complications. Anterior body augmentation by transpedicular bone grafting has been developed as an alternative to overcome this failure and in means of biological support in addition to fractured vertebra fixation in preventing loss of kyphosis correction.

To study the radiological and clinical outcome in patients with dorsolumbar burst fractures treated with dorsal instrumentation and transpedicular bone grafting and in an effort to outline the advantages of transpedicular bone grafting, this study was undertaken.

Inclusion Criteria

1. patients having unstable dorsolumbar burst fractures with or without neurological deficit
2. burst fractures with TLICS score 5 or more
3. age from 15 to 70 years
4. Presentation less than three weeks after the timeof the injury

Exclusion Criteria

1. fracture dislocation, anterior wedge compression fractures
2. comorbid conditions not permitting major surgical procedures
3. patients not willing for surgery
4. pregnancy
5. presentation more than three weeks after the injury
6. Un co-operative patients

Materials & Methods

The prospective study was done in patients with Post Traumatic dorsolumbar burst fractures in the Department of Orthopaedics, Madurai Medical College & Govt. Rajaji Hospital, TamilNadu. Twenty one patients were treated surgically between August 2014 to September 2016 and followed for a period of 12 months to two years.

First assessment of a patient included the history of injury, the mode of injury, a thorough clinical and neurological examination, and status of the stability. Then, priorities included resuscitation of patient, and treatment of life-threatening injuries before stabilization of the spinal injuries.

The skeletal system was examined to rule out associated injuries. The patient's spine was examined any swelling, contusion, tenderness, haematoma, gibbus or step off. Full neurological examination (sensation, motor, anal tone)was done and documented. Protection of the spinal column was given immediately. Daily neurological examination was done. Pattern & level of neurological injury were identified and noted & Cord injury graded by Frankel's Classification if neurological injury present.

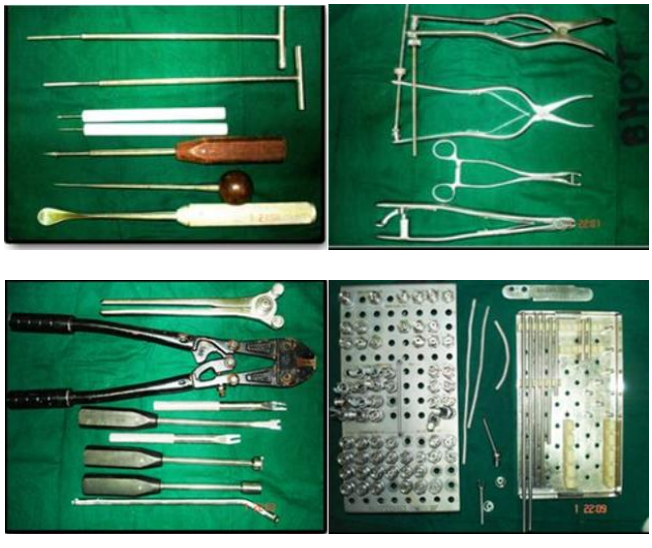
Antero posterior and lateral plain X rays, CT scans, and MRI were taken to identify all injuries and to assess the severity and nature of the injury. Neural canal and pedicle were identified in CT scan. Soft tissue injuries and cord changes were identified in MRI. The level and type of fractures were classified according to AO Magrel classification. Vaccoro's ThoracoLumabar Injury Classification Score (TLICS) was calculated and according to that treatment was given.The indications for surgical intervention were TLICS score five or more.

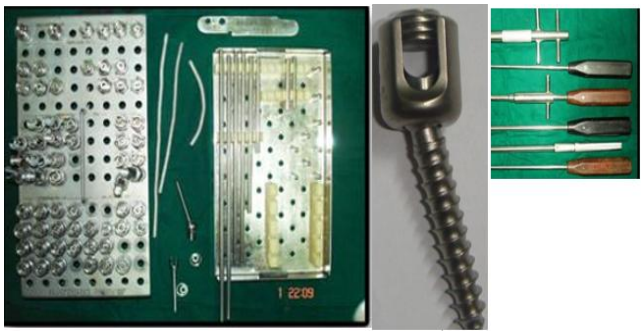
The patients under the effect of general anesthesia were positioned on the fracture table and antero-posterior & lateral X rays were taken to determine the direction of the pedicles, end plates and disc spaces. All patient underwent short segment posterior stabilization using Moss Miami rods and pedicle screws and posterior decompression done in patients with neurological deficit and transpedicular bone grafting at the fractured vertebra done for all patients

Surgical Technique

All patients were placed in prone position over radiolucent table. A standard posterior midline approach was used for exposure the spine. Pedicle screws were inserted into the vertebra one level above and below the fractured vertebra under fluoroscopic control at the intersection point of transverse process and facet joint. After connecting the rods and screws, distraction force was applied using distractor forceps to restore lordosis and anterior body height. A 3-4 centimeter wound was created over the posterior iliac crest to harvest iliac cancellous bone grafts. A trocar was used as a pedicle finder to create a transpedicular pathway within the defect of the fractured vertebra on the least comminuted pedicle under C-arm using funneling technique described by Gaines. This transpedicular pathway was dilated with different size pedicle tap upto 6.5mm. A 6.5 mm pathway is enough for insertion of the metallic Daniaux funnel. The harvested bone grafts was morselized and mixed with tricalcium phosphate. It was placed in the metallic funnel and pushed into the defect of the fractured vertebra using a pusher. The defect of the fractured vertebra was impacted with morselized cancellous bone graft gradually and monitored under C-arm fluoroscopy [4, 8].

Instruments and Implants

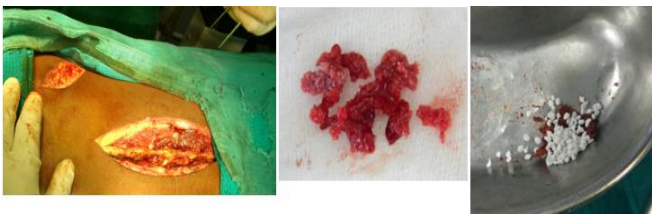




Daniaux funnel and funnel with pusher

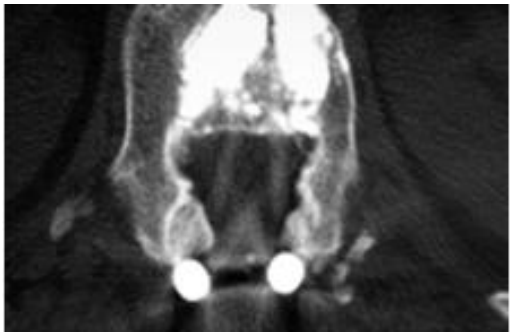
Posterior approach in prone position

After short segment posterior instrumentation with transpedicular screws and rod



Graft harvested from posterior iliac crest

Cancellous graft



Postoperative CT scan shows the graft

Post operative protocol

- 2nd POD - drain removal
- Patients were encouraged to sit upright on the second postoperative day with brace support
- 3rd POD – 1st EOT, 6, 9th POD – 2nd, 3rd EOT
- 11th POD- suture removal
- Bladder, bowel and back care in neurologically deficit patients
- 0-3months – Mobilisation with brace, increasing the activities gradually
- After 3 months – patient can resume his routine activities

For functional assessment, Denis Pain scale and Denis Work scale used in all patients. Neurological status assessed at 3rd month postoperatively using ASIA scale. Radiologically, Anterior Wedge Angle (AWA), Anterior Height, Posterior Height and Kyphotic angle were calculated pre operatively, immediate post op and 3rd month, 6th month and 12 months follow up X rays.

Results

In our study of 21 patients [20 males (95.3%) and 1 female (4.7%)] with a mean age of 34 years with highest number of patients were seen in 20-40 years (57.1%). Among 21 patients, D11 level involved in 1 (4.7%) patient, D12 level in 2 (9.6%) patients, L1 level in 9 (42.9%) patients, L2 level in 5 (23.8%) patients and L3 in 4 (19.0%) patients.

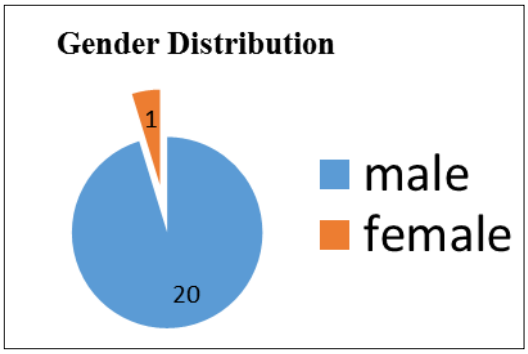
In our study, 16 patients (76.1%) had score of 5, one patient (4.7%) had score 6, two patients(9.6%) had score of 7 and two patients (9.6%) had score of 8.Among 21 patients, 18 patients (85.7%) had history of fall from height and 3 patients (14.3%) had history of road traffic accident.

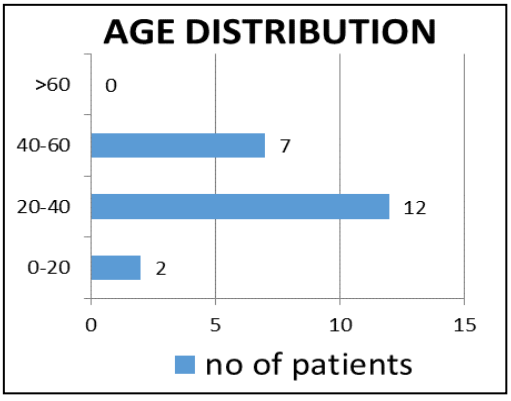
In our study, eighteen patients (85.7%) had Denis pain scale of P 1 and three patients (14.3%) had Denis pain scale of P 2.

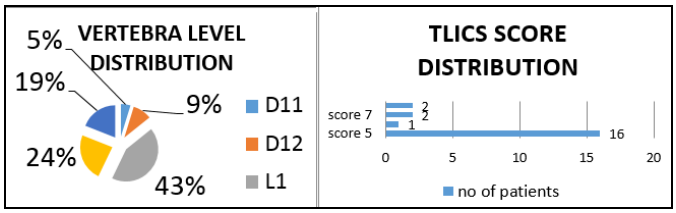
Among the 21 patients, eleven patients (52.5%) had Denis work scale of W 1, five patients (23.8%) had Denis pain scale of W 2, one patient (4.7%) had Denis Work scale of W3 and four patients (19.0%) had Denis Work scale of W4

Among the 21 patients, four patients (19.0%) had neurological deficit of which one case ASIA C grade, two cases ASIA B grade and one case ASIA A grade and 17 patients (81.0%) presents without neurological deficit. Two patients improve from ASIA B grade to ASIA C grade, one patient improve from ASIA C grade to ASIA D grade on assessment at 3rd month. None of the patients had detoriation or new onset of neurological deficit.

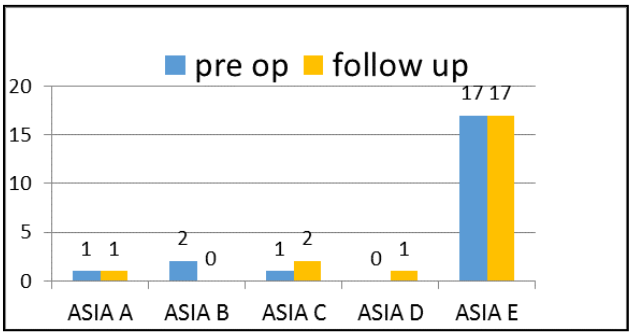
In our study, among 21 cases, mean Anterior Wedge Angle (AWA) was 18.04° pre operatively which was corrected to 9.42° and on follow up, mean AWA was 10.14°. Mean Anterior Height (AH) was 64.09% pre operatively which was improved to 83.66% and on follow up, mean Anterior Height was 78.57%. Mean Posterior Height (PH) was 83.90% pre operatively which was improved to 93.80% and on follow up, mean Posterior Height was 92.33%. Mean Kyphotic angle was 8.85° pre operatively which was corrected to 5.42° and on follow up, mean Kyphotic angle was 6.38°.

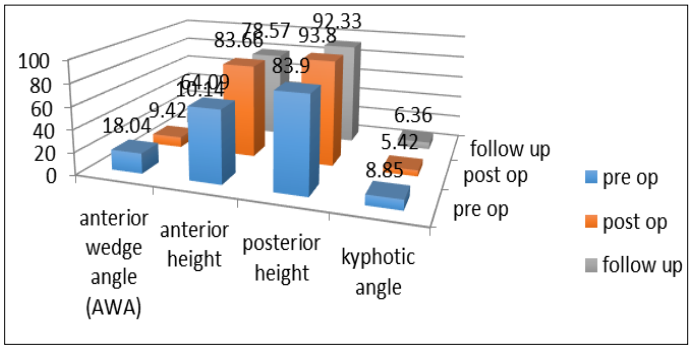


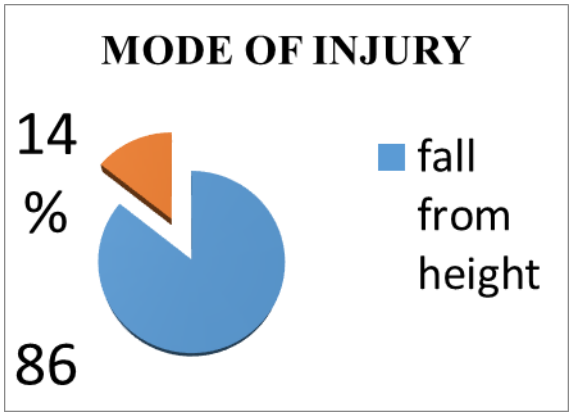




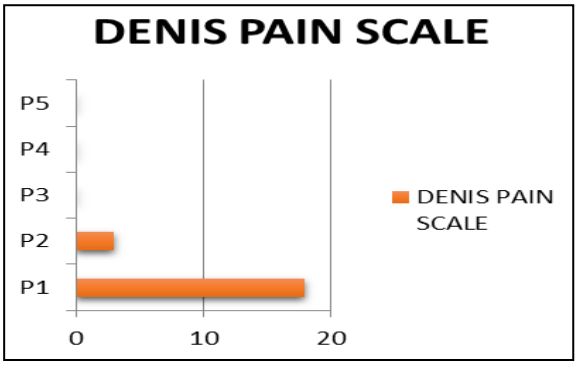
Neurological Recovery

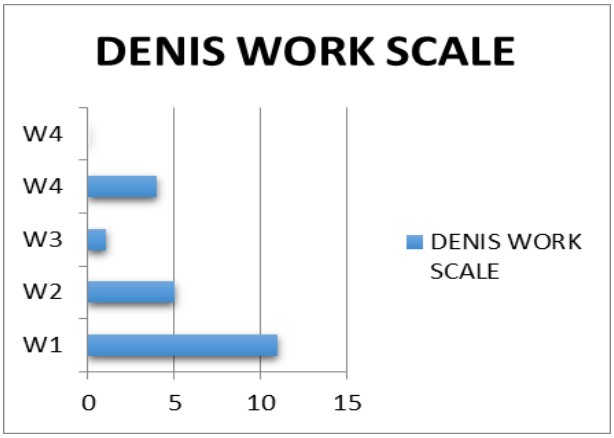






Radiological Outcome





Complications

In our study, among the 21 patients, one patient (4.7%) had proximal screw breakage and the patient had no pain and no neurological deficit. For that patient, implant removal was done. Patient had no pain and resumed her activities. One patient (4.7%) had superficial wound infection which was treated with antibiotics and dressing. Among the patients with neurological deficit, no patient had bed sore. 19 patients (90.6%) had no complications.

Discussion

The dorsolumbar spinal injuries are common in whole of the spinal trauma. The transitional anatomy of the dorsolumbar spine renders it uniquely vulnerable to the high-energy deceleration trauma associated with falls and motor-vehicle accidents. The primary objectives of initial evaluation and diagnosis include characterization of the injury and identification of any neurological deficit. The goals of the treatment are to obtain the pain free stable spine and restoration of maximum function.

Thoracolumbar junction is the commonest site of the spinal injuries, 52% between T11 & L1 (Burgoss *et al* 1988; krauss *et al* 1975). In our study, regarding the level of vertebral fracture, L1 (9 patients- 42.9%), L2 (5 patients -23.8%) were the commonest sites.

Spinal injuries are more common in younger individuals. They are most commonly caused by fall from height and motor vehicle accidents (Carpenter *et al* 1991). But in adolescents it is more common in sports activities (Hubard *et al* 1974). In our study the commonest mode of injury was fall from height in 18 patients (85.7%) most of them were painters and tree climbers. The other mechanisms being road traffic accident in 3 patients (14.3%).

Males have four fold increased risk than females in most of the studies. We also encountered a more number of male patients (95.3%) with the mean age group of 34.3 years.

Depending on the type of DL spine injury, associated spinal and non spinal injuries occur in up to 50% of patients (Cotler *et al* 1986, Court-Brown 1988). Intra thoracic injuries occur in about 20% of patients while intra abdominal injuries occur in 10% associated skeletal injuries occur in up to 20% of patient. Calcaneal fractures are the commonest one. Calcaneal (19%) and Pubic rami (4.7%) fractures were the commonest associated injuries in our study.

Regarding the level of fusion depends on location of the fracture. A long segment fusion can be done. But thoracolumbar junction is functionally very important. Preservation of mobility in these segments important for manual workers. So short segment stablisation without fusion is done [1, 2].

Transpedicular screw rod system is currently the standard in segmental fixation of thoracolumbar spine. Posterior surgery with a short segment stabilization allows early mobilization. Posterior surgery corrects deformity but post operative vertebral collapse common, which leads to post surgical kyphosis. To prevent these complication transpedicular bone grafting at the fractured vertebra should be done. In our series all patients underwent posterior short segment fixation and transpedicular bone grafting using autograft and tricalcium phosphate at the fractured vertebra which will give additional stability and maintain the reduction, it prevents post operative body collapse and instrumentation failure. Ligamentotaxis done in all burst fractures with intact neurology in 17 cases utilizing the partially intact posterior ligamentous complex (PLC). Patients with neurological deficit posterior decompression was done. In our study we have not encountered loss of kyphosis correction for any of our cases and vertebral body height was maintained post operatively even after 18 months of follow up what we achieved on table. In our series we used funnelling technique for transpedicular bone grafting with autograft and tricalcium phosphate on one side of pedicle was done after distraction on the opposite side [4, 5, 8].

Tricalcium phosphate is bioactive (composed of two of the primary elements contained in bone), as they absorb and it can remodel into bone. Tricalcium phosphate has good biocompatibility, it act as marker on radiological assessment after application and its osteoconductive properties are useful for the reconstruction [6].

Post-operative ASIA grade improved from grade B to grade C in two patients, from grade C to grade D in one patient at three months after surgery which were comparable with most of the major studies. No new onset or deterioration of neurological deficit status [7].

Among the 21 patients, eighteen patients (85.7%) had Denis pain scale of P 1 and three patients (14.3%) had Denis pain scale of P 2. Among the 21 patients, eleven patients (52.5%) had Denis work scale of W 1, five patients (23.8%) had Denis pain scale of W 2, one patient (4.7%) had Denis Work scale of W3 and four patients (19.0%) had Denis Work scale of W4.

In our study, among the 21 patients, one patient (4.7%) had proximal screw breakage at the end of 11 months and the patient had no pain and no neurological deficit. For that patient, implant removal was done. Patient had no pain and resumed her activities. One patient (4.7%) had superficial wound infection which was treated with antibiotics and dressing.

Leferink *et al* in his study noted that mean Anterior Wedge Angle (AWA) was 16.2° pre operatively which was corrected to 7.2° and on follow up, mean AWA was 8.5°. Wang *et al* in his study noted that mean AWA was corrected to 6.4° and maintained on follow up. In our study, among 21 cases, mean Anterior Wedge Angle (AWA) was 18.04° pre operatively which was corrected to 9.42° and on follow up [the longest duration of follow up being one year six months with a mean duration of 12 months], mean AWA was 10.14° [8].

Mean Anterior Height (AH) was 68.09% pre operatively which was improved to 83.66% and on follow up, mean Anterior Height was 78.57%. Mean Posterior Height (PH) was 83.90% pre operatively which was improved to 93.80% and on follow up, mean Posterior Height was 92.33%.

Herck *et al* [5] in his study noted that mean kyphotic Angle was 7° pre operatively which was corrected to 5° and on 2 years follow up, mean kyphotic angle lost by 1°. In our study

mean Kyphotic angle was 8.85° pre operatively which was corrected to 5.42° and on follow up [the longest duration of follow up being one year six months with a mean duration of 12 months] lost by 1° (mean 0.96°).

Posterior short segment fixation and transpedicular bone grafting has the advantages of less operative time, avoiding excessive bleeding, hypovolemic injury to cord and preserving the motion at thoracolumbar junction in comparison with long segment posterior stablisation. Posterior short segment fixation and transpedicular bone grafting using auto graft and tricalcium phosphate at the fractured vertebra which will give additional stability and maintain the reduction. Anterior vertebral body augmentation by means of posterior approach reduces the risks of anterior approach. It prevents postoperative vertebral body collapse, loss of kyphosis correction and instrumentation failure.[3,8]

Conclusion

Based on the Results of the study the following conclusions were made

1. Advantages of surgical stabilization of unstable dorsolumbar burst fractures in terms of restoration or preservation of neurological function, achievement of pain-free fracture site, early mobilization, and thereby fewer complications associated with prolonged bed rest.
2. Transpedicular bone grafting using autograft and tricalcium phosphate at the fractured vertebra for anterior body augmentation will prevent the late vertebral collapse and prevent postoperative late kyphosis and instrumentation failure.
3. Tricalcium phosphate has a good biocompatibility, act as marker for radiological assessment after application and its osteoconductive properties are useful for the reconstruction of vertebral body

Dorsolumbar burst fractures treated with dorsal instrumentation and transpedicular bone grafting facilitate early mobilisation of patients and achieving stable, pain free spinal column and preventing the late vertebral collapse, loss of kyphosis correction and instrumentation failure.

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