FUNCTIONAL AND RADIOLOGICAL OUTCOME OF THORACO-LUMBAR BURST FRACTURE

Dissertation submitted to the Tamil Nadu Dr. M.G.R Medical
University in partial
Fulfillment of the requirement for the M.S Degree Examination

Branch II (Orthopaedic Surgery) May
2019

CERTIFICATE

This is to certify that the dissertation titled **"FUNCTIONAL AND RADIOLOGICAL OUTCOME OF THORACOLUMBAR BURST FRACTURE "** is a bonafide work of **Dr. PANDIYAN LOGANATHAN**, in the Department of Orthopaedic Surgery, Christian Medical College and Hospital, Vellore in partial fulfillment of the rules and regulations Of the Tamil Nadu Dr. M.G.R Medical University for the award of M.S Degree Branch II (Orthopaedic Surgery), under the supervision and guidance of **Prof. K.VENKATESH** during the period of his postgraduate study from April 2017 to May 2019.

This consolidated report presented herein is based on bonafide cases, studied by the candidate himself.

GUIDE

Prof. K.VENKATESH

D.Orth, Dip. N.B. Orth. M.N.A.M.S

Prof and Head of Spinal Disorders Surgery

Department of Orthopaedics

Christian Medical College & Hospital,

Vellore.

CERTIFICATE

This is to certify that the dissertation titled **"FUNCTIONAL AND RADIOLOGICAL OUTCOME OF THORACOLUMBAR BURST FRACTURE "** is a bonafide work of **Dr. PANDIYAN LOGANATHAN**, in the Department of Orthopaedic Surgery, Christian Medical College and Hospital, Vellore in partial fulfillment of the rules and regulations Of the Tamil Nadu Dr. M.G.R Medical University for the award of M.S Degree Branch II (Orthopaedic Surgery), under the supervision and guidance of **Prof. Dr. K.VENKATESH** during the period of his post-graduate study from April 2017 to May 2019.

This consolidated report presented herein is based on bonafide cases, studied by the candidate himself.

PRINCIPAL:
Dr. Anna Pulimood,
Principal,
Christian Medical College, Vellore

DECLARATION

I hereby declare that this dissertation titled "**FUNCTIONAL AND RADIOLOGICAL OUTCOME OF THORACOLUMBAR BURST FRACTURE**" was prepared by me in partial fulfillment of the regulations for the award of the M.S Degree (Final) Branch II (Orthopaedic Surgery) of the Tamil Nadu Dr. M.G.R Medical University, Chennai towards examination to be held in May 2019. This has not formed the basis for the reward of any degree to me before and I have not submitted this to any other university previously.

Dr. PANDIYAN LOGANATHAN

Post Graduate Registrar

Diploma in Ortho, (M.S Orthopaedics),

Department of Orthopaedics,

Christian Medical College - Vellore,

Vellore-632002

ACKNOWLEDGEMENTS

I wish to express my sincere gratitude to my guide and mentor Dr.K. VENKATESH, Professor of Orthopaedics and Head of Spinal Disorder Surgery, for enabling me to choose and analyze a topic that is of significant clinical value and is a challenge to the present and future generations of Orthopaedic Surgeons.

I am eternally grateful to all my teachers for the guidance and encouragement throughout my entire post graduate program. I wish to thank my teachers for demonstrating and sharing their experiences and insights regarding surgeries and patient care. I wish to thank Dr. Vernon N. Lee, Dr. Alfred Job Daniel, Dr. V.T.K.Titus, Dr. Vrisha Madhuri, Dr. Vinoo M. Cherian, Dr. Venkatesh K., Dr. Kenny S. David, Dr. Thilak Jepegnanam, Dr. Pradeep M. Poonnoose,Dr. Rohit Amritanand, Dr.ThomasPalocaren, Dr. Manasseh. Dr.P.R.J.V.CBoopalan, Dr. Anil T. Oomen, Dr.Thomas Mathai, Dr. S.V Justin Arockiaraj

I acknowledge the help rendered by Hepsy YS, Department of Biostatistics in performing the statistical analysis of the data and for sharing his insights into statistical methods for carrying out future studies.

I am grateful to all my patients without whom this study would not be possible

I thank my parents, my family members, my wife Saranya and my son Nidhulan for being there with all tough times.

Table of contents **Page no**

Key words

CT - Computed Tomography

MRI - Magnetic Resonance Imaging

TL - Thoraco- Lumbar junction

ASIA - American Spinal Injury Association

FIM - Functional Independence Measure

TLICS - Thoraco -Lumbar Injury Association Classification and Scoring system

RCT -Randomized Control Trial

RTA - Road Traffic Accident

ZFP - Zero Foot Print

DVT - Deep Vein Thrombosis

ICD - International Classification of Disease

AVH - Anterior Vertebral Height

PVH - Posterior Vertebral Height

Tables

Table 13- Local kyphotic angle measurement in patients treated with pedicle instrumentation via posterior approach.

Table 14- Comparison of Local kyphotic angle treated by various non-operative methods

Table 15- 2 vertebral angle measurement in patient treated with pedicle instrumentation via posterior approach.

Table 16 - Comparison of 2 vertebral angle measurement in patient treated by various non-operative methods.

Table 17 - Load sharing classification and types of approach.

Graphs

Graph 1 – Pie chart on Gender distribution

Graph 2 – Pie chart on associated injury

Graph 3 – Bar diagram on mode of injury

Graph 4- Bar diagram on level of fractured vertebra

Graph 5 – Bar diagram on Denis classification of burst fractures

Graph 6- Bar diagram on neurological status of the operative group at the time of admission

Graph 7 & 8-Correlation of Cobb's angle with Denis pain scale of operative and nonoperative group at follow up

Figures

Figure 1 - Denis three column concept

Figure 2 - Denis classification of burst fractures

Figure 3 - Distribution of associated fractures in upper and lower limbs

INTRODUCTION

Burst fractures are most common in the thoracolumbar region. It occurs secondary to a fall from height or following a road traffic accident. Thoracic & lumbar spine are divided into three regions- thoracic (T1-T10), thoracolumbar junction (T10-L2) & lumbar spine (L3-L5)(1). Holdsworth described Burst fracture first in the year 1963, as a fracture caused by axial load leading to the herniation of nucleus pulposus through the upper end plate leading to the disruption of the vertebra within(2). It was Denis who later redefined Burst fracture with three column theory as compression fracture of the anterior and middle vertebral column which leads to retropulsion of the posterior vertebral body fragment into the spinal canal(2). Though burst fracture is common, the ideal treatment for burst fracture is still controversial, especially in patients with intact neurology. Burst fracture can be treated either by operative or nonoperative methods. There are various factors to be considered in the management of burst fracture such as the neurological status of the patient, stability of the fracture pattern, patient age and associated co-morbidities. The treatment goal is to prevent further neurological damage, recovering sagittal balance, achieve adequate stability and fusion, early rehabilitation and early return to work. The advantages of surgery include shorter period of bed rest and hospitalization, initial kyphotic deformity correction, decompression of the neural element (direct or indirect), avoidance of external immobilization with brace and early return to work. Controversy on how these fractures should be approached (anterior, posterior and combined) still exist. However stable burst fracture can be treated conservatively with brace. Conservative treatment in patients with intact neurology would avoid surgery and its complications.

AIM

To study the functional and radiological outcomes in patients treated for thoracolumbar burst fractures by various methods (OPERATIVE AND NON-OPERATIVE) from 2007-2016 in Spinal Disorder Surgery unit, Department of Orthopedics, Christian Medical College.

OBJECTIVES

1. To assess the neurological recovery using ASIA impairment scale at follow up in patients with neurological deficits at the time of injury.

2. To assess the functional status using Functional Independent Measure (paraplegic patients) and Denis work scale in all patients.

3. To analyze the worsening of kyphosis and its correlation with Denis functional pain scale at follow up

4. To analyze the degree of loss of correction of the angle of kyphosis at follow up using various radiographic parameters.

LITERATURE REVIEW

EPIDEMIOLOGY

The incidence of new vertebral fracture is around 5 million worldwide (3). Study by Hu et al in Canadian population shows an incidence of 64/100,000 of spinal injuries. Around 160,000 spinal injuries occur every year in North America. Thoracolumbar region is the most common site of involvement in traumatic spinal injuries. Almost

90% of injuries occur in this region of which burst fracture constitutes about 20% to 30% (4). Injuries at thoracolumbar region can also lead to neurological deficit in around 20-40%(5). Burst fractures in general population most commonly occur secondary to fall from height (34-54%). In younger individuals it occurs secondary to high velocity injury such as road traffic accident(51-65%)(6). In elderly individual it occurs secondary to trivial trauma and other associated metabolic disorders such as such as osteoporosis. The incidence of burst fracture is more common in males.

PATHOANATOMY

The unique anatomy of the thoracolumbar region and the pattern of transmission of force is necessary to classify thoracolumbar injuries. The thoracic spine is more rigid than the lumbar spine due to the attachment of rib cage. The facet joints in the upper thoracic region have a coronal orientation, resist flexion and extension as compared to lumbar spine were the facet joints are sagittal oriented which increases motion in flexion and extension. In thoracic region kyphosis ranges from 18º to 51º and in lumbar region lordosis ranging from 42º to 74º. The thoracolumbar region is (T10-L2) is either straight or slightly kyphotic (0ºto 10º) in sagittal plane. Thus, in kyphotic thoracic spine the body center of gravity located anterior to the spine causes compressive forces to be transmitted anterior to the vertebral body along with a tensile stretch or distraction of the posterior elements. In lordotic lower lumbar spine, forces are transferred more posterior and the compressive loads pass through posterior elements. Thoraco-lumbar region (T10-L2) represents the transition zone from the rigid kyphotic thoracic segment to mobile lordotic lumbar segment making it very vulnerable to trauma. Thus, in upright posture the axial load is exerted on the vertebral column passes anterior to the thoracic spine, through the thoracolumbar junction and posterior to the lumbar spine and through sacral promontory. The sudden application of supraphysiological axial load with or without flexion or extension can lead various components of the vertebral column to fail. Multiple fracture lines which propagate due to axial loading of the vertebral body in burst fracture lead to discontinuity of the posterior vertebral body and adjacent pedicles. Thus, the explosive nature of burst fracture lead to variable degrees of vertebral body retropulsion into the canal. The osseous fragments from the posterior superior endplate which cause the canal compromise which are responsible for various neurological manifestations.

PATHOPHYSIOLOGY

Spinal cord injury is common in traumatic spine injuries. About 35% of thoracolumbar fractures associated with spinal cord injury(7). The primary injury to the cord refers to the physical tissue disruption caused by mechanical forces, such as contusion, compression, stretch and laceration. In cord contusion the compressive the force exceeds the tissue components which results in disruption of axons and damage of the neuronal cell bodies, myelinating cells and vascular endothelium. Compression results because of decreased size of the spinal canal due to angulation or translation of the spinal column either mechanically or by interruption of the spinal vascularity. Compression and contusion in spinal cord injury differ in the rate of deformation. Stretch occurs when there is excessive longitudinal traction as seen in flexiondistraction injuries. Laceration is caused by penetrating foreign bodies, missile fragments or displaced spicules. Based on macroscopic findings spinal cord injury is classified into four groups such as a) Solid cord injury: the cord appears normal after injury (least common type) b) Contusion: areas of hemorrhage and expanding necrosis/cavitation seen without disruption in the surface of the cord (the most common type) c) Laceration: clear cut disruption of the surface anatomy d)massive compression: the cord is macerated to varying degree(8). As a result of primary injury there is damage to the microvasculature, edema develops progressively, ongoing ischemia worsens and a pro-apoptotic signaling is initiated which lead to the disruption of blood-spinal barrier, influx of inflammatory cells and release of coagulation fracture which promote thrombosis and spasm of the micro vessels, leading to further hypoxia. In primary cord injury the maximum deficit occurs immediately after the injury, the axonal transmission disrupted or blocked by abrupt neuronal cellular damage, endothelial and blood vessel damage which is mostly irreversible. The secondary injury refers to the cascade of events following trauma which might begin immediately after the injury or few days later which leads to variable degree of tissue destruction. There is decreased blood flow to the spinal cord within few hours after the spinal cord injury with failure to restore the blood flow which results in ischemic hypoxia and tissue destruction(9). There is depletion of high energy phosphate reserves, lactic acidosis and tissue edema leading to propagation of interdependent reaction which leads to tissue destruction and functional loss.

PATIENT EVALUATION

Patients with spinal injury needs a multidisciplinary team approach to avoid mortality and morbidity. Patient with suspected spine injury is immobilized first, the airway, breathing and circulation is restored before proceeding to thorough neurological examination. In patients with polytrauma, the life threatening injuries which impair the respiratory and circulatory function is addressed first and spine injury examination is done secondarily. In poly-traumatized patient thoracolumbar injuries can be associated with cervical injury in around 11%. During resuscitation manual inline cervical traction using log roll technique should be carried out till secondary assessment and spinal injuries are ruled out. After adequate primary resuscitation, a thorough clinical examination is to be done. Detailed history on the nature and time of injury has to be recorded, symptoms such as back pain and examination for the presence of bruising in the back, abrasion, tenderness, local kyphosis and palpable step between spinous processes at thoracolumbar region suggestive of thoracolumbar injury. Patient who has associated neurological injuries will present with motor weakness, paresthesia or anesthesia below the injured level and associated with bowel and bladder incontinence. American Spinal Injury Association guideline which focuses on motor, sensory and proprioceptive levels can be used for detailed neurological examination. Sensation in each dermatome, motor system examination such as motor power and tone in the key muscle examination in both upper and lower limb should be examined and documented. Deep tendon reflex, rectal examination including anal sphincter tone and perianal sensation examined and charted. Patients with spinal injuries can have progression of neurological deficit hence serial examination is necessary to plan further treatment. Patients who present with spinal shock in emergency department, resolution of symptom such recovery of neurological deficit takes place within 24 hours of the injury, but it can last from a few days to week. Absent bulbocavernous reflex indicates spinal shock and the return of anal wink indicates the end of spinal shock. The spinal cord can variably terminate between D11-L2 and since burst fractures are common at the thoracolumbar junction it can present as a variety of neurological deficit ranging from complete injury to the spinal cord to cauda equina syndrome. However the intact neurological status does not rule out spinal fractures since majority of thoracolumbar injury do not have neurological deficit. Further imaging such as x-rays, computed tomography and magnetic resonance imaging will help us in planning further treatment(10).

IMAGING

Radiographs play a vital role in differentiating burst fractures from other vertebral fractures. Imaging also gives detail on the number of segments involved, level of the vertebra fracture and associated fractures such as fracture of the spinous and transverse fractures of the vertebra. Denis in his three column theory stated that the retropulsion of the posterior vertebral fragment into the spinal canal is the radiographic hallmark of burst fracture(2). Denis classified burst fractures based on the radiographic appearance. Most burst fractures can be diagnosed with good quality anteroposterior and lateral plain radiographs. There are various characteristic features peculiar to burst fractures, the lateral plain radiograph shows loss of anterior and posterior vertebral height, comminution of the superior or the inferior endplate, retropulsion of the bone into the spinal canal (radiographic hall mark). In the anteroposterior radiograph there is increase in the interpediculate distance, interspinous widening, sagittal vertebral body fracture, lateral translation or flexion (burst variants)(11). Computed tomography gives more diagnostic information when it is difficult to differentiate compression fractures from burst fracture. In plain radiograph about 20% of the burst fractures can be misdiagnosed as compression fracture(12). In such cases computed tomography gives detail on the fracture pattern. Computed tomography description of burst fractures was described by Nykamp et al in 1978(11). Sagittal fracture of the vertebra, associated lamina fractures and fracture dislocation of the facets are identified with CT. McAfee et al described the importance of demonstrating the vertebral arch fracture in computed tomography which is seen in unstable burst fracture in contrast to stable burst fracture were the posterior column is intact(13). The degree of canal compromise secondary to the retropulsed fragment is well demonstrated with CT in the sagittal images. CT not only helps in diagnosing the fracture, it can also be used to decide the type of approach in case of surgical fixation e.g. McCormack classification used CT to assess the vertebral bone fragment shift in the sagittal images. It gives better idea of the adjacent vertebral bodies and pedicles which might help the surgeon to decide the level of instrumentation in case of operative management. In case of operative management, ideal CT should include the vertebra above and below the fractured vertebra. The disadvantage of CT is that it does not give much information of the soft tissue injury and associated ligamentous injury.

MRI is mostly used to detect the associated ligament injury (posterior longitudinal ligament and inter spinous ligament), soft tissue component of spinal cord, and status of the intervertebral disc. In burst fractures, MRI is mostly useful in patients who have neurological deficit where magnetic resonance imaging can differentiate between complete cord transection, mixed conus, cauda equina, which gives idea on the neurological recovery. Patients with incomplete spinal cord injuries, the neurological recovery is better when compared to patient with complete cord transection(14). MRI is contraindicated in patients with aneurysm clips, cardiac pacemaker, medical implants where a myelogram followed by post myelogram CT can be done.

CLASSIFICATIONS

There are several classifications described for burst fractures. The ideal classification system should facilitate understanding the fracture patterns between the surgeons, guide treatment and predict the prognosis. The classification should be simple, comprehensive, reproducible and reliable. This classification described earlier were based on the radiographic findings which convey very less understanding about the associated ligament injuries. However, the classification system evolved over time with better understanding of the biomechanics and improvements in the imaging modalities such as computed tomography and magnetic resonance imaging conveying the information pertaining to the spine stability and neurological status which is important to decide the type of management and predict prognosis.

Lorenz Bohler described classification system for thoraco-lumbar fracture in 1929 based on geometry and mechanism of injury. He classified it into 5 categories such as

a) compression fracture, b) flexion distraction injury, c) extension injury, d) rotational injury and e) shear fracture.

In 1938 Watson Jones introduced the concept of stability and emphasized that the integrity of the posterior ligament complex (PLC) is essential for stability. His classification system includes four types namely a) simple wedge fracture, b) comminuted fracture, c) fracture dislocation, d) hyper extension injuries.

Nicoll in 1949 emphasized importance of stability in his classification. He also stated that in any injury the vertebral body, disc, intra-articular joint and the interspinous ligament should be examined separately. He classified thoraco- lumbar fractures a) anterior wedging, b) lateral wedging, c) fracture –dislocation and d) neural arch injury

Sir Frank Holdsworth was the first to describe Burst fracture in 1970. He introduced the concept of "Two Column" in which he divided the spine into anterior column which consist of vertebral body and disc, and posterior column which consists of the facet joints and Posterior ligament complex. He also emphasized that posterior ligament complex is important in maintaining stability of spine. He classified spine injuries into a) Anterior compression injury b) Flexion rotation injury c) Extension injury d) Shear injury e) Burst fracture

In 1983 Denis described three column concept Fig (1). According to his classification the anterior column consists of anterior longitudinal ligament, anterior annulus fibrosus and the anterior part of the vertebral body. He described the concept of middle column which included the posterior wall of the vertebral body, posterior longitudinal ligament and posterior annulus fibrosus. The posterior column consists of posterior bony complex along with posterior ligament complex which includes supra- spinous, ligament flavum, infra-spinous ligaments and capsule of intra-articular joints.

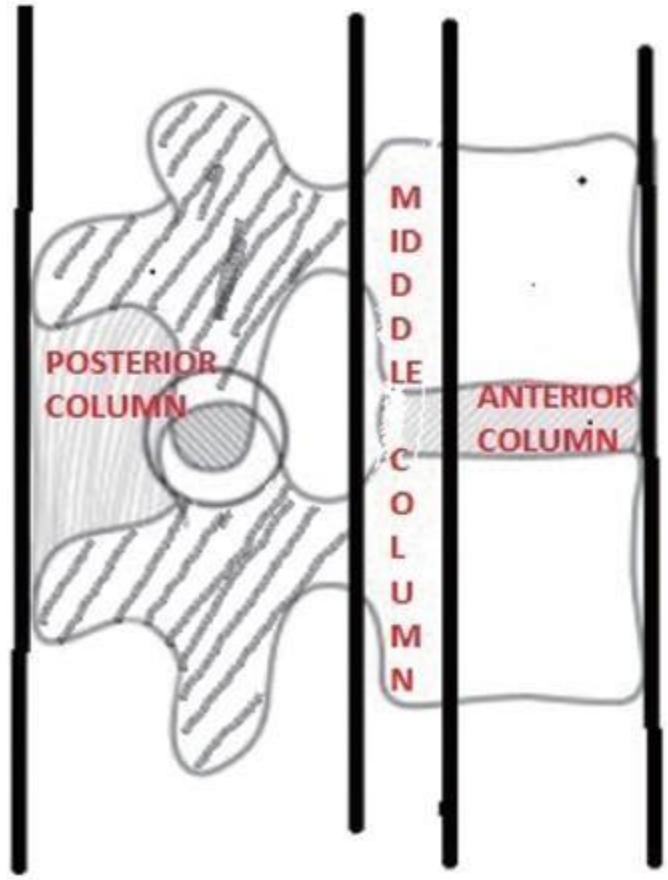


Figure (1)

According to his classification in burst fracture the middle column fails in compression resulting in loss of posterior vertebral height with retropulsion of the fragment into the neural canal leading to various neurological compromise. The radiographs in burst fracture characterized by increase in the inter-pedicular distance, vertical fracture of the lamina and splaying of the posterior joint.

Denis further classified burst fracture into 5 subtype's Figure (2)

Type A: Fracture of both end plates. The bone is retropulsed into the canal.

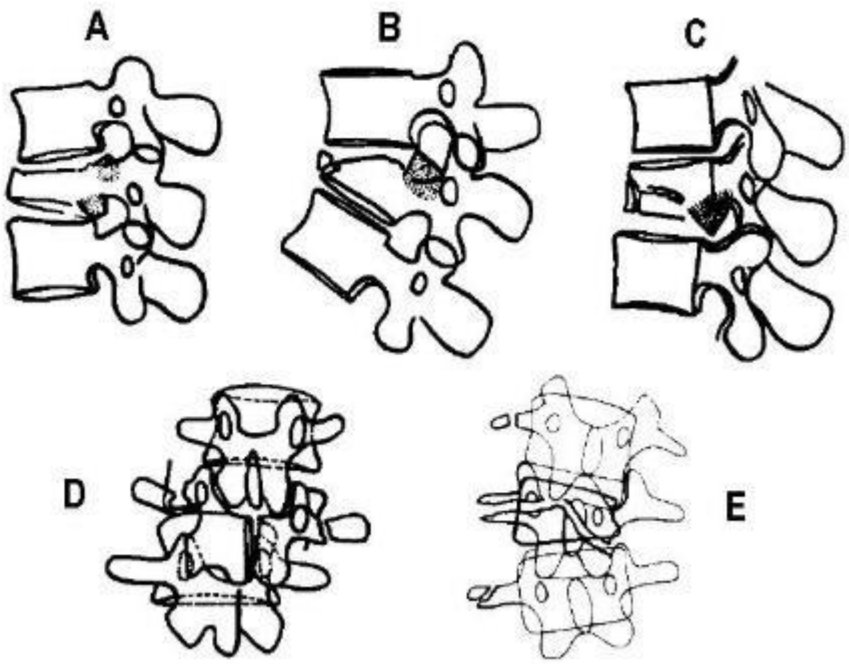
Type B: Fracture of the superior end plate. It is common and occurs due to a combination of axial load with flexion.

Type C: Fracture of the inferior end plate

Type D: Burst rotation

Type E: Burst lateral flexion

Figure 2 (Semin Spine Surg 22:2)



Paul C McAfee in 1983 subdivided burst fracture into stable and unstable type. He described in stable burst fracture the anterior and middle column fails due to compression force without involving the posterior column. In unstable type the posterior column is involved due to compression/lateral flexion/rotation forces leading to facet joint sub-luxation or disruption of the neural arc.

Mc Cormack in 1994 devised a scoring (Table 1) which helps in assessing the risk of failure of short segment pedicle screw construct. He identified three factors - 1)

Degree of kyphosis correction on lateral view 2) Degree of vertebral comminution and 3) Apposition of the fracture fragment, that correlate with the failure of the posterior segment pedicle screw. Each factor is graded as mild, moderate or severe with corresponding point values of 1, 2, and 3 respectively with total score ranging from 3 to 9. Higher scores demonstrate weaker anterior column support. According to McCormack if the score is 6 or less, it represents a stable fracture and posterior short segment pedicle construct can be used. If the score is 7 or more without translation, an anterior surgical approach with anterior column support using an instrument of strut graft can be used. If the score is 7 or more with fracture dislocation, short segment posterior fusion followed by anterior support can be used or long segment posterior instrument can be used. However, the load sharing classification has high degree of inter and intra observer reliability and load sharing classification does not include the ligamentous or neurological status hence it cannot be used to assess surgical

indication.

Table 1

McCormack Classification

Score	**1 point**	**2 points**	**3 points**
Sagittal collapse	30%	>30%	60%
Displacement	1mm	2mm	>2mm
Correction	3°	9°	10°

Total	3points	6points	9points

AO (Arbeitsgemeinschaft fur osteosynthesenfragen)/ Magerl classification.

Magerl in 1994 developed a classification for thoracolumbar fracture which is very comprehensive and highly detailed. This classification system considered spinal column as two columns. Based on the increasing morphological damage and mechanism of injury three types of injuries are described. Type A injuries which is a failure under axial compression of the anterior elements with intact posterior constraining elements, Type B injuries are failure of the posterior constraining elements and Type C injuries are failure of anterior and posterior elements leading to displacement. Each type has three group and each group has three sub groups. The severity progress from type A through type C as well within the sub groups. Burst fractures come under type A injuries (compression) type A3.

Table 2

AO classification

Type A	**Compression**
A1.1	End plate fracture
A1.2	Wedge-compression
A1.3	Compression
A2.1	Sagittal split

A2.2	Coronal split
A2.3	Pincer fracture
A3.1	Incomplete burst fracture
A3.2	Burst-split
A3.3	Complete burst
Type B	**FLEXION –EXTENSION FRACTURES**
B1.1	Degeneration from disc surface
B1.2	Type A + posterior ligamentous injury
B2.1	Transverse double column
B2.2	Flexion spondylolysis
B2.3	Flexion-split+ Type A
B3.1	Extensive extension
B3.2	Extensive extension- Spondylolysis
B3.3	Backward dislocation
Type C	**ROTATIONAL**
C1.1	Rotation + A1
C1.2	Rotation + A2
C1.3	Rotation + A3
C2.1	Rotation + B1
C2.2	Rotation + B2
C2.3	Rotation + B3 shearing

C3.1	Shearing/Cut
C3.2	Shearing-oblique fracture

Vaccaro and his associates in 2005 described TLICS (Thoracolumbar Injury Classification and Scoring system) which includes the morphology of injury, integrity of posterior ligament complex and neurological status of the patients. While in all other classification the neurological status was not included TLICS includes the neurological status at the time of injury which is necessary for the ultimate final prognosis. If the score is less than 3, then there is no need for surgical intervention, if score is 4, either operative or non-operative treatment is required and if the score is more than 4 operative intervention is suggested.

Table 3

TLICS SCORING SYSTEM

Points
Fracture mechanism

Compression fracture	1
Burst fracture	1
Rotational fracture	3
Splitting	4
Neurological involvement	
Intact	0
Nerve root	2
Conus medullaris incomplete	3
Conus medularis complete	2
Cauda equina	3
Posterior ligamentous complex	
Intact	0
Possibly injured	2
Injured	3

Importance of concept of stability in burst fracture

It is important to know whether the fracture pattern is stable or unstable to plan further treatment. Stability in thoracolumbar junction depends in the integrity of ligaments and bony structures. Various authors emphasized the importance of stability in burst fracture. Nicoll described the concept of post traumatic instability. He described the unstable fractures patterns as fracture dislocation, fracture subluxation with rupture of the interspinous ligament and any laminar fracture at L4-L5(15).He also stated that in stable fracture there is no risk of progression of deformity and no risk of injury to the spinal cord hence the stable fracture can be treated less aggressively when compared to unstable fracture where there is the risk of progression of deformity. White and Panjabi stated that the stable spine is able to maintain its normal movement under physiological load so that there is no initial or additional neurological deficit, no major deformity and no incapacitating pain. They also proposed the checklist for assessing instability as mentioned below

Table 4

White and Panjabi checklist for thoracic instability
Anterior elements destroyed or unable to function :2
Posterior elements destroyed or unable to function :2
Relative sagittal plane translation >2.5mm :2
relative sagittal plane rotation >5 degrees :2
Spinal cord/cauda equine damage :2
Disruption of costovertebral articulations :1
Dangerous loading anticipated :1

A score of 5 or more, the spine is considered unstable. Denis et al classified spine instability to the three groups. I) Mechanical instability (first degree) is the structural instability in which there is potential for further collapse and angulation. The mechanical instability is based on whether the posterior ligament complex is injured or not. In plain radiograph if there is decrease in the vertebral body height more than fifth percent, increase in the interspinous distance and kyphotic angle more than 30 degree suggestive of posterior ligament complex injury. Further imaging like computed tomography is used to assess the diastasis of facet joint and magnetic resonance imaging which is more sensitive and specific to assess the posterior ligament complex injury. II) Neurological instability (second degree) is determined by ASIA (American Spinal Injury Association) there are 5 types of neurological status such as

ASIA A- Complete

No motor or sensory function is preserved in the sacral segments S4-S5

ASIA B- Incomplete

Sensory function preserved but not motor function is preserved below the neurological level and includes the sacral segments S4-S5

ASIA C -Incomplete

Motor function is preserved below the neurological level and more than half of key muscles below the neurological have a muscle grade less than 3

ASIA D -Incomplete

Motor function is preserved below the neurological level and at least half of key muscle below the neurological level have a muscle grade of 3 or more

ASIA E -Normal

Motor and sensory function are normal

Any type of lesion which is not type E is classified as neurological instability regardless of the instability of the fracture or posterior element injury. III) Combined mechanical and neurological instability (third degree). McAfee et al divided burst fracture into stable and unstable type based on integrity of posterior column.

INITIAL TREATMENT

Patient with spinal cord injury needs careful resuscitation and treatment to prevent further damage to the spinal cord. Respiratory complication are main cause of mortality and morbidity in acute phase of spinal cord injury ranging from 36%83%(16). The level of injury and ASIA classification are the two important predictors of intubation. In patient with cervical spine injury lesion above C5 patient should be intubated electively rather than as emergency. In patients with spinal cord injury hypotension is very frequent complication in acute phase. The hypotension could be due the part of polytrauma of it could result from the direct cervical or thoracic spinal trauma itself which leads to neurogenic shock. If hypotension is secondary to blood loss the patient will have decreased blood pressure with tachycardia in contrast to neurogenic shock where there is loss of peripheral tone and bradycardia. It is necessary to differentiate between these two types for the proper initial management of shock. According to the recent studies hypotension in spinal cord injury contributes to the secondary injury which leads to reduction the spinal cord flow and perfusion. The current recommendation is to maintain mean arterial pressure (MAP) at 85-90mm of hg for the seven days after the injury. The hypotension can be managed with intravenous fluid therapy along with vasopressor based on the level of spine injury. The benefits of administration of methylprednisolone in acute spinal cord injury is extensively controversy. Methyl prednisolone is a synthetic corticosteroid that up regulates the anti-inflammatory factors and decrease the oxidative stress enhancing endogenous cell survival. It reduces edema and prevents intracellular potassium depletion and inhibit lipid peroxidation. Steroids contraindicated in age<13 years, pregnancy, gastrointestinal bleeding.

There are various randomized control trial that assessed used of use of glucocorticoid in the use of acute spinal cord injury. A double blinded randomized control trial by National Acute Spinal Cord Injury Study (NASCIS I 1984) treated patient with spinal cord injury with 100 mg bolus of methylprednisolone followed by 25 mg every 6 hours for 10 days or 1000 mg of bolus methylprednisolone followed by 250mg every 6 hours for 10 days. This study concluded at 6 months of follow up there was no difference in motor or sensory recovery observed between two groups and significant increase in wound infection high dose group. In 1990 NASCIS II published double blinded RCT which compared 30mg/kg bolus of methylprednisolone followed by

5.4mg/kg for 23 hours with naloxone 5.4mg/kg bolus followed by 0.5mg/kg/hour for 23 hours and placebo. At one year of follow up there was no significant difference in the motor or sensory scores. However, the sub analysis by post-hoc they found there was five-point improvement in the motor score for patient who received steroid with eight hours of injury when compared to patient who received steroid after eight hours. The validity of post-hoc analysis is controversial till date. In 1979 NASCIS III multicenter study which extended the methylprednisolone infusion up to 48 hours to see associated therapeutic benefit. In this study with acute spinal cord injury presented within 8 hours of injury were recruited and received 30mg/kg methylprednisolone bolus and patients were randomized into 5.4mg/kg/hour methylprednisolone for

24hours,5.4mg/kg/hour methylprednisolone for 48hours and tirilazad 2.5mg/kg every 6hours for 48 hours. At one year follow up there was no significant difference between groups. In Post-hoc analysis patients who received 48 hours of steroid between 3-8 hours of injury had improvement in the motor score. The also reported prolonged use of steroid associated with increased risk of severe pneumonia. In the year 2000 Pointillart et al double blinded RCT which compared methylprednisolone, nimodipine and combination of both. At one year his study also found there was no significant neurological improvement between the groups. The American Association of Neurological Surgeons and the Congress of Neurological Surgeons released a consensus statement in 2013 that the use of glucocorticoids in acute traumatic spinal cord injury is no longer recommended. There are various new drugs like Riluzole which reduces the motor neuron degeneration, minocycline which reduces apoptosis and increases neuroprotective effects, tirilazadmesylate which is non-glucocorticoid amino steroid which inhibits lipid peroxidation still under experimental study and not available for clinical use.

TREATMENT OF BURST FRACTURE

There are various options available treatment of burst fracture. The ideal management of burst fracture is still controversial. Burst fracture can be treated either by surgical or non-operative methods. The aim of treating any burst fracture is to restore the spine stability. Prevention and limitation of neurological injury, correction of deformity and early return to normal life. The advantages of surgery include direct or indirect decompression of spinal cord, correction of deformity, restoration of stability, avoidance of external immobilization with brace and early return to normal activities. However, patients with burst fracture with intact neurology if treated conservatively would avoid complication secondary to surgery. Surgical intervention is usually needed in patient with neurological deficit and unstable fracture. Controversy still exist on whether conservative or surgical intervention is better in patients with intact neurology. There is considerable debate on how the fractures should be approached either anterior, posterior or combined approaches, how many segments to include during surgery.

OPERATIVE AND NON-OPERATIVE TREATMENT

The ideal goals of treatment in burst fracture in general are

1. Decompression of spinal canal and nerve root to enhance recovery
2. Restoration of sagittal balance and vertebral body height
3. Rigid stabilization for early ambulation and rehabilitation
4. Correction of deformity and prevention of collapse of the injured segment
5. Preservation of spine function with adequate fusion

NON-OPERATIVE TREATMENT

The ideal candidates for non-operative treatment are patient with stable fracture pattern with no neurological deficit. There are various methods of non-operative treatment such as use of brace, or orthosis, plaster cast, bed rest and analgesics. Surgery in burst fracture done for neural decompression and stabilization however they are not achieved in conservative method of treatment. The advantages of nonoperative treatment are it reduces the cost burden especially in developing countries and also prevents from surgery related complication such as infection and hardware failure. Non-operative treatment of burst fracture was described in 1940 by Ludwig Guttman which was later described by Nicoll and it was continued by Frankel and Bed brook. Denis et al in his retrospective study comparing operative and non-operative methods in patients with intact neurology he found the patients who were treated by surgical methods had return to full time work when compared to non-operative method who could not return to full time work and he also stated in his patient who had treated by non-operative methods had developed neurological problems(17).

Denis concluded that all burst are unstable and they need surgical intervention due to neurological complications. Krompinger et al stated that in thoracolumbar fractures with no neurological involvement when there is less than 50% of canal encroachment & kyphosis angle less than 30º those fractures can be considered as stable fracture and can be treated by non-operative methods(18). Reid et al concluded from his study that not all the burst fractures requires surgery, in patients with intact neurology, kyphosis less than 35º, when there is no contraindication to use total contact orthosis and patient who can understand and cooperate for the treatment regimen can be considered for conservative method of treatment(19). Wood et al from his randomized study between operative and non-operative method in patient without neurological deficit he found that patient who were treated by surgical methods had long duration of stay in hospital and complications were more in surgical group. There was no difference in terms of pain score or return to work. They concluded that in stable thoracolumbar burst fracture with intact neurology the surgical treatment does not have long term advantage when compared to non-operative treatment(20). Weinstein from his study on long term follow up burst fracture treated by non-operative methods he found that none of the patients had neurological deterioration, 80% of patients were returned to their normal activity, he concluded that in patient without neurological deficit non-operative method is viable option(21). There are various studies which compared the various methods of conservative treatment (brace, plaster of Paris cast) Stadhouder et al in randomized control trial compared plaster cast to brace he found that there was no significant difference in outcome measure(Visual analog score,

Oswestry Disability Index) between the groups for the patients with burst fractures(22). Bailey et al in 2013 in his multicenter randomized trial compared AO- A3 burst fracture treated with and without orthosis in skeletally matured patient with thoracolumbar burst fracture who had no neurological deficit. From his study he concluded there was no difference in outcome measure between these two groups(23). Shen et al in his prospective study compared non-operative with posterior fixation in patient without neurological deficit from his study he concluded that surgical fixation resulted in earlier pain improvement and partial kyphosis correction when compared to non-operative method. However the functional outcome at 2 years were similar between these two groups (24). A meta-analysis by Gnanenthiran et al in 2012 on thoracolumbar burst fractures(10), stated that there was no difference in terms of

Visual Analogue Score, return to work between operative and non-operative methods. From their review they concluded the no evidence to suggest that operative method of treatment is superior to non-operative methods in patient with intact neurology. Even though there is lot of controversy of treatment for stable burst fracture in patient with intact neurology the non-operative method of treatment either with brace or plaster cast considerable option which would avoid the complication secondary to surgery, reduce the financial burden.

OPERATIVE TREATMENT

There are various surgical methods, approaches described for surgical management of burst fracture. However, the ideal approach either (anterior, posterior, combined), number of segments of instrumentation and timing of surgery are still controversial. The various options available for surgical management of burst fracture are anterior decompression and fusion, posterior fusion with or with decompression, posterior stabilization without fusion, decompression anteriorly with 360º fusion, posterior fusion combined with cement augmentation and posterior fusion with reconstruction of anterior and middle column using cage or bone graft. The goals of surgery in burst fracture is achieve adequate spinal decompression, stable fixation and fusion. Operative treatment is indicated in patients with neurological deficit, progressive worsening of neurological deficit and patients with unstable burst fractures. Surgery is relatively indicated in poly trauma patient for early rehabilitation, obese patients and condition were bracing or plaster casting is not possible. Reid et al in his study concluded that all patients with burst fracture who have neurological deficit or kyphotic angle more than 35º needs surgical intervention(19). Willen et al suggested that surgery for burst fractures done when the canal compromise is more than 50% and when the anterior column comminution exceeding 50% and the kyphosis angle than 20º(25). In the recent studies there is positive correlation with progressive kyphotic deformity and back pain so kyphotic deformity was considered as an indication for surgery. Sagittal index was used to predict the progression of segmental kyphosis. Farcy et al suggested that when the sagittal index is more than 15º the risk for progression of kyphosis and he concluded that surgical intervention might be needed in those patients (26). However surgical intervention in patient with stable burst fracture with no neurological deficit still inconclusive.

TIMING OF SURGERY

The optimal time of surgery in patient with complete neurological deficit and patient with intact neurology is controversial. In patients with incomplete deficit and with rapid worsening of neurology the surgery should be done at earliest where there is chance for neurological recovery. The advantages of early surgery are it reduces the number if stay in the hospital, early mobilization, reduces the number of days of stay in intensive care unit, decrease the pulmonary and thromboembolic complications. However, the disadvantage of early surgery is increased operative blood loss, increased neurological complication in decompression of acute edematous spinal cord and visceral injury. Xing et al in his systematic review concluded that early stabilization of thoracolumbar fracture reduces the mortality and morbidity(27). There are various retrospective study which states the acute thoracolumbar fracture should be stabilized less than 3 days to prevent overall mortality and morbidity(28). There are few studies on early surgical stabilization and improvement in the neurological outcomes. Mirza et al his retrospective study on cervical spine injury compared early (<72 hours) and delayed (>72 hours) from his study he concluded that early might help in improving the neurological recovery and decrease the hospital stay(29). Cengiz SL et al his prospective study stated that patient who underwent early surgical stabilization (less than 8hours) had lesser systemic complication, lesser intensive care unit monitoring. He also concluded early surgery may improve neurological outcome(30). Bourassa-moreau et al in 2016 prospective study concluded that there was no significant difference in the neurological recovery in patient who underwent early surgical stabilization less than 24 hours when compared with patient who were operated after 24hours(31). The neurological recovery not only depends on the timing of surgery it also depends various other factors such as either complete or incomplete cord injury, amount of initial impact on the spinal cord at the time of injury.

ROLE OF DECOMPRESSION, STABILIZATION AND FUSION

Adequate decompression of spinal is one of the most important goal in surgical management of burst fracture. It can be broadly divided in two group’s decompression in patient with and without neurological deficit. Decompression can be done by direct and indirect methods. The choice of decompression is can differ based on the surgeon choice and experience. Benzal et al stated that surgical decompression and stabilization had better neurological and functional outcome when compared to other non-operative methods(32).

ANTERIOR DECOMPRESSION AND STABILIZATION

Anterior decompression usually done in patients with severe canal compromise with neurological deficit, severe vertebral comminution and kyphotic deformity and in patients were adequate decompression not achieved with posterior approaches. The other indication of anterior decompression in patients with incomplete neurology with imaging demonstrating the retropulsed fragment causing canal compromise. In burst fracture is the compression tissue or the fragment invariably seen in the anterior spinal canal, using anterior approach the retropulsed fragment can be visualized directly adequate removal soft tissue or the fragment and direct decompression of the neural canal can be done. However anterior approach has its own disadvantages its risk of bleeding, visceral injury and pulmonary complication and long duration of surgery more with anterior approach. It's technically demanding procedure which unfamiliar to the junior surgeons. Once adequate decompression done stabilization and fusion can be done using various implants. Anterior spinal reconstruction can be done using iliac crest graft or using titanium mesh cages and stabilization can be done using vertebral plates, screws and rod system. Kaneda et al in his study on anterior decompression and fusion using Kaneda device in patients with neurological deficit reported 93% of fusion rate and complete recovery of bladder function in 72%. He also concluded that anterior approach gives adequate decompression and superior mechanical stability(33). Hitchon et al reported from his retrospective cohort study that correction and maintenance of deformity is better with anterior approach when compared with posterior(34). Biomechanical study by Shono et al stated that anterior reconstruction had superior mechanical stability when compared with posterior instrumentation and permits effective decompression of spinal canal(35). Xu et al in his meta-analysis comparing anterior and posterior approach on surgical management of burst fracture concluded that anterior approach had no significant superior results as compared to posterior approach in concern to neurological recovery and return to work(36).

Posterior decompression and stabilization

Posterior approach and stabilization is most common method used in treatment of burst fractures. Posterior approach is simple, and it does not encounter any important structure as compared to anterior approach. Posterior approach most commonly used in patient with burst fracture with no neurological deficit with disrupted posterior ligament complex, nerve root involvement with intact posterior ligament complex and in patients with complete neurological deficit with or without involvement of posterior ligament complex. Using posterior approach decompression can be done based on mechanism and fracture pattern. The decompression done by indirect reduction using ligamentotaxis and direct decompression with laminectomy can be done. There is risk of nerve damage while manipulation or while removing the retropulsed fragment even with posterior approach. It is alternative approach especially in obese patient were anterior approach carries risk to vital structures.

Various implants can be used to stabilize such as rods, hooks, wires, plates and pedicle screws. Sub laminar wires are rarely used since wire passage can damage the spinal cord. Harrington rod distraction was initially used in stabilization of burst fractures though restoration of vertebral height and reduction of kyphosis attained it is a semi rigid fixation and it requires immobilization more number of mobile segments. Complications such as early hardware failure, dislodgement of hook, persistent pain common with rod and hook system(37).Mc bride et al in his study on thoracolumbar fractures using hook-rod fixation reported 93% fusion rate but he also stated that complication of early hard ware failure, pain and progression of deformity seen in about 22%(2). Pedicle screws replaced hooks and rod system as pedicle screw provide fixation to all three column, greater force can be applied to reduce the deformity and simultaneous axial compression, or distraction can be done. Pedicle restore stability by fixing less number of segments which also spares the adjacent mobile segments.

Posterior transpedicular screw technique was first reported in 1959 by Boucher(38). Pedicle screw system prevents motion segments, provide stable construct and avoids ling fusion. It maintains reduction until bony union is achieved. Initial study suggest that burst fracture can be successfully treated short segment pedicle screw fixation.
The advantage of short pedicle screw fixation is it limits the number of segments to be fixed and fused, which also preserve the motions in the other segments. However, the later studies suggested that short segment pedicle fixation associated with high incidence of hardware failure and loss of reduction as the short segment cannot prevent the anterior collapse. The residual kyphotic deformity results in higher stress on the pedicle screws, with over loading the implant loosens and leads to screw breakage or dislodgment. Markel and Graziano suggested that thoracolumbar burst fracture could be treated with short segment instrumentation. Park et al reported 98% fusion rate in burst fractures without extensive comminution treated by short segment fusion(2). However other studies reported 20-50% failure rate and 50-90% loss of reduction with short segment system. To prevent compilations of short segment system various other techniques were described. The number of segments fixed were extended (2 above and 2 below the fractured vertebra), one level above and one level below fixation including the fractured vertebra, 2 level above and 1 level below the fracture vertebra. Using long constructs gives multiple fixation point which distribute the force over the number of segments which decrease the screw pull out. There are various studies suggest that long segment stabilization provides more stability and greater reduction of kyphotic

deformity. Tezeren and Kuru et al on comparing short and long segment fixation they concluded that long segment stabilization had favorable radiological outcome in comparison with short segment fixation(39). Altay et al reported using 2 level above and 2 level below the fractured vertebra gives more stability and reduction of the deformity(40). McAfee in his calf spine model demonstrated that 2 level above and 2 level below fixation provided more stiffness when compared to normal spine(40). McCormack in 1994 devised a scoring system which helps in predicting screw breakage in short segment stabilization according his classification a total score more than 6 points would either require long segment fixation or anterior approach and anterior reconstruction (41). However meta-analysis on comparing short and long segment fixation by Aly et al concluded that no difference between these two types in terms of back pain, correction of deformity and return to work(40). But long segment posterior stabilization had favorable radiological outcome when compared to short segment fixation in meta-analysis by Filho et al (42). The main reason for failure of posterior stabilization was due to loss of anterior column support. To reinforce the anterior column and to improve the stability of posterior instrumentation several techniques were described such as fill in the defect in the fractured vertebra with bone cement (polymethyl methacrylate), transpedicular cancellous grafting, using artificial bone substitute and adding screws at the fracture level. There are various studies suggest that reinforcement of screw at the fracture level provides better deformity correction (kyphosis), restore the height of the vertebra and it also improves the biomechanical stability of the construct. Study by Guven et al reported that fixation that includes the fracture vertebra provided better deformity correction, restoration of anterior vertebral height and lower rate of correction failure(43). Biomechanical study by Anekstein et al on pig lumbar spine suggest additional screw at the fracture level increased the stiffness of the fixation (44). Zhao et al in his study of posterior instrumentation including fracture vertebra has similar result of restoration of anterior vertebral height, loss of correction with good functional outcome(45). Transpedicular bone grafting in addition to short segment fixation had good result on short term follow up, on the long term follow up there was no significant between the bone grafting and no bone grafting group(46). Polymethyl methacrylate cement provide immediate spine stability like anterior plate and screw fixation as it hardens during the process restore the anterior vertebral height which leads to change in the loading force in the anterior column and decrease the stress on the instruments. Cho et al his study reported that reinforcement of short segment instrumentation With cement achieved kyphotic correction, increase in the anterior vertebral height and good functional outcome(47). However, leakage of cement into the canal is a worrisome complication. Vertebroplasty and kyphoplasty is mainly indicated in osteoporotic compression fracture however its use in traumatic burst fracture is not well documented. There are other studies which reported usage of absorbable bone cement in addition to short segment fixation had better clinical outcome and low implant failure (48). Liao et al reported that adding screws at the fracture site had better results in terms of surgical time implant failure. He suggested that addition on screw at the fracture site is better than augmentation with absorbable calcium cement(49). Though posterior approach simple and with less complications, in posterior approach denervation of paraspinal muscles, facet capsule which leads to fusion disease. There is increase blood loss especially in long segment fixations.

COMBINED APPROACH

Combined posterior and anterior approach is indicated in few cases. Patient with complete disruption of posterior ligament complex associated with incomplete neurological deficit and patient with rigid post traumatic kyphotic deformity seen in more than 2 weeks old injury will benefit from combined approach (posterior and anterior). Combined surgical approach improves the sagittal alignment, decompression of spinal and neural decompression thoroughly and stabilization of the posterior ligament complex. However combined approach associated with increased risk of blood loss and longer duration of surgery. While considering combined approaches the age of the patient and associated co-morbidities, injuries to be considered to avoid surgery related complication. Study by Danisa et al on comparison of surgical approaches reported there was no significant difference between the approaches in terms of deformity correction, improvement in the neurological function and return to work. He also stated that posterior surgery is as effective as anterior-posterior or anterior approach(50). Oprel et al in his literature review in comparison of various approach concluded there is significant higher deformity correction and improvement in the vertebral height in combined approach and it is associated with higher intraoperative and postoperative complications(51). Been et al in his retrospective study reported there was no significant difference in clinical outcome, fusion rate deformity correction between posterior and combined approaches. He also stated that in his study there was loss of reduction and instrumentation failure was more with posterior fixation group (52).

ROLE OF FUSION

Spinal fusion is a part of stabilizing procedure. Initial studies suggested that spine fusion promote biological stabilization and protect the implant form fatigue failure. Fusion is done by decorticating the exposed bone, removal of intervening soft tissue and adding bone graft. Auto or allograft can be used. Auto graft harvested from iliac crest or the local graft from the spinous process can be used. In places were requirement of large amount of graft, allograft can be considered. Usage of allograft avoids donor site pain but lack osteogenic potential when compared to auto graft. Auto grafts are in posterior fusion placed over the decorticate facets, lamina or the transverse process. In posterior lumbar inter body fusion bilateral laminectomy done, removal of disc and followed insertion of bone graft into the anterior disc space and inter body spacers are placed. In case where the disc space is narrow, inter body spacer cannot be inserted grafts inserted between the transverse process (posterolateral fusion) can be done. The role of spine in fusion in burst fracture is still unclear. Metaanalysis by Tian et al in 2013 suggested that fusion is not necessary in for thoracolumbar fractures treated by posterior instrumentation. He reported that there no significant difference in the radiological or functional outcome between fusion and non-fusion groups(53). Linz et al in 2017 in meta-analysis reported similar results there no significant difference in clinical or radiological outcome between fusion and non-fusion groups. Fusion in burst fracture might be useful in anterior approach or in combined approach its role in posterior instrumentation is still unclear.

MATERIALS AND METHODS

This study was done in single tertiary care hospital (Christian Medical College and hospital, Vellore) at Spinal Disorder Surgery unit. Retrospective study of all the patients who underwent treatment for the thoracolumbar burst fracture (D10-L2) by various methods (operative and structured non-operative methods) between the years January 2007- April 2016. The inclusion and exclusion criteria as mentioned below. Patients with two years follow up for the patients treated by operative methods were included and since there was no adequate follow up in patients who were treated by structured non-operative method patients with follow up for three months were included.

INCLUSION CRITERIA:

1) Patient with single level thoracolumbar (T10-L2) burst fracture 2) Minimum follow up of two years

EXCLUSION CRITERIA:

1) Patient treated elsewhere

2) Patient who underwent surgery for malunion or non-union burst fractures

3) Burst fractures with proximal or distal fractures other vertebra

4) Pathological fractures

5) Osteoporotic fractures

6) Patients without adequate radiographs

The study proposal was submitted to institutional review board and after the approval of the institutional review board the patient's details were collected. Patient who underwent surgical procedure the details were collected from spine department operation theatre register and patient who were treated by structured non-operative methods the details were collected using ICD coding. Patients who had adequate follow up and radiographs the demographic details, radiographs, mode of injury, type of fracture, mode of treatment (operative and structured non operative), level of vertebra involved, type of approaches used in operative technique (posterior, posterior

+ anterior, anterior), neurological status of the patient at time of admission, Functional Independence measure after the rehabilitation data were collected from the electronic sources (clinical work station). Patient who were followed up detailed information sheet was given explaining all the information regarding consent, patient who were willing to participate in the study included, patient who were not willing for the study excluded. All the details were entered in the structured pro-forma. Patient who did not have adequate follow up as per department protocol were asked to follow up via letters and phone calls. Patients who were followed up underwent detailed clinical examination including neurological status, per rectal examination and radiographs. Functional Independence Score was calculated at follow up for patients with

neurological deficit at the time of injury.

FUNCTIONAL OUTCOMES

All the patients treated for burst fractures of thoracolumbar region the functional outcome measure done using Denis Pain Scale and Denis Work Scale

FIM (Functional Independence Measure) score was used in patient who had neurological deficit at the time of injury

DENIS PAIN SCALE

Based on patient symptoms and use of analgesics pain scale scoring was done. Pain scale ranging from P1-no pain to scale P5-severe pain with chronic use of medication.

P1-No pain

P2-Minimum pain, without use of medication

P3-Moderate pain, with occasional use of medication

P4-Moderate to severe pain, with constant use of medication

P5-Severe pain, with chronic use of medication

In patients whose details were available obtained from electronic source, patient who followed up detail obtained at the time of follow up.

DENIS WORK SCALE

Patient return to work was assessed using Denis Work Scale.

W1-Return to previous employment to W5-no work, completely disabled. W1- Return to previous employment (heavy labor) or physically demanding activities

W2-Able to return to previous employment (sedentary) or return to heavy labor with restrictions

W3-Unable to return to previous employment but works full time at new job

W4-Unable to return to full time work

W5-No work completely disabled

In patients whose details were available obtained from electronic source, patient who followed up detail obtained at the time of follow up.

ASIA (American Spinal Injury Association) Impairment scale

Neurological status which was charted using ASIA impairment scale in patients who had neurological deficit at the time of admission and at follow up were obtained from electronic resources (clinical workstation) and for patient who had followed up detailed motor, sensory system examination and per rectal examination done, neurological status was charted accordingly. ASIA impairment scale used as shown below. Patients who do not have adequate documentation were excluded from the study.

ASIA (American Spinal Injury Association) Impairment scale

A- Complete

No motor or sensory function is preserved in the sacral segments S4-S5

B- Incomplete

Sensory function preserved but not motor function is preserved below the neurological level and includes the sacral segments S4-S5

C -Incomplete

Motor function is preserved below the neurological level and more than half of key muscles below the neurological have a muscle grade less than 3

D -Incomplete

Motor function is preserved below the neurological level and at least half of key muscle below the neurological level have a muscle grade of 3 or more

E -Normal

Motor and sensory function are normal

FIM (Functional Independent measure)

Functional assessment quantification was done using FIM score in patients who had neurological deficit. Patient was asked to single out the option describing his/her status. FIM score suggests patient's ability to perform task in 18 activity of daily living. Each item is graded from scale of (total dependence) 1to7 (total independence). Both motor and cognitive are scored. Minimum FIM of 18 means total dependence and 126 imply no disability. FIM scores were made by direct examinations. The functional activity was described and explained to the patient was described and explained to the patient who was followed by various options regarding level of independence in performing each of these activities. It was taken at the time of discharge after rehabilitation and at follow up. Patient with inadequate data excluded from study.

FIM is comprised of 18 items, grouped into 2 subscales - motor and cognition.

The motor subscale includes:

- Eating
- Grooming
- Bathing

- Dressing, upper body
- Dressing, lower body
- Toileting
- Bladder management
- Bowel management
- Transfers - bed/chair/wheelchair
- Transfers - toilet
- Transfers - bath/shower
- Walk/wheelchair
- Stairs

The cognition subscale includes:

- Comprehension
- Expression
- Social interaction
- Problem solving
- Memory

Each item is scored on a 7-point ordinal scale, ranging from a score of 1 to a score of 7. The higher the score, the more independent the patient is in performing the task associated with that item.

1 - Total assistance with helper

2 - Maximal assistance with helper

3 - Moderate assistance with helper

4 - Minimal assistance with helper

5 - Supervision or setup with helper

6 - Modified independence with no helper

7 - Complete independence with no helper

The total score for the FIM motor subscale (the sum of the individual motor subscale items) will be a value between 13 and 91.

The total score for the FIM cognition subscale (the sum of the individual cognition subscale items) will be a value between 5 and 35.

The total score for the FIM instrument (the sum of the motor and cognition subscale scores) will be a value between 18 and 126.

RADIOLOGICAL OUTCOMES

All the patients who were included in the study the radiological parameters measured using Centricity Universal Viewer Zero Footprint Version: 6.0 SP7.0.2

The radiographic parameters measured at admission, immediate post-operative and at follow up for patients treated by various operative methods. Patient who were treated by structured non-operative methods radiographic parameters measured at the time of injury and at follow up period. All the radiographs were done in supine position at the time admission since patient were unable to stand due to acute injury. The radiographs were done in standing position at follow up. Patient without adequate radiographs were excluded from the study. Radiological union assessed, and various radiological parameters measured.

RADIOLOGICAL UNION

Fusion was assessed using plain radiograph. Flexion and extension views were used to assess movement at the fracture site. We have used two criteria two in patients who have interbody fusion we have used Brantigan, Stefee, Fraser criteria and in patient who had posterior instrumentation without interbody

Fusion we have used Ray’s criteria.

Brantigan, Steffee, Fraser

BSF-1: Radiographical pseudarthrosis is indicated by collapse of the construct, loss of disc height, vertebral slip, and displacement of the carbon cage, broken screws, and significant resorption of the bone graft or lucency visible around the periphery of the graft or cage.

BSF-2: Radiographical locked pseudarthrosis is indicated by lucency visible in the middle of the cages with solid bone growing into the cage from each vertebral endplate

BSF-3: Radiographical fusion: bone bridges over at least half of the fusion area with at least the density originally achieved at surgery.

Ray's criteria for radiographic assessment of bridging osseous fusion

Less than 3º of inter-segmental position change lateral flexion and extension views

No lucent area around the implant

Minimal loss of disk height

No fracture of the device, graft or vertebra

No sclerotic changes in the graft or adjacent vertebra

Visible bone formation in or about the graft material

The radiological parameters measured in this study are

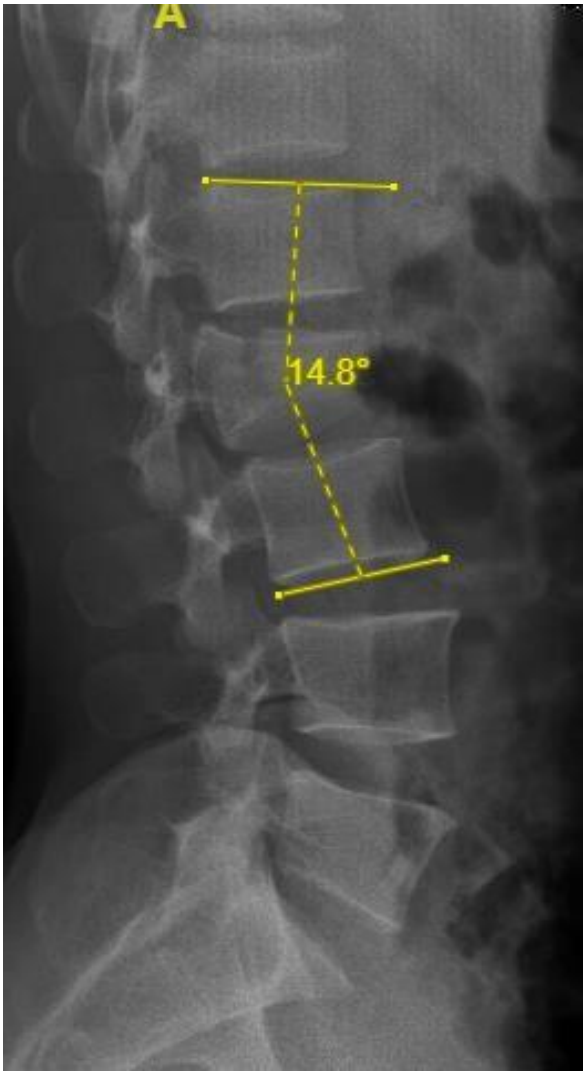
1- 3 vertebral angle or Cobb’s angle

2- Local kyphotic angle

3- 2 verterbral angle
4- Anterior vertebral height

5- Posterior vertebral height **3 Vertebral angle or Cobb’s angle**

Cobb’s angle will be measured, from the superior endplate of the adjacent cranial vertebral body to the inferior endplate of the adjacent caudal body (bi-segmental angle). Cobb’s angle were measured for all group of patients treated by both operative and non-operative methods.



2 Vertebral angle

Angle measured from the inferior end plate of the fractured vertebra to the superior end plate of the adjacent cranial vertebra. 2 vertebral angle was measured for screw through the fracture group in operative and all groups patient treated by non-operative methods.

Local Kyphotic Angle

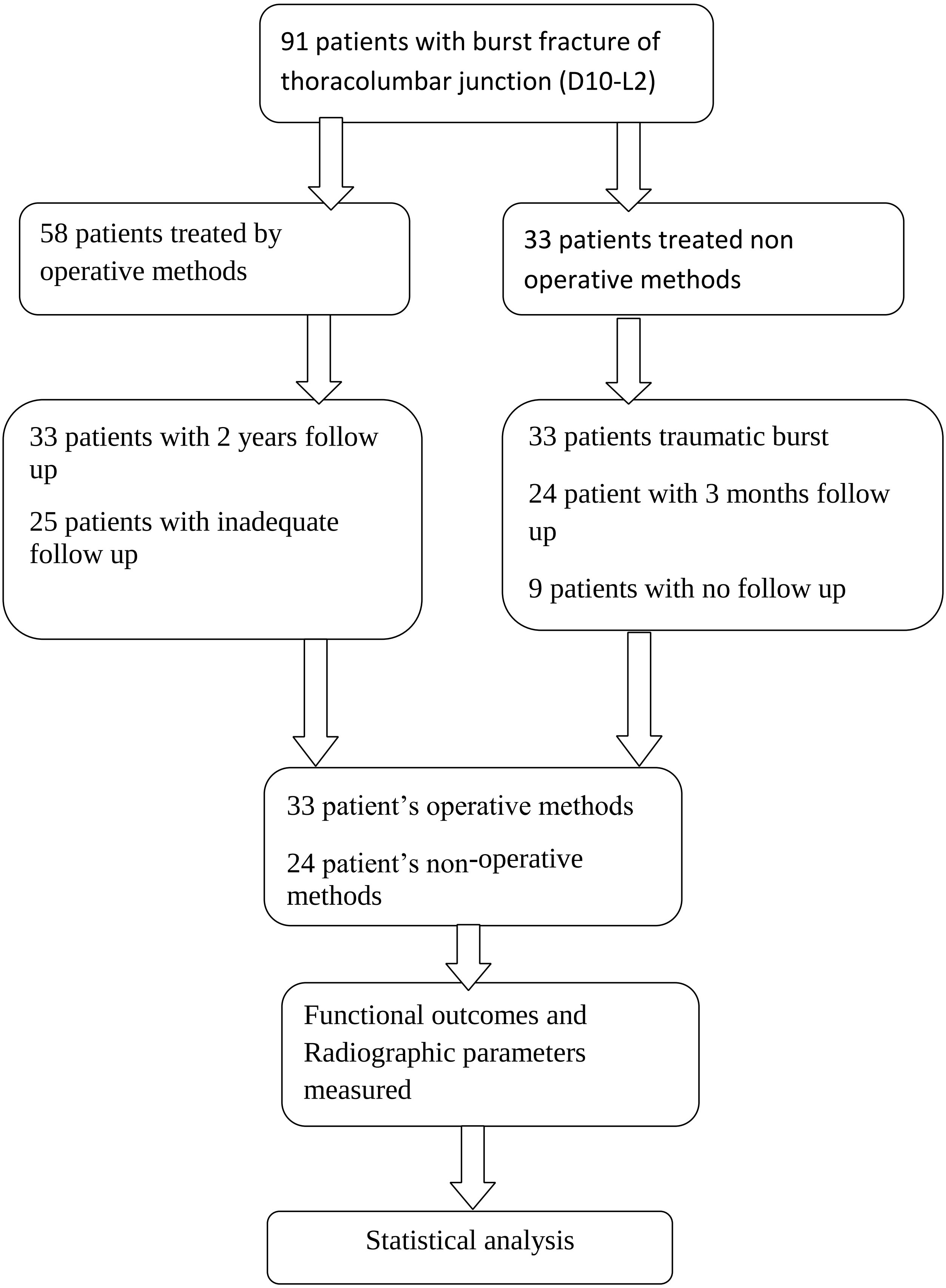
Angle measured from superior end plate and inferior endplate of the fractured vertebra. Local kyphotic angle was measured for screw through the fracture group in operative and all group patients treated by non-operative methods.

Anterior Vertebral Height

Anterior vertebral height was measured as the distance between the superior and inferior end plate of the fractured vertebra. It was measured for screw through the fracture group in operative and all group patients treated by non-operative methods.

Posterior Vertebral Height

Posterior vertebral height was measured as distance between superior and inferior endplate of the fractured vertebra. It was measured for screw through the fracture group in operative and all group patients treated by non-operative methods.

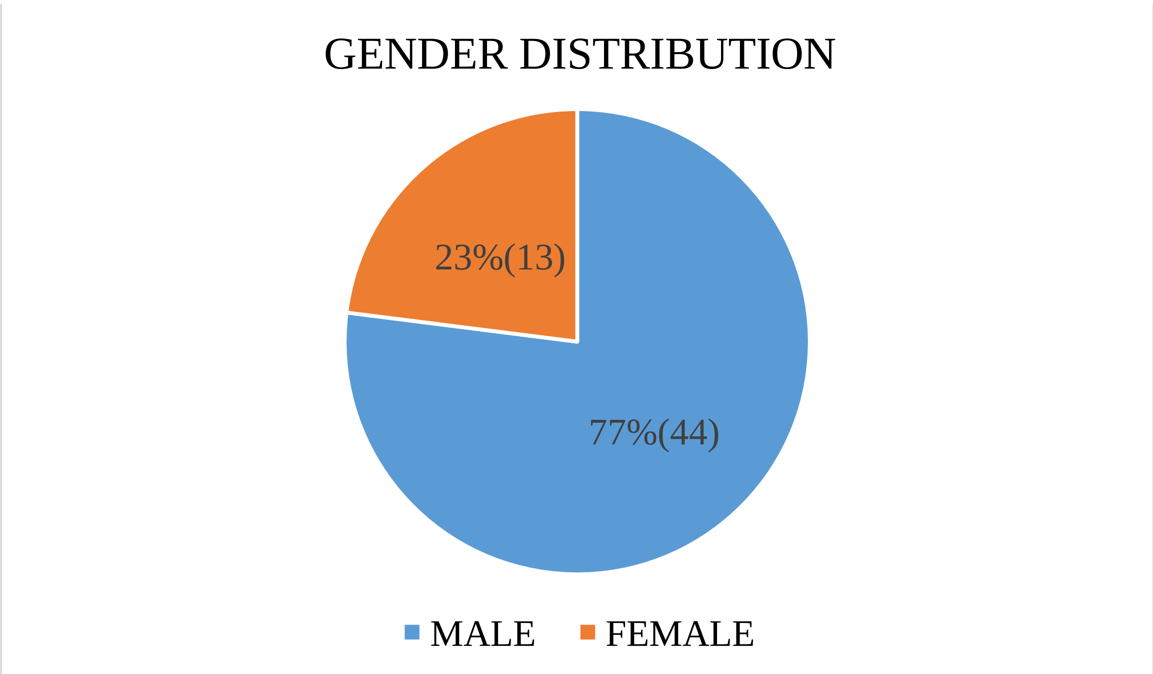

91 patients with burst fracture of thoracolumbar junction (D10-L2)
58 patients treated by operative methods
33 patients treated non operative methods
33 patients with 2 years follow up
25 patients with inadequate follow up
33 patients traumatic burst
24 patient with 3 months follow up
9 patients with no follow up
33 patient’s operative methods
24 patient’s non-operative methods
Functional outcomes and Radiographic parameters measured
Statistical analysis

RESULTS

AGE DISTRIBURTION

Of 91 patients, 25 patients in the surgical group and 9 patients treated by nonoperative method did not have adequate follow up. 33 patients treated by various surgical methods and 24 patients treated by various non-operative methods total of 57 patient's data with follow up were analyzed. In our study burst were more commonly seen in Males (77%) when compared to females (23%). The mean age for males were 37 years ranging from 15-62 years. The mean age for females were 31 years ranging from 15-50 years.

Graph 1



GENDER	OPERATIVE (n-33)	NON-OPERATIVE (n-24)	TOTAL (n-57)
MALES	25(57%)	19(43%)	44
FEMALES	8(62%)	5(38%)	13

Table 5

The detail demographic distribution operative and non-operative given in table (5)

Of 44 males 25(57%) males were treated by operative methods and 19(43%) were treated by non-operative methods. Out of 13 (62%) females were treated by operative methods and 5(38%) females were treated by non-operative methods.

In our study we found that patients with burst fractures (thoracolumbar junction) had 38% (n-15) associated injuries, lower limb injuries were common around 23 %(n-13) when compared to upper limb injury 3 %(n-2). Among the injuries in the lower limbs calcaneum (12%) and talus (8%) fractures were more common. The associated injuries given in table (6), distribution of various injuries both upper and lower limbs given in fig (3)

Table 6

ASSOCIATED INJURIES	FREQUENCY	PERCENTAGE
UPPER LIMBS	2	3%
LOWER LIMBS	13	23%

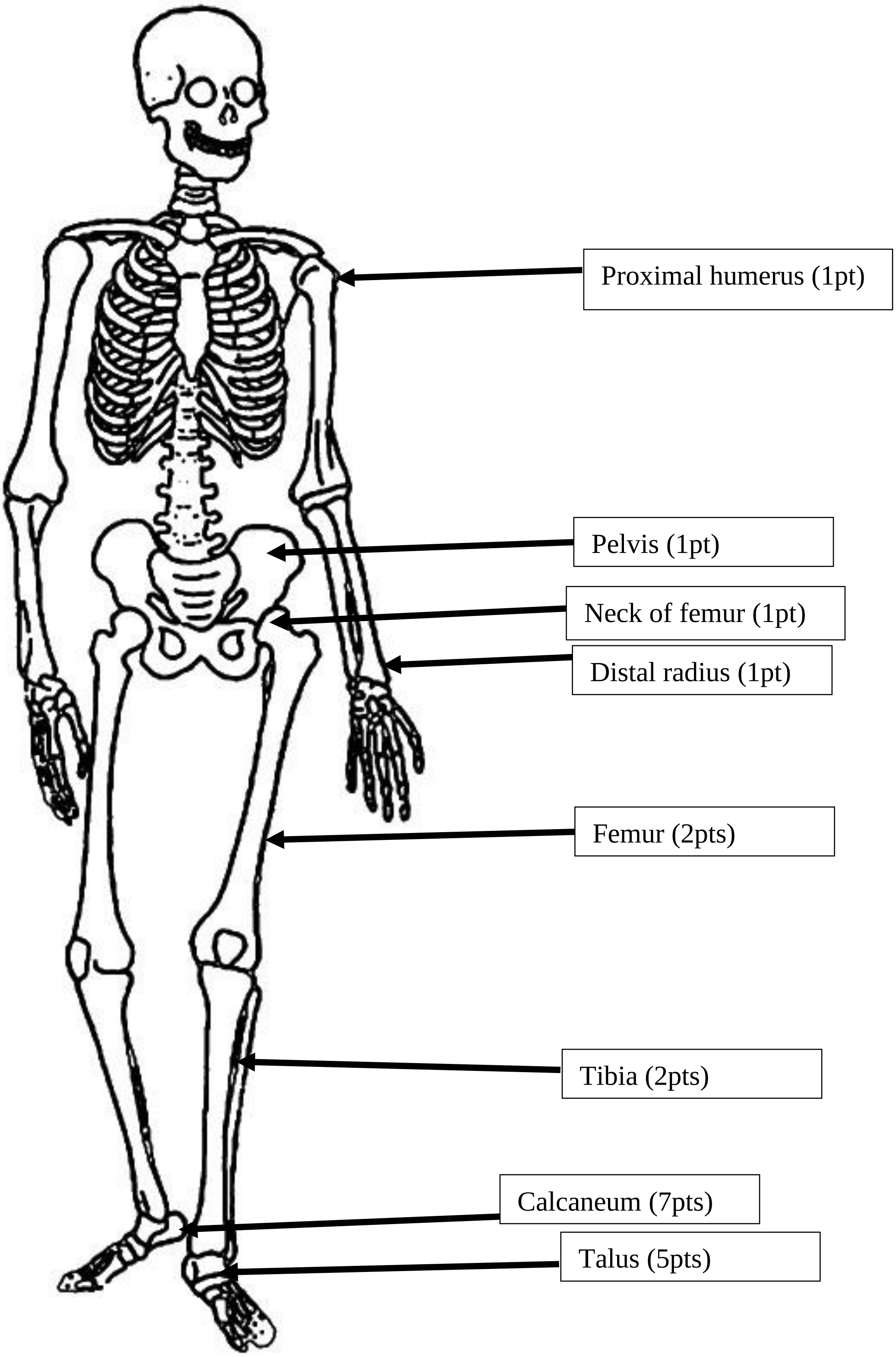
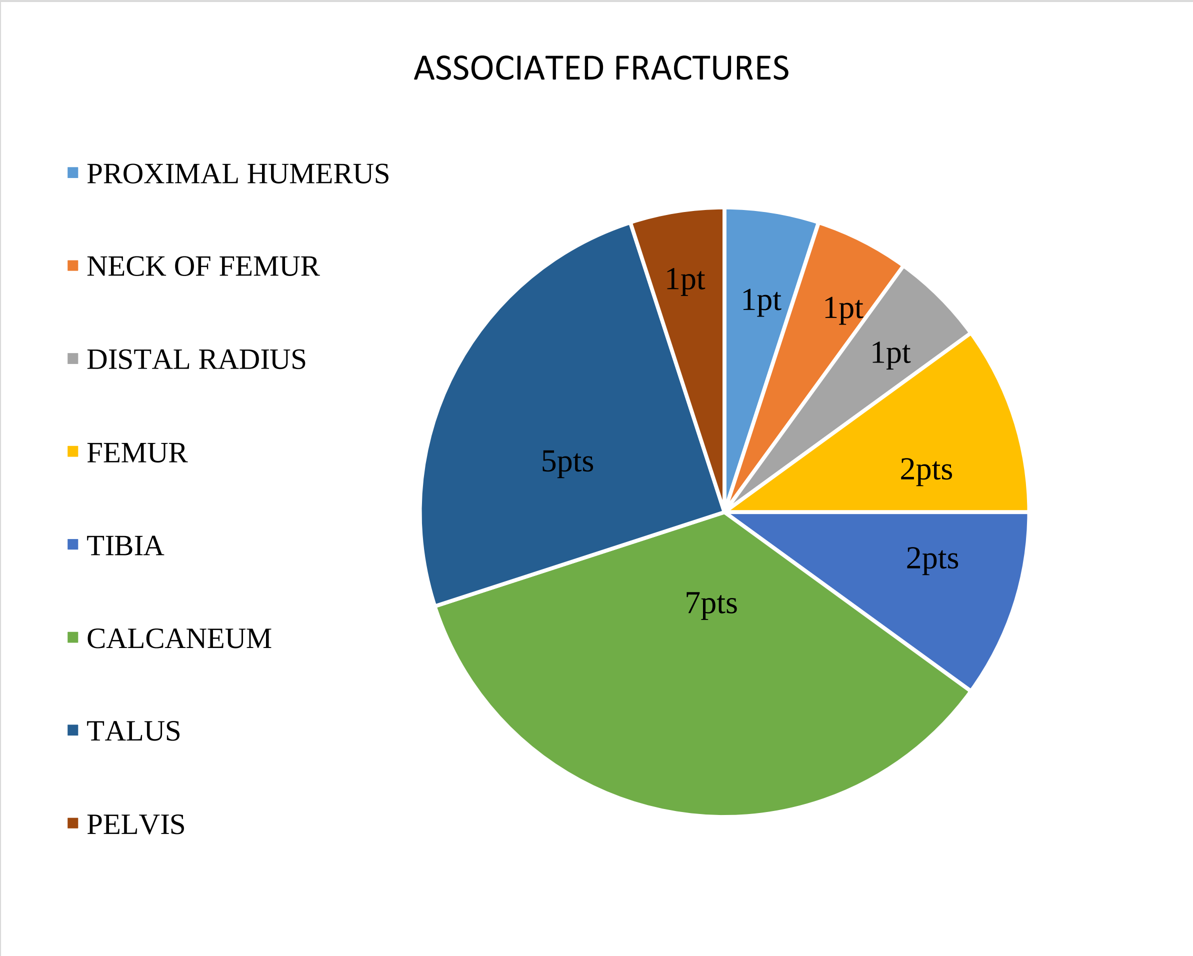


Figure 3

Table 7

Bones involved	**Frequency**	**Percentage**
Proximal humerus	1	2%
Neck of femur	1	2%
Pelvis	1	2%
Distal radius	1	2%
Femur	2	4%
Tibia	2	4%
Calcaneum	7	12%
Talus	5	9%

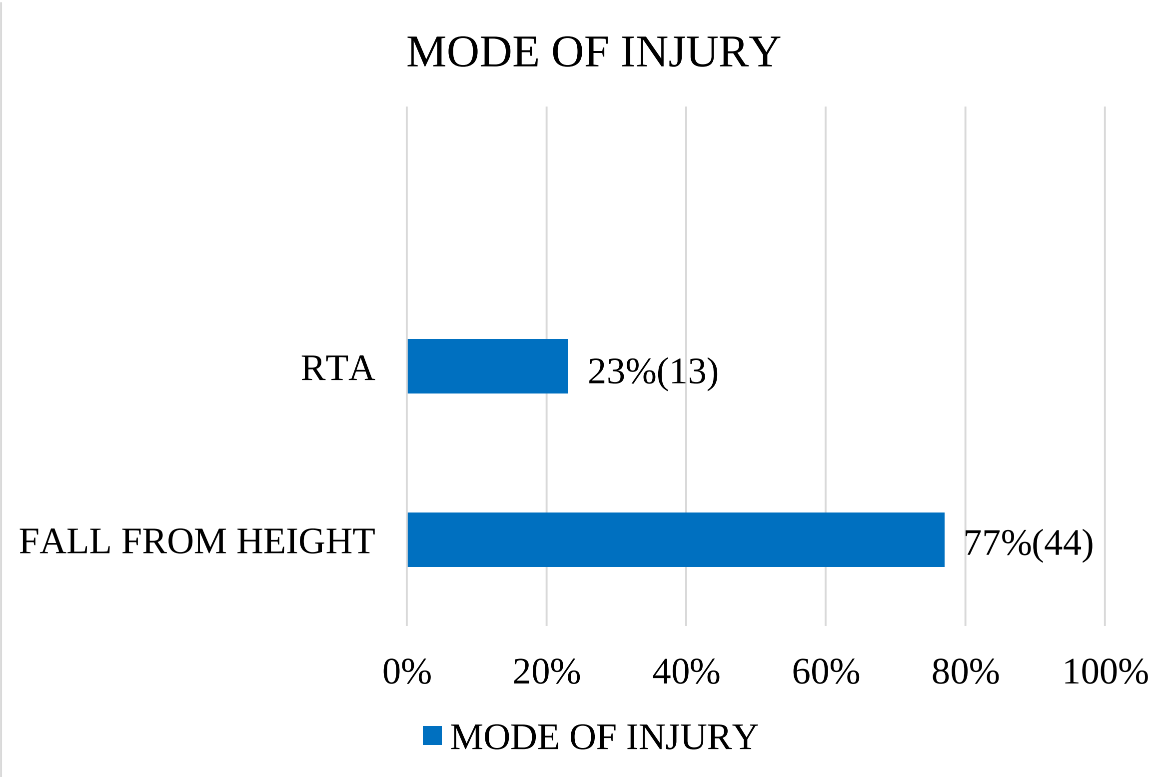
Graph 2


ASSOCIATED FRACTURES
PROXIMAL HUMERUS
NECK OF FEMUR
DISTAL RADIUS
FEMUR
TIBIA
CALCANEUM
TALUS
PELVIS
1pt
1pt
1pt
1pt
2pts
2pts
7pts
5pts

MODE OF INJURY

In our study we found 77% (n-44) people had history of fall from height (fall from tree or fall from building while working) and 23 % (n-13) of people had history of road traffic accident.

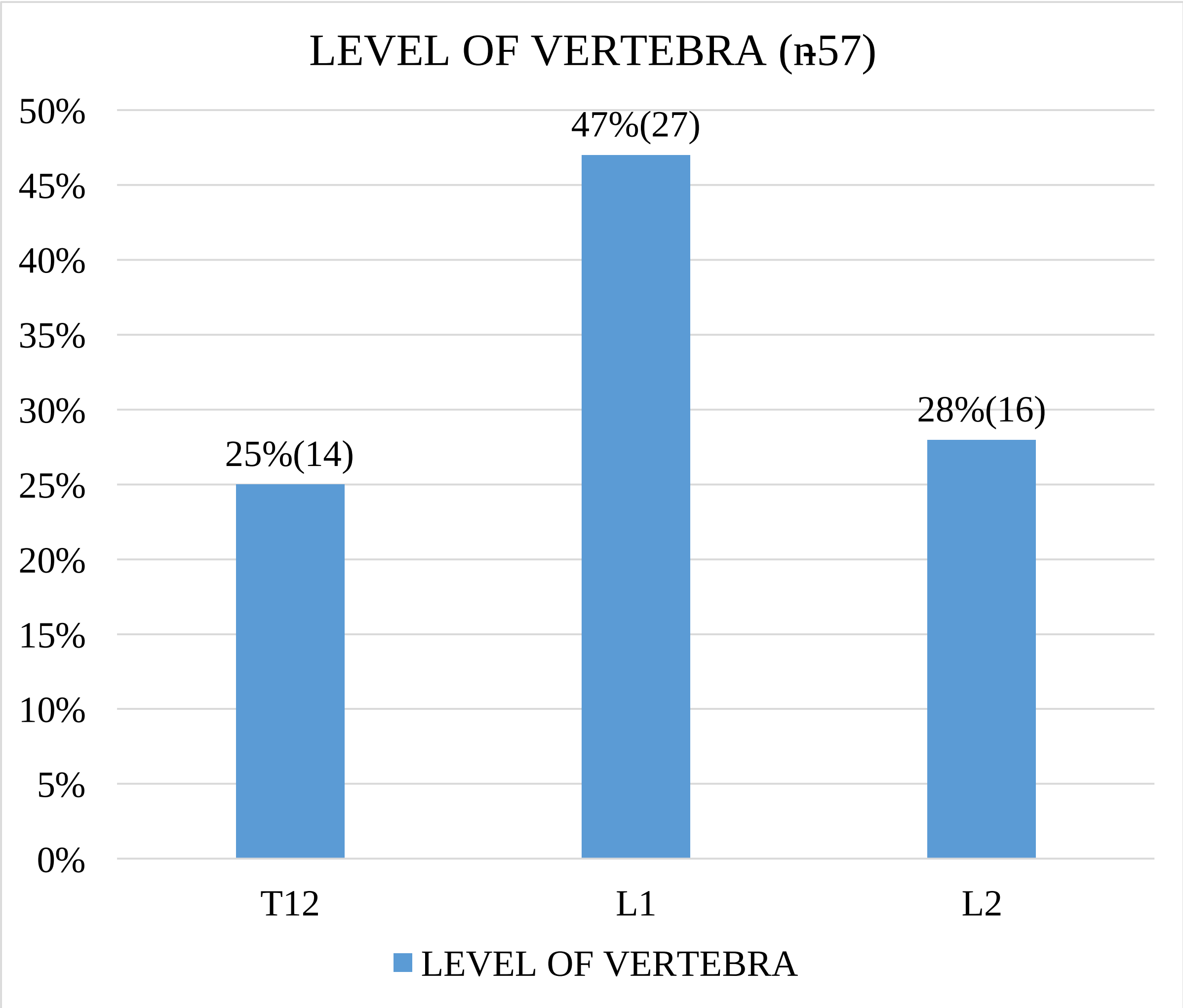
Graph 3



VERTEBRAL LEVEL INVOLVEMENT

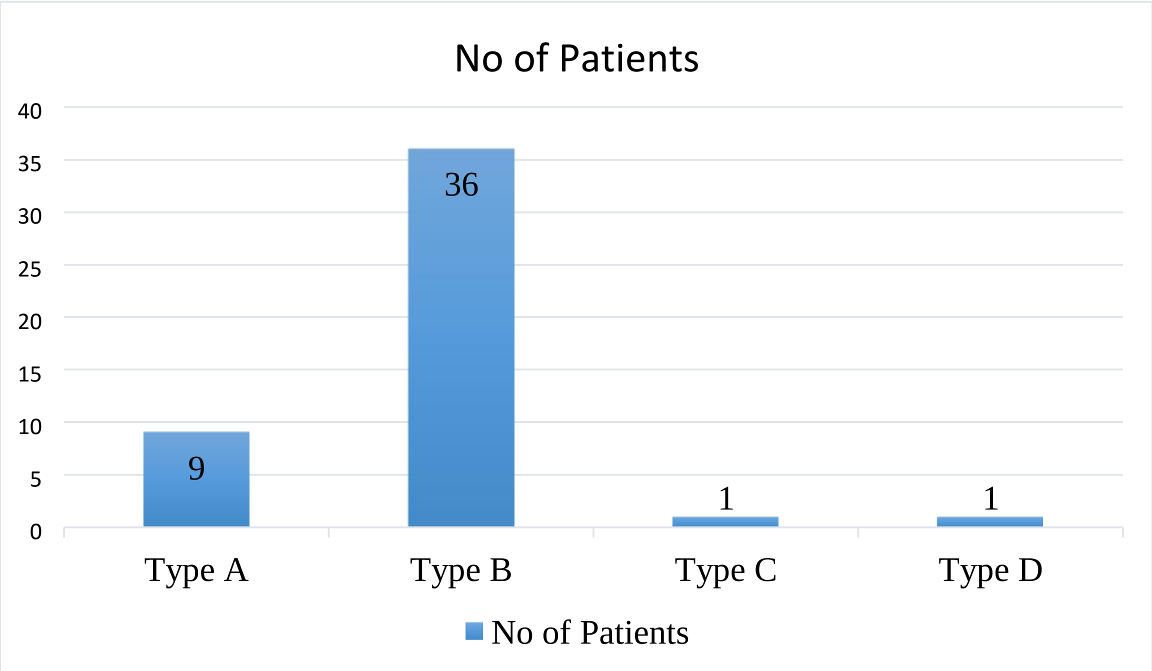
In our study T12 vertebra was involved in 25 %(n-14). L1 vertebra were involved in about 47 %(n-27).L2 vertebra involved in 28 %(n-16) of cases. We did not have any cases occurring at T10 or T11 vertebra.

Graph 4



Of 57 patients 33 patients (58%) treated by various operative methods and 24 patients (42%) of patients treated by various non-operative methods. Classification was done according to Denis classification, in our study 19 patients (33%) had type A, type B was seen 36 patients (63%) and type C & D were seen in 1 patient (2%). In our study we did not have any type E fractures.

Graph 5



Of patients treated by various operative method further divided on the type of approach used for instrumentation into anterior, posterior, posterior+ anterior and patients treated by non-operative methods were divided into patients treated with bed rest, brace and plaster jacket.

Operative methods (n-33)	
Anterior	5 patients (15%)
Posterior	18patients (55%)
Posterior +anterior	10 patients (30%)

Of 5 patients operated by anterior approach two level instrumentation one above and one below the fractured vertebra were done, 2 patients iliac crest graft was used and in other 3 patient's titanium mesh cage was used for interbody fusion. Of 18patients who were operated by posterior approach, 15 patients the fractured vertebra included in the instrumentation and the other 33 patients had instrumentation 2 level above and below the fractured vertebra. In patients who underwent combined approach in 5 patient iliac crest graft and in 5 patients titanium mesh cage was used for interbody fusion.

ANTEIOR

- Iliac crest graft(n-2)
- Titanium mesh cage(n-3)

POSTERIOR

- Screws in the fractured vertebra (n-15)
- Instrumentation 2 level&2 level below(n-3)

COMBINED

- Iliac crest graft (n-5)
- Titanium mesh cage(n-5)

Patients treated by non-operative methods are divided into patients treated by bed rest, plaster jacket and brace. In our study 24pts treated by non-operative methods of which 12pts treated by rest, 5pts treated by brace and 7pts treated by plaster jacket.

Non-Operative methods (n-24)	
Bed rest	12 patients (50%)
Brace	5patients (21%)
Plaster jacket	7patients (29%)

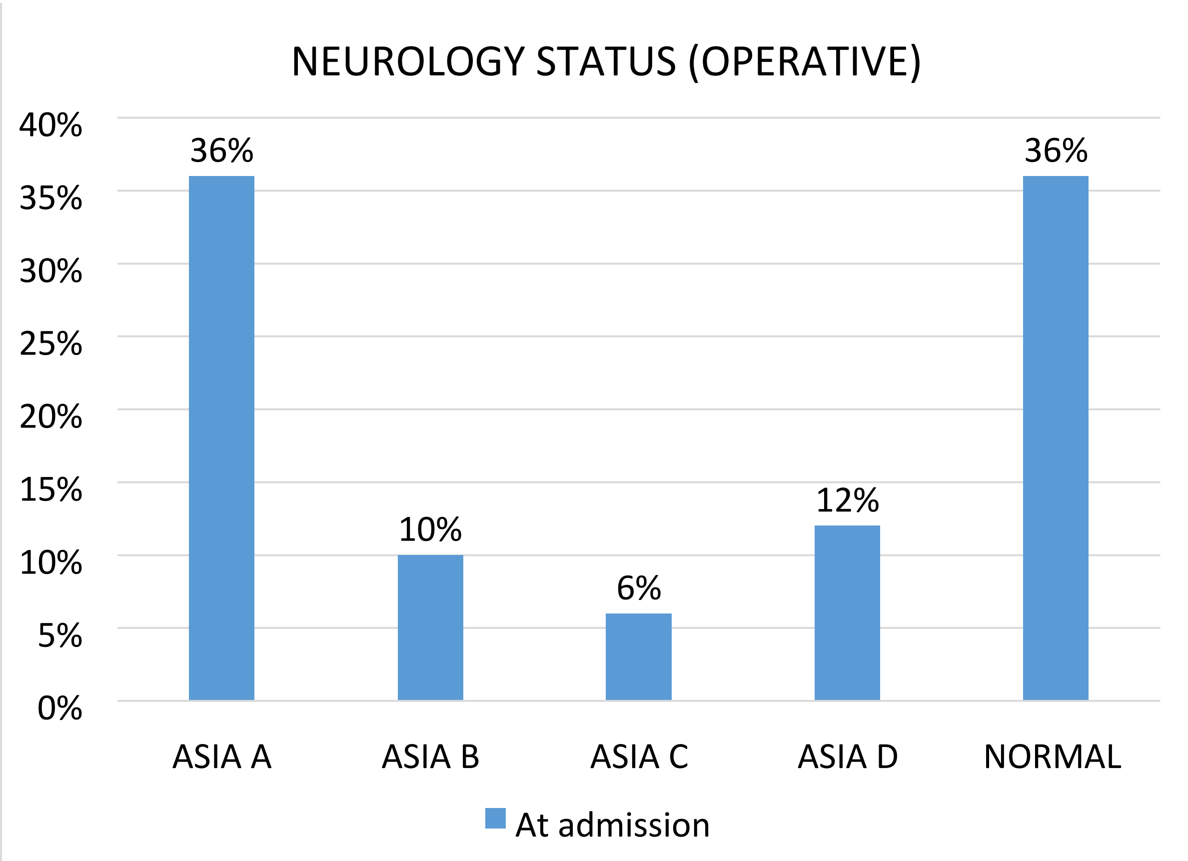
FUNCTIONAL OUTCOMES

Functional outcomes measured based on the neurological recovery, return to activities and FIM score. Neurological recovery assessed using ASIA scale and DENIS work scale was used for scoring return to activities.

Neurology status (operative group)

In our study of patients treated by operative methods (n-33), 12pts (36%) had ASIA A, 3pts (10%) had ASIA B, 2pts (6%) had ASIA C, 4pts (12%) had ASIA D and 12pts (36%) had normal neurology at the time of admission.

Graph 6



Neurological recovery was charted using ASIA scale & score at follow up. In our study in 12pts (36%) who had intact neurology did not have any worsening of neurological status. 12pts (36%) with ASIA A, 2pts (10%) with ASIA B, 4pts (12%) with ASIA D, 1 patient (3%) with ASIA C did not have any improvement and worsening of neurological status at follow up. 1 patient (3%) with ASIA C had improved neurology by one grade.

OPERATIVE GROUP

		ASIA AT FOLLOW UP				
		A	B	C	D	E
ASIA AT INJURY	A	12				
	B		3			
	C			2	1	
	D				4	
	E					12

Neurology status (non-operative group)

In our study of patients treated by non- operative methods (n-24), 1pt (4%) had ASIA A, 1pt (4%) had ASIA C and 22pts (91%) had normal neurology at the time of admission. Patients with neurological deficit (n-2) advised for surgical intervention for early rehabilitation however patients were not willing for surgical intervention.

Among the patients treated by non-operative group there was no worsening of neurological status in patients (n-22) who had intact neurology at the admission. In patient with partial neurological deficit (n-1) there was no worsening or recovery in the neurological status and in patient with complete deficit (n-1) there was no improvement in the neurology at available follow up.

NON OPERATIVE GROUP

		ASIA AT FOLLOW UP				
		A	B	C	D	E
ASIA	A	1				
AT	B		-			
INJURY	C			1	-	
	D				-	
	E					22

WORK SCALE

Return to work status was assessed using DENIS WORK SCALE

OPERATIVE GROUP n-33 (AT FOLLOW UP)

Among the patients treated by various surgical methods 3 %(n-1) of the patients were able to return to their previous work without restrictions.33 %(n-11) of patients returned to previous work with restrictions.39% (n-13) of patients were not able to return to their previous work, but modified their jobs.18%(n-6) of patients were unable to work full time job and 6%(n-2) did not go to any job.

DENIS WORK SCALE AT FOLLOW UP (OPERATIVE GROUP)

WORK SCALE	ASIA A	ASIA B	ASIA C	ASIA D	NORMAL
W1	-	-	-	-	1
W2	-	-	-	2	9
W3	4	3	1	3	2
W4	6	-	-	-	-
W5	2	-	-	-	-

NON-OPERATIVE GROUP n-24 (AT FOLLOW UP)

Among the patients treated by various non-operative methods 4 %(n-1) of the patients were able to return to their previous work without restrictions.63 %(n-15) of patients returned to previous work with restrictions.20% (n-5) of patients were not able to return to their previous work, but modified their jobs.8% (n-2) of patients unable to work full time .4%(n-1) did not go to any job. In non-operative one patient had ASIA A grade did not go any work.

DENIS WORK SCALE AT FOLLOW UP (NON-OPERATIVE GROUP)

WORK SCALE	ASIA A	ASIA B	ASIA C	ASIA D	NORMAL
W1	-	-	-	-	1
W2	-	-	-	-	15
W3	-	-	1	-	4
W4	-	-	-	-	2
W5	1	-	-	-	-

FIM SCORE (Functional Independence Measure)

FIM score was calculated in all patients with neurological injury at the time of discharge from the hospital after rehabilitation and during subsequent visit. In our study we found there was increasing trend in the FIM score at follow up. Most of the patient return to work with modifications.

DENIS PAIN SCALE

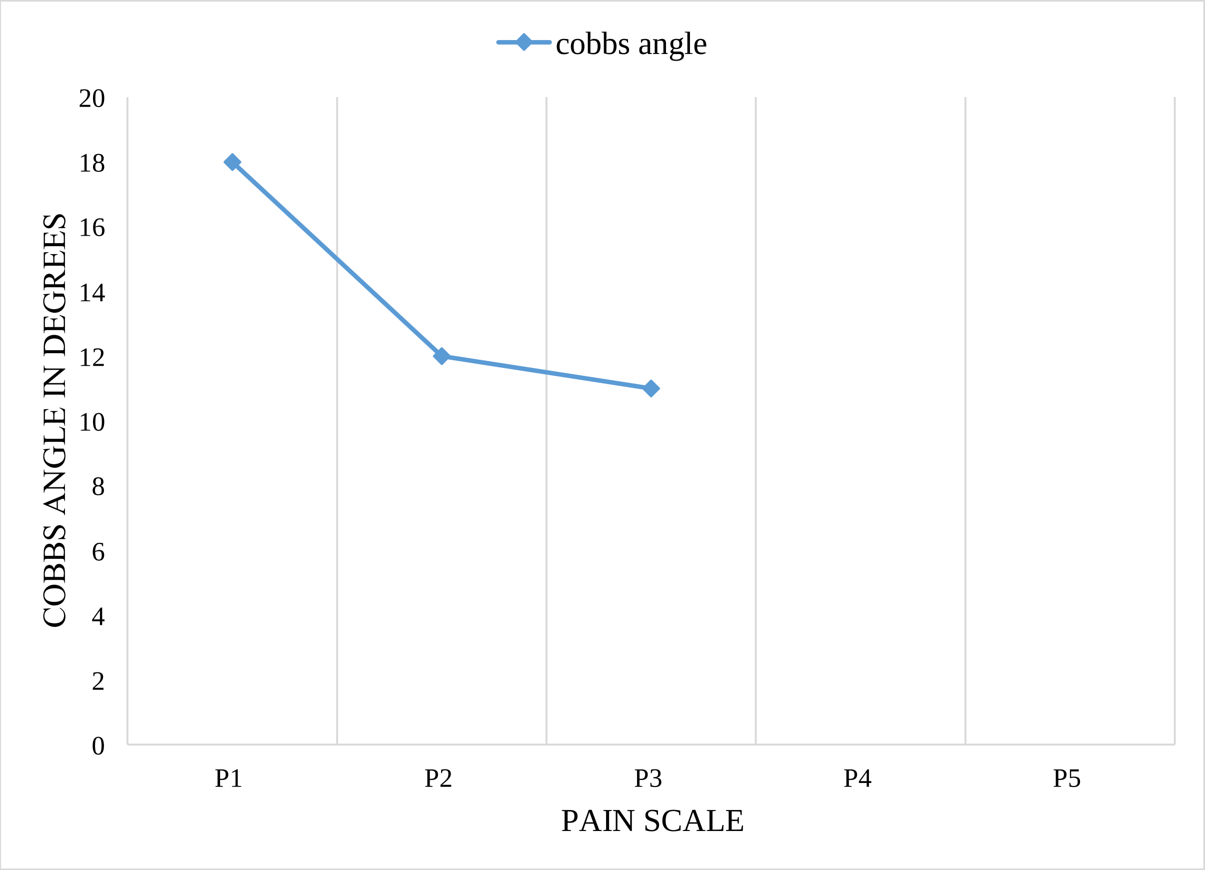
All patients pain scale scored at follow up using DENIS PAIN SCALE. Scale graded from 1 to 5 based on the severity of pain and usage of analgesics.

OPERATIVE GROUP n-33

Of patients treated by various surgical methods 27% of patients did not have any pain two years of follow up.67% of patients had minimal pain which did not require any pain medication.6% of patients had moderate pain which relieved with occasional usage of analgesics. In our study no patients had severe pain which require chronic usage of pain medications. The pain scale at follow up was correlated with Cobb’s angle at follow up to look for positive correlation. However, in our study there was no significant association between pain scale and Cobb’s angle at follow up. Patients with less pain had more Cobb’s angle when compared to patient with moderate pain had less Cobb’s angle

Table 8

DENIS PAIN SCALE	OPERATIVE n-33	AVG COBB'S ANGLE	S.D
P1	9(27%)	18 º (6-34)	9.36
P2	22(67%)	12 º (6-32)	8.91
P3	2(6%)	11 º (8-15)	4.31
P4	-	-	-
P5	-	-	-



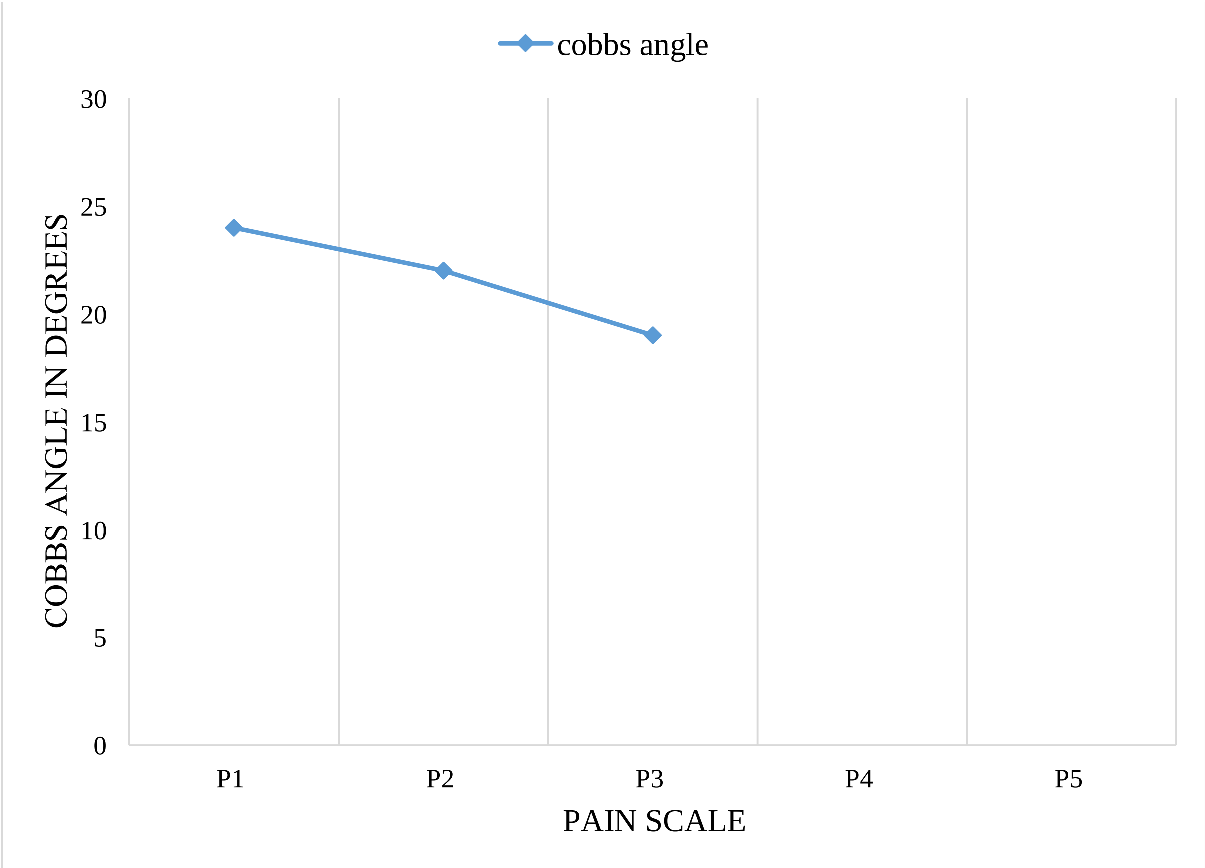
Graph 7

NON-OPERATIVE GROUP (n-24)

Of patients treated by various non-operative methods ,21% of patients did not have any pain at available period of follow up.67% of patients had minimal pain which did not require any pain medication.12% of patients had moderate pain which relieved with occasional usage of analgesics. In our study no patients had severe pain which require chronic usage of pain medications. The pain scale at follow up was correlated with Cobb's angle at follow up to look for positive correlation. However, in our study there was no significant association between pain scale and Cobb's angle at follow up.

Table 9

DENIS PAIN SCALE	NON-OPERATIVE n-24	AVG COBB'S ANGLE	S. D
P1	5(21%)	24 º (16-30)	5.45
P2	16(67%)	22 º (13-47)	11.22
P3	3(12%)	19 º (14-28)	19.53
P4	-	-	
P5	-	-	



Graph 8 DENIS PAIN SCALE AND AVERAGE COBB'S ANGLE OF BOTH OPERATIVE

AND NON-OPERATIVE METHODS

DENIS PAIN SCALE	OPERATIVE n-33	COBB'S ANGLE OPERATIVE	S.D	NON-OPERATIVE n-24	COBB'S ANGLE NON OPERATIVE	S. D
P1	9(27%)	18 (6-34)	9.36	5(21%)	24 º (16-30)	5.45

P2	22(67%)	12 º (6-32)	8.91	16(67%)	22 º (13-47)	11.22
P3	2(6%)	11 º (8-15)	4.31	3(12%)	19 º (14-28)	19.53
P4	-	-		-	-	
P5	-	-		-	-	

In our study in both operative and non-operative groups there was no correlation between the Cobb's angle and Denis pain scale at follow up.

Cobb's angle (operative group n-33)

Cobb's angle were measured in all patients at injury, immediate post-operative and at follow up and loss of angle of kyphosis were measured at follow up and compared between three groups

Table 10

Cobb's angle	At injury	Immediate postoperative	At follow up	Loss of correction
Anterior(n-5)				
Mean	22.14	9.90	20.00	-10.10
Standard deviation	6.45	5.92	11.70	7.68
Posterior (n-18)				
Mean	19.50	4.34	11.36	-7.02
Standard deviation	7.17	2.36	6.39	6.98
Posterior +anterior (n-10)				
Mean	18.16	7.99	15.13	-7.14
Standard	5.47	4.18	10.73	8.87
deviation				

Loss of correction of kyphosis	Anterior	Posterior	Posterior +anterior	p value
Mean	-10.10	-7.02	-7.14	0.1041

Standard deviation	7.68	6.98	8.87	

In our study there was loss of correction of kyphosis in all three groups. The loss of correction is less in patients underwent various methods of surgical fixation by posterior approach when compared with other two groups. However, on comparison between the groups the difference the loss of correction did not have statistically significant value.

Non-operative group (n-24)

Cobb's angle were measured in all patients at injury and at follow up, loss of angle of kyphosis were measured at follow up and compared between three groups

Table 11

Cobb's angle	At injury	At follow up	Loss of correction
Bed rest (n-12)			
Mean	19.58	26.27	-6.69

Standard deviation	9.71	10.22	3.132
Brace(n-5)			
Mean	22.54	23.36	-0.82
Standard deviation	6.54	7.74	6.91
Plaster jacket (n-7)			
Mean	11.27	15.41	-4.41
Standard deviation	6.28	6.37	3.76

Loss of correction of kyphosis	Bed rest	Brace	Plaster	pvalue
Mean	-6.69	-0.82	-4.41	0.0796
Standard deviation	3.132	6.91	3.76	

In our study there was loss of correction in all three groups, the loss of correction was less with patient treated with brace when compared to other two groups, however the difference in the loss of correction did not have any statistical significance.

Anterior vertebral height

Anterior vertebral height was measured in patient treated by various fixation techniques using posterior approach mainly pedicle screw insertion in the fractured vertebra, since the other two groups involves the corpectomy,AVH was not measured and AVH was measured in all patients treated by various non-operative methods. Operative group (posterior n-17)

Table 12

Anterior vertebral height	At injury	Immediate post-operative	At follow up	value
(in cms)				
Mean	1.47	2.18	2.07	0.0004
Standard deviation	0.33	0.30	0.27	

In our study there was increase in the anterior vertebral height in patients who had pedicle screw inserted through the fracture vertebra and at follow up there was decrease in the vertebral height however the decrease in the vertebral height did not have statistically significant value. Since other two groups involve anterior corpectomy and fusion with cage anterior vertebral height could not be calculated.

Local kyphotic angle

Local kyphotic angle was measured in patients treated with pedicle screw insertion through the fracture vertebra and in all patients treated by various non-operative methods

Operative group (posterior n-17)

Table 13

Local kyphotic angle	At injury	Immediate post-operative	At follow up	pvalue
Mean	21.40	5.45	11.20	0.0005
Standard deviation	5.59	2.92	1.14	

In our study there was decrease in the local kyphotic angle in the immediate postoperative period and at follow up of two years there was increase in the local kyphotic angle however the difference in the loss of correction did not have

statistically significant value.

Non-operative group (n-24)

Table 14

Local kyphotic angle	At injury	At follow up	pvalue
Bed rest (n-12)			
Mean	23.37	29.56	0.017
Standard deviation	6.65	8.53	
Brace (n-5)			
Mean	26.08	24.68	0.08
Standard deviation	4.80	8.46	
Plaster jacket (n-7)			
Mean	19.84	21.63	0.19
Standard deviation	5.68	7.24	

In our study there was increase in the local kyphotic angle in patients treated with bed rest and plaster jacket. In patients treated with brace there was decrease in the local kyphotic angle, however on comparison with each group there was no statistically significant value.

2 VERTEBRAL ANGLE

2 vertebral angle was measured in patient treated by various fixation techniques using posterior approach mainly pedicle screw insertion in the fractured vertebra, since the other two groups involves the corpectomy and fusion 2VA was not measured and 2 vertebral angle was measured in all patients treated by various non-operative methods

Operative group (posterior n-17)

Table 15

2VA angle	At injury	Immediate post-operative	At follow up	Pvalue
Mean	21.68	4.52	13.19	0.0003
Standard deviation	7.90	3.11	4.70	

In our study there was decrease in the 2VA immediate post op, on follow up there was increase in the 2VA when compared to immediate post op, however the difference 2VA at follow up was not statistically significant.

Non-operative group (n-24)

Table 16

2VA angle	At injury	At follow up	value
Bed rest (n-12)			
Mean	23.99	30.39	0.02
Standard deviation	7.96	7.99	
Brace (n-5)			
Mean	24.54	24.50	0.16
Standard deviation	5.36	8.88	
Plaster jacket (n-7)			
Mean	19.54	21.77	0.14
Standard deviation	6.76	7.26	

There was increase in the 2VA in patients treated with plaster jacket and bed rest group when compared to patients treated with brace however on comparing the difference between the groups did not have statistically significant value.

LOAD SHARING CLASSIFICATION

The scores using load sharing classification was calculated for the all the patients who were treated by operative methods. One patients who did not have CT at the time of injury were excluded Table 17

Score at injury	Anterior	Posterior	Posterior anterior	Total (n-32)
5	0	3(17%)	0	3(9%)
6	0	13(72%)	0	13(41%)
7	4(100%)	2(11%)	7(70%)	13(41%)
8	0	0	3(30%)	3(9%)
	100%	100%	100%	100%

$p<0.0001$

In our study 4 patients with score of 7 underwent anterior surgical approach and instrumentation and fusion.13 patients with score of 6 &3 patients with score less than 6 and 2 patients with score of 7 underwent posterior approach and instrumentation.3 patients with score more than 7, 7 patients with score of seven were treated with combined approach. Load sharing classification is useful to decide the type of approach, in our study there was a statistical significant p value using load sharing classification and type of approach using the scores.

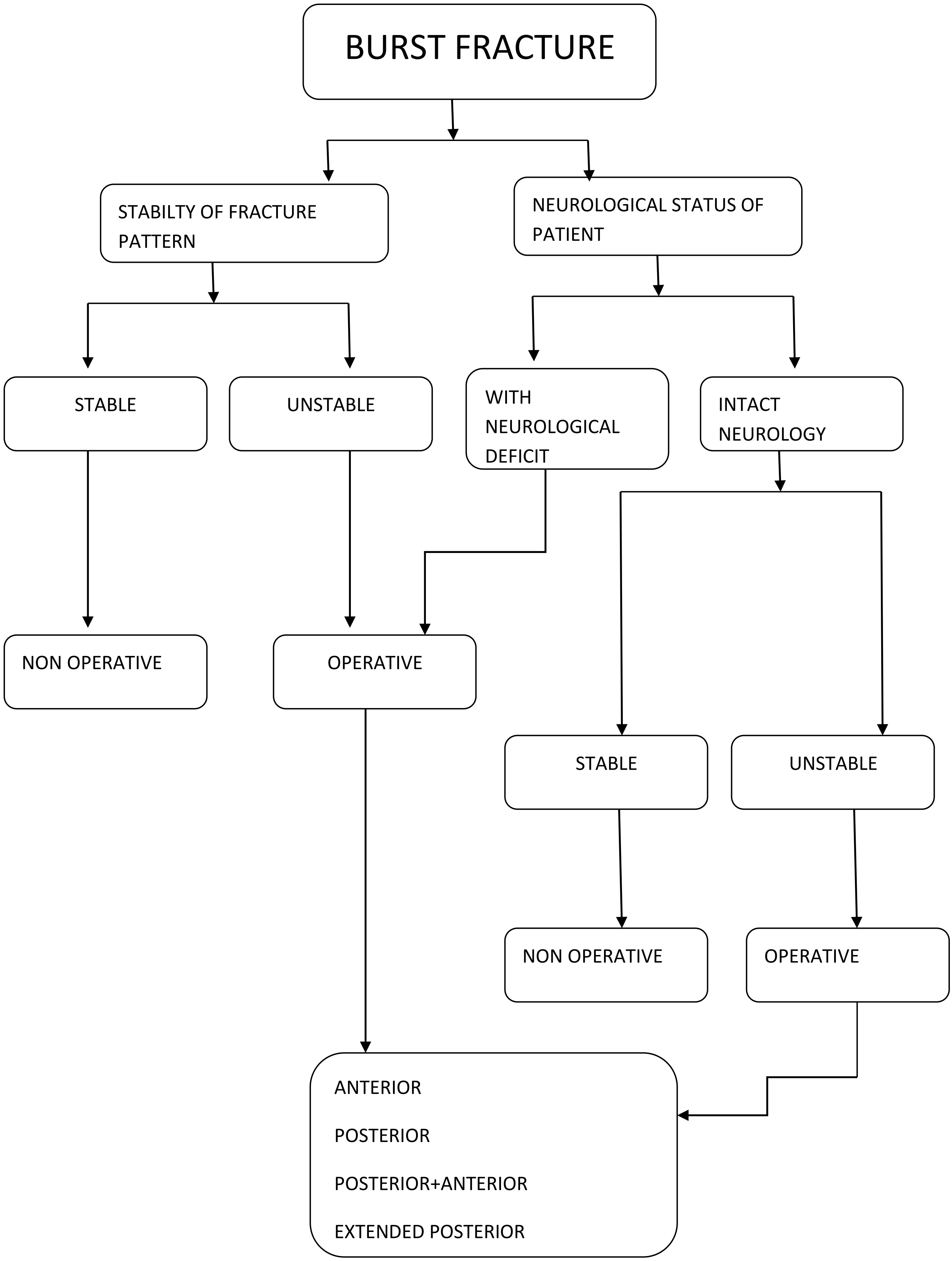
COMPLICATIONS

Operative group

All the patients had satisfactory radiological union at follow up. One patient treated by combined approach who had retro diaphragmatic dissection had pleural tear intraoperatively for which ICD was inserted. One patient had deep vein thrombosis immediate post- operative period for which heparin was given and titrated with oral anticoagulants. One patient had post - operative wound discharge in the 1st week for which debridement and washout was done, implants were retained patient was started on appropriate antibiotics patient went into satisfactory union and implant removal was done at 18 months.1 patient had implant failure at one year follow up however the patient was asymptomatic ,had radiological union did not require implant removal .3 patients had erectile dysfunction at follow up and patients were referred to andrology department for further evaluation.2 patients had pressure sore at follow up was admitted and transferred to PMR department for further rehabilitation. In our study there was no life threating complication. Patient who were paraplegic who had underwent rehabilitation had better quality of life and return to some form of work at follow up. No patients had implant prominence or severe pain requiring implant removal.

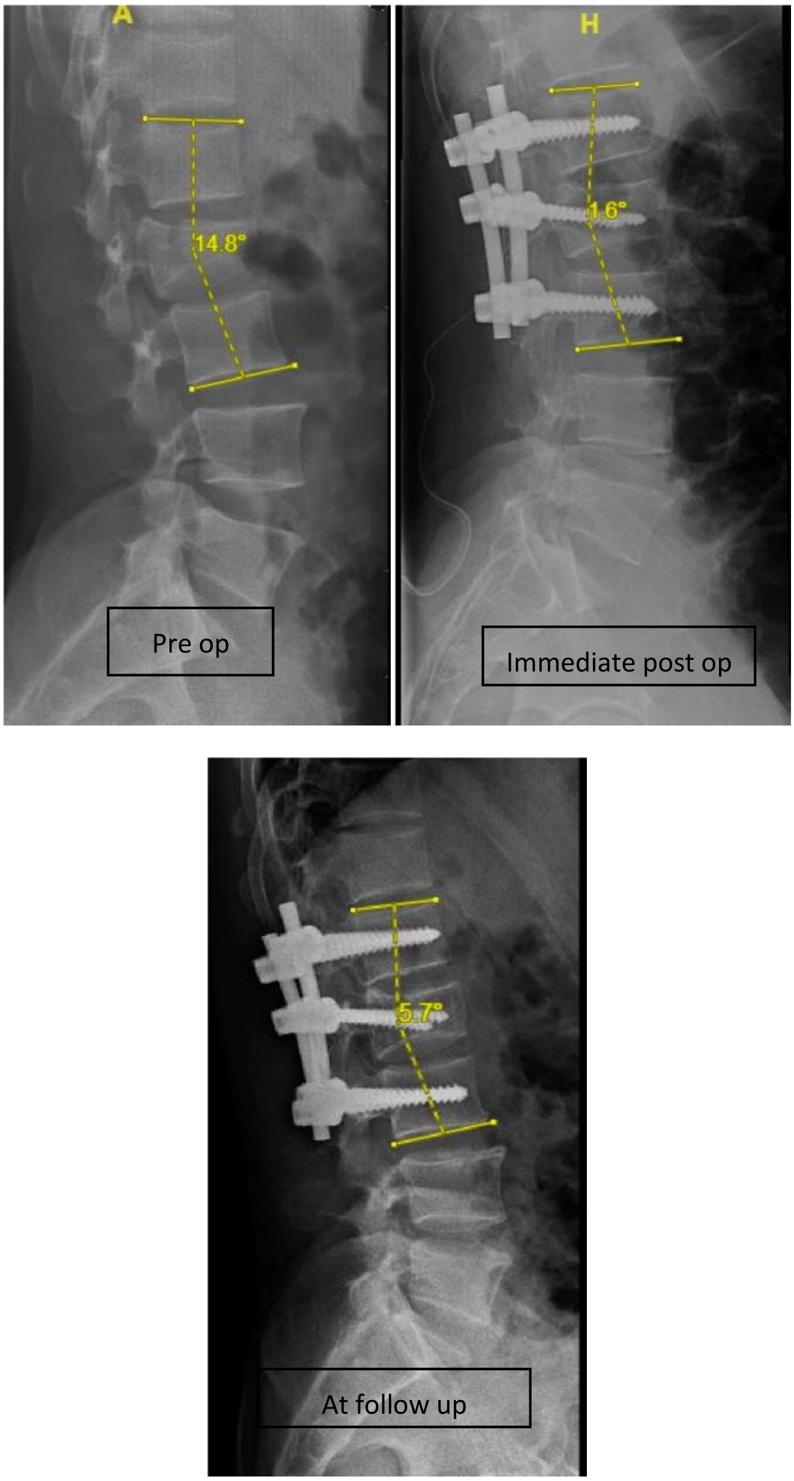
Non-operative group

No patient had instability and worsening of neurology at available follow up which required surgical intervention. There was worsening of kyphosis in all patients treated by non-operative methods however the worsening of kyphosis did not have any influence on functional outcome in terms of pain (Denis pain Scale) and return to work (Denis Work Scale). In non-operative group there increase number of lost to follow up. No other major complications in patients treated by non-operative methods with available follow up.

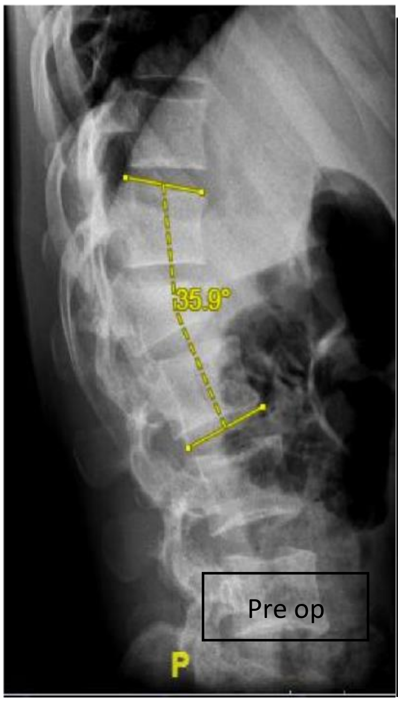

BURST FRACTURE
STABILTY OF FRACTURE PATTERN
NEUROLOGICAL STATUS OF PATIENT
STABLE
UNSTABLE
WITH NEUROLOGICAL DEFICIT
INTACT NEUROLOGY
NON OPERATIVE
OPERATIVE
STABLE
UNSTABLE
NON OPERATIVE
OPERATIVE
ANTERIOR
POSTERIOR
POSTERIOR+ANTERIOR
EXTENDED POSTERIOR

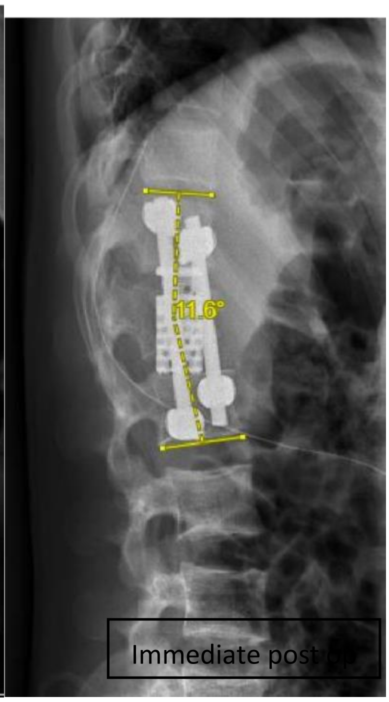
RADIOGRAPHS

Cobb’s angle (posterior instrumentation with screw including fracture vertebra)

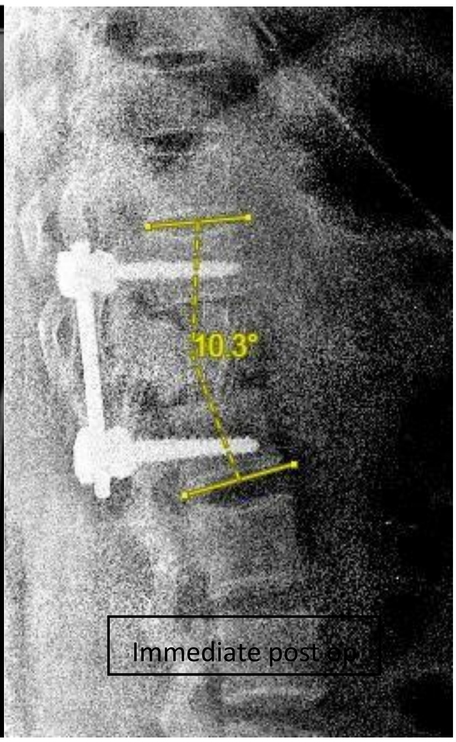


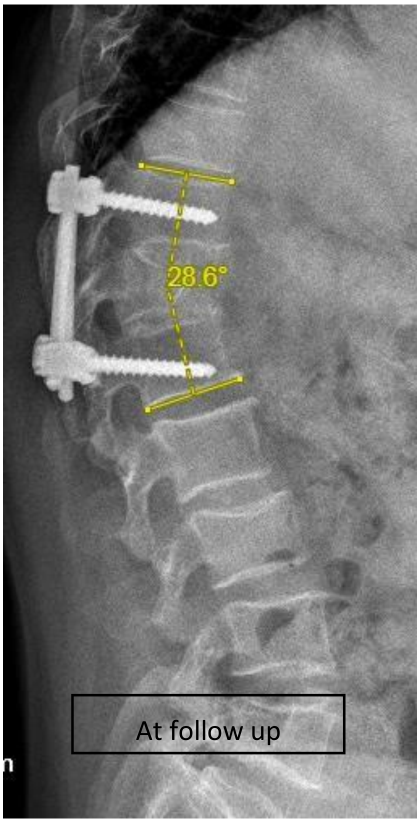
Cobb’s angle (anterior stabilization)



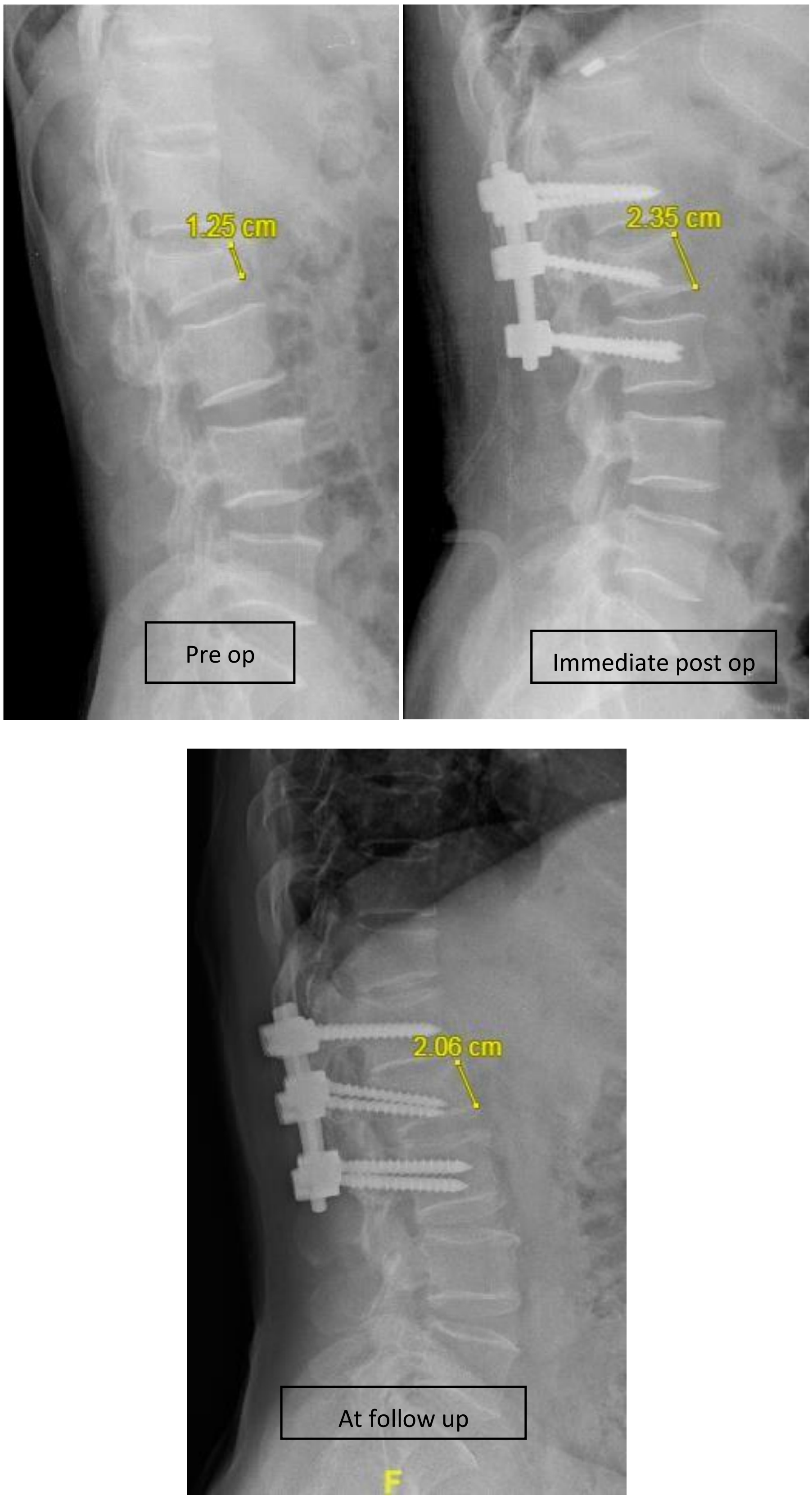


Cobb’s angle (posterior anterior)

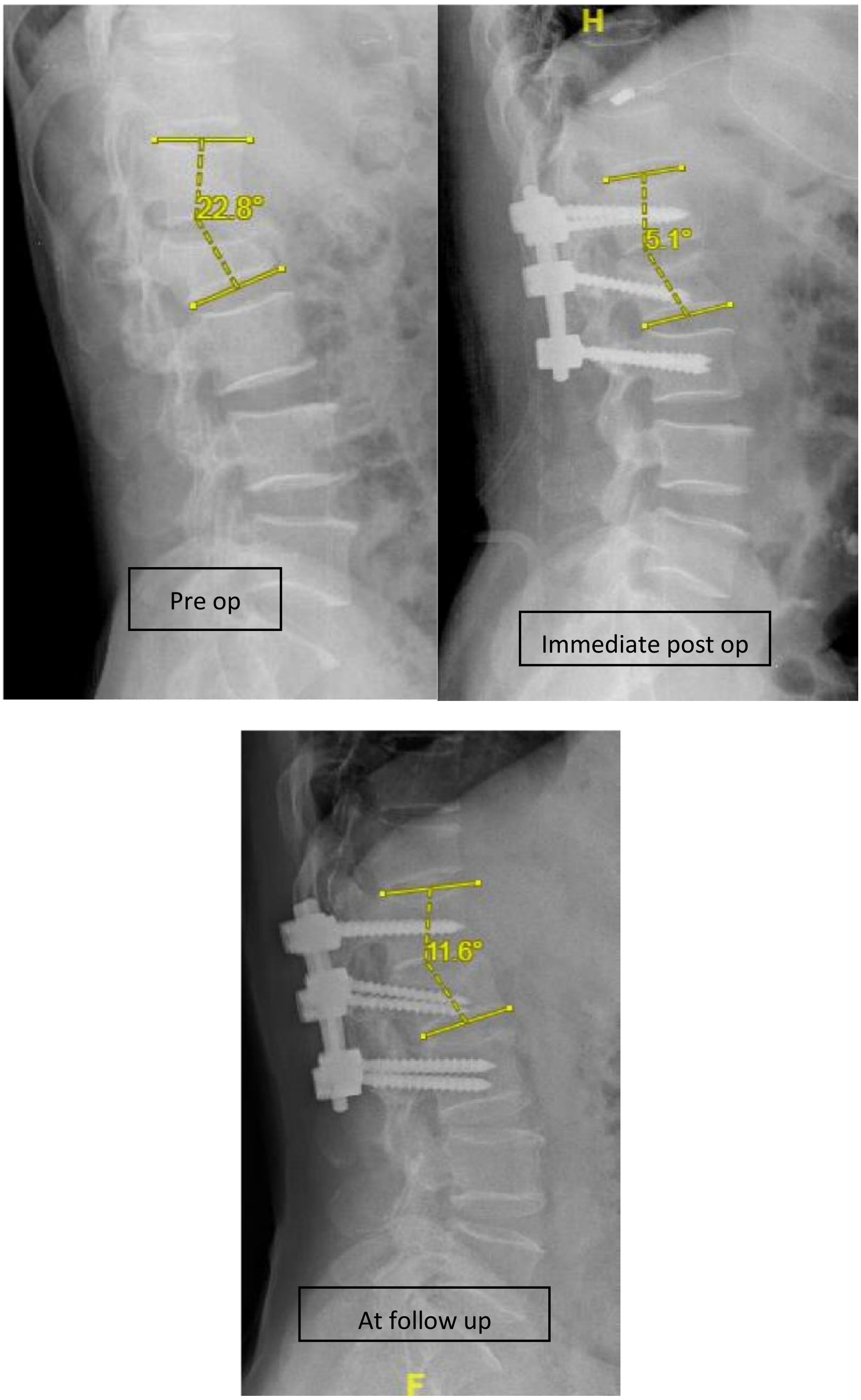




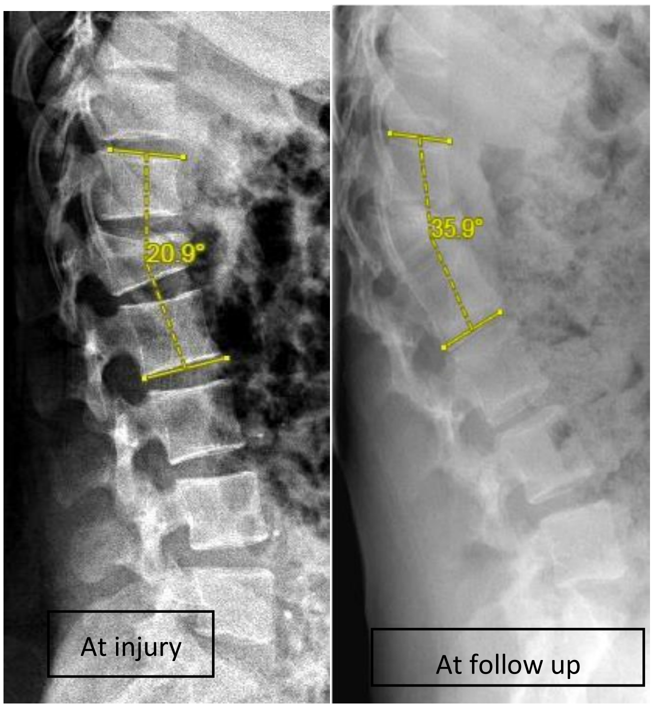
ANTERIOR VERTEBRAL HEIGHT (SCREW INCLUDING THE FRACTURE)



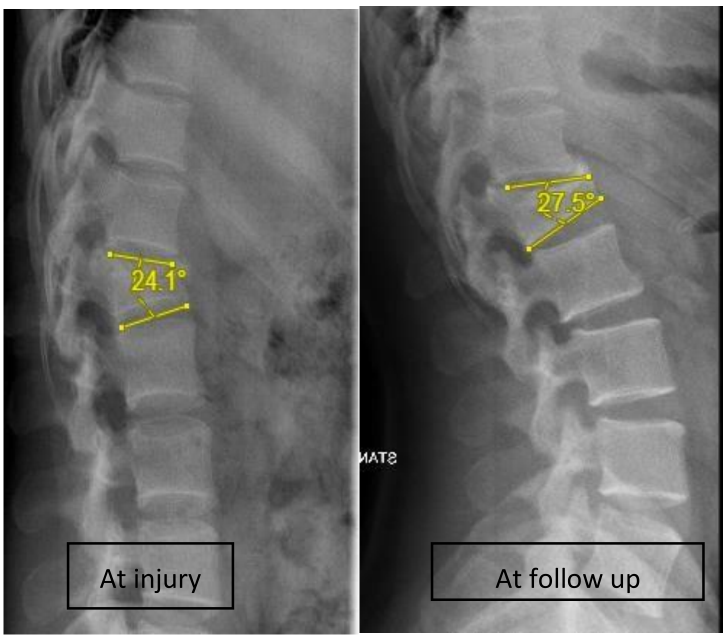
2 VERTEBRAL ANGLE



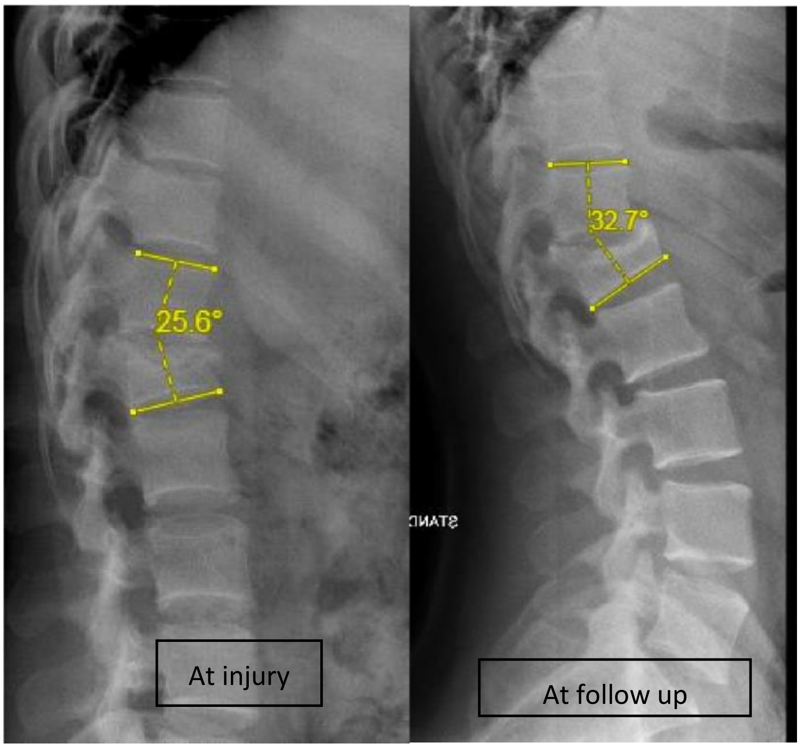
Cobb's angle (non- operative method)



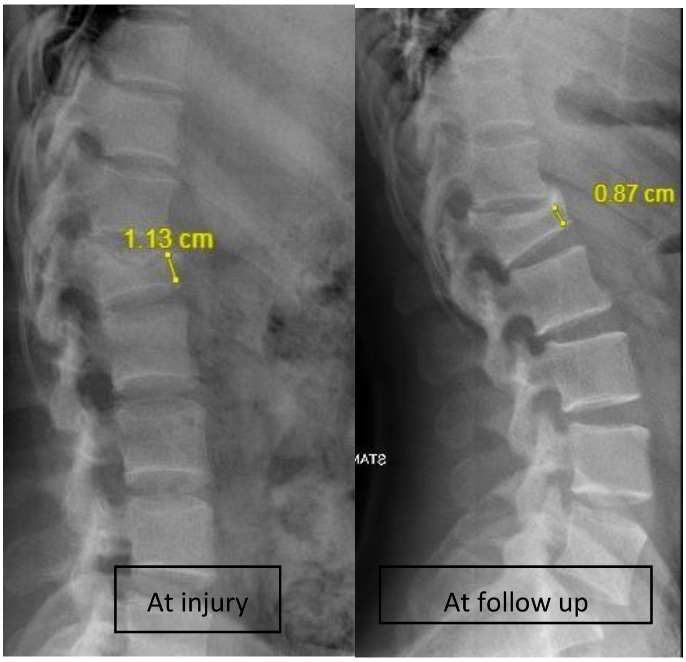
Local kyphotic angle (non-operative method)



2 vertebral angle (non-operative method)



Anterior vertebral height (non-operative method)



DISCUSSION

Spine trauma is most common at thoracolumbar junction almost 90% of the injuries occurs ar thoracolumbar junction due to its unique anatomy(54). Of all spine fractures BURST fractures are more common in thoracolumbar junction which account for 17% of the major spinal fractures(55). Burst fracture was first described by Holdsworth and later redefined by Denis. The etiology of burst fracture vary according to the age in young population burst fracture commonly occurs secondary to high energy trauma including road traffic accident and fall from height. In elderly population it occurs secondary to trival fall and associated oestoporosis plays a vital role etiology. In a study by Scheer et al (34-54%) of the burst fracture occurred secondary to fall from height and (51-65%) of fracture secondary to motor vehicle accident and around 9% of the injury due to high intensity sports(56). Study by Khurjekar et al in indian population had similar results as our study such as the most common mechanism of injury was fall height constitue about 50%(fall from building or tree) and in 46% secondary to road traffic accident(57). Aligizakis et al study showed 75% of burst fracture secondary to fall from height and 25% of the fracture secondary to motor vehicle accident(58). In our study 77% of injury resulted secondary to fall from height (fall from tree or building) and 23% of injury resulted secondary to road traffic accident. In our study burst fractures were more common in males(77%) when compared to females(23%) which is comparable to other studies. A study by Senturk et al also showed similar gender distribution, 66% of burst fractures in males and 34% in females(59). The overall mean age of patients was 49 in the study by Senturk et al(59), the mean age in males was 49(16-84) while in females it was 49(20-72). In our study the mean age of male patients was 37 years(15-62) and the mean age of the female patients was 31 years(15-50). In our study the mean age was less compared to the other studies because this study excluded oestoporotic burst fractures which is common in elderly population. In our study the most common vertebra involved was L1(47%) which is comparable with other study by Senturk et al(59) where L1 vertebra was involved in (43%) and according to Hur et al(60), where L1 vertebra was involved in (40%). Aligizakis et al study L1 vertebra was involved in 83%(58).

The associated upper and lowerlimb fracture are common in burst fracture study by Aligizakis et al showed 25% of lower limb fractures associated with burst fractures,10% of upper limb injuries and 5% of other system involvement was seen. In our study there was 23% of various lowerlimb fractures and 3% of various upper limb fractures was seen. In our study we did not have other major systems involvement.

Though burst fractures are very common, the ideal classification and ideal management of the burst fracture is still controversial. The surgical fixation of the burst fracture helps in decompression of the spinal canal, restoration and maintainace of the vertebral body height, early ambulation and rehabilitation, prevention of progression of the kyphotic deformity. Non operative treatement of burst fractures in patients with intact neurology would avoid surgery and its related complications.

Literature suggest that stable burst fracture can be managed non operatively. Agus et al,Wood et al and Shen et al (54) suggests that stable burst fracture with intact neurology can treated by non operative methods. In our study all patients treated by non operative methods had intact neurology(except for 2 patient who had neurolgical deficit but were not willing for surgery) and stable fracture pattern with average kyphotic angle of 20 º. Hitchon et al(54) suggested that burst fracture can be managed by non operative methods in patients who has angular deformity less than 20º, anterior vertebral height greater than 50% and residual canal diameter exceeding 50%.

Surgical fixation is widely accepted in literature in patients with neurological deficit. Reid et al stated that in patients with neurological deficit and kyphotic angle more than 35º will need surgical fixation(19). Benson et al and Willen et al concluded that operative treatment should be limited to fractures with canal compromise more than 50%, compression of the anterior coloumn more than 50% and kyphotic angle more than 20 º(54). Alpantaki et al(4) stated that surgical fixation indicated in patients with progressive neurological deterioration,incomplete neurological injury, 50% of canal compromise, more than 50% of anterior vertebral height loss and more than 30º of kyphotic deformity. In our study of patients who underwent surgical fixation 36% of patients had complete neurological deficit and 28% of incomplete neurological injury. 36% of the patients in the surgical group had intact neurolgy. In our study the average kyphotic angle of the patient who underwent surgical fixation with intact neurology was 30º. Our indications of surgical fixation and patients treated by various non operative methods was comparable with all available literature. The incidence of neurological deficit in burst fracture ranges from 21-40% with complete injury to the spinal cord at thoracic spine level due to the narrow spinal canal(5). In our study 36% of the patients had complete neurological deficit. In our study there was no deterioration of neurology as a result of surgery, 7(21%) patients had incomplete neurological injuries of which

1(14%) patient had improved by atleast by one grade(ASIA) at follow up. In our study 12(36%) patients who had complete deficit did not show any neurological recovery. Study by Ge et al (61) had similar results as our study,in their study there was no improvement of neurology in patients with complete deficit. A similar study by Yang al (54) on outcomes of surgical fixation for thoracolumbar fractures has similar results as our study,according to his study there was no neurological deterioration as result of surgery, patients with incomplete deficit had neurological improvement by one grade. Our study results in neurological recovery is comparable with other studies. Denis et al (54) reported late neurological deterioration in 6 cases(17%) patients with burst fracture treated by non operative methods,however in our study patients treated by various non-operative methods did not have neurological deterioration with available follow up. However other studies by Yi L et al, Natelson et al and Celbi et al(4) did not have any neurological deterioration by treating non operetively. Our study had comparable neurological outcome with available studies. Functional outcomes in our study was assesed using Denis pain scale and Denis work scale and FIM score was used in patients with complete neurological deficit. Our study had a favourable functional outcome. In surgical group patients with intact neurology one patient returned back to same work without restriction, nine patients went back to same work with slight restrictions. No patients had severe pain at follow up requring multiple analegesics. Our results were comparable with other studies such as Siebenga et al and Wood et al (62). Weinstein et al (55)in study 80% of the patients treated by non operative methods able to return to pre trauma occupation. In our study 4% of patients return pre trauma occupation and 63% of patient return to previous work with slight restrictions. Mumford et al had overall good outcome in terms of pain and function in 49% of the patients (55). In our study in patients treated but non operative methods 21% of patients had no pain and 67% of the patient had mild pain no requiring analgesics with available follow up. The functional outcomes of our study is comparable with other studies. In our study there was loss of correction of kyphosis in surgically treated patient and progression of kyphosis in patient treated by non operative methods. Study by Avanzi et al(63) had progression of kyphosis in patients treted by conservative method with average of 045 º. In our study in patients treated by conservative method had average progression of kyphosis around 22 º (3-56 º) with available follow up. The post traumatic kyphotic deformity at follow up in patients treated by conservative method did not have any correlation with functional outcome in terms of pain and return to work. Avanzi et al (63) study on corelation of post traumatic kyphotic deformity and functional outcome had similar results. Sadatsunel et al(64) concluded there was no corelation between residual kyphosis and fucntional outcome in terms of pain and return to work. Our study we had similar outcome the residual kyphosis did not affect the functioal outcome. Loss of correction kyphosis at follow up for patients treated by various surgical methods widely described in various studies. Study by Kramer et al reported progression of deformity upto 12º following posterior method and Stephens et al reported progression upto 11.9 º following surgical fixagtion(55). In our study average loss of correction around 8º with various surgical fixation method. In our study the loss of correction of kyphosis 7º was less in patients treated with posterior stabilisation with pedicle screw including the fractured vertebra when compared to anterior and combined apporaches. Study by Guven et al(43) had similar results as comparable to our study. Xing et al(27) suggested tat early stabilisation of thoracoumbar fractures prior to 72 hrs reduces mortality and morbidity. In our study the average time of surgery from the time of admission was less than 72 hours. Various studies compared anterior and posterior apporach meta analysis by Xu et al (36) concluded that anterior apporach not significantly superior to posterior apporach interms of neurlogical recovery, pain and return to work. In our study there was no difference in neurlogical improvement with various apporaches.Meta analysis by Tian et al (53)concluded that fusiont was not necessary in throracolumbar burst fracture treated by posterior pedical fixation. In our study fusion was not done in patients treated by posterior pedicle screw fixation there was no implant faliure at follow up thus our techniques of surgical fixations was comparable with various other studies.Altay et al(53) suggested that posterior pedicle instrumentation can be done in patient with load sharing score less than 7, the overall implant faliure rate was 6.2%. In our study 72% of the patient with load share score less than 7 and 2 patients with score of seven treated by posterior pedicle instrumetation there was no implant faliure in our study in patients treated by posterior pedicle instrumentation.

CONCLUSION

Though BURST FRACTURE is a very common fracture at the thoracolumbar junction the ideal management still remains controversial.

In patients with complete neurological deficit surgical fixation helps in early mobilization, rehabilitation and improvement in the quality of life. If they are managed non-operatively they can be managed with plaster cast providing support for early mobilization.

Though there is loss correction of kyphosis at follow up in operative group and progression of kyphosis in the non-operative group, there was no correlation with the functional outcomes in terms of pain(Denis pain scale) or return to work(Denis work scale).

No single classification system can be applied to decide on the ideal management of burst fracture.

AO classification is an useful tool to describe the morphology.

LOAD SHARING CLASSFICATION can be used to decide on the type of approach.

LIMITATIONS

Our study was a retrospective study .

Small sample size.

Loss of follow up in non-operative group.

Future recommendation

Needs a prospective study on various methods of operative and non-operative managment in patients with intact neurology.

Needs newer classification systems for better understanding and management of BURST fractures.

Angle of kyphosis should not be taken as the denominator for calcualting sample size in future studies.

BIBLIOGRAPHY

1. Rajasekaran S, Kanna R, Shetty A. Management of thoracolumbar spine trauma an overview. Indian J Orthop. 2015;49(1):72.

2. Dai L-Y, Jiang S-D, Wang X-Y, Jiang L-S. A review of the management of thoracolumbar burst fractures. Surg Neurol. 2007 Mar;67(3):221–31.

3. Heary RF, Kumar S. Decision-making in burst fractures of the thoracolumbar and lumbar spine. Indian J Orthop. 2007; 41(4):268–76.

4. Alpantaki K, Bano A, Pasku D, Mavrogenis AF, Papagelopoulos PJ, Sapkas GS, et al. Thoracolumbar Burst Fractures: A Systematic Review of Management. Orthopedics. 2010 Jun 1; 33(6):422–9.

5. Pneumaticos SG, Triantafyllopoulos GK, Giannoudis PV. Advances made in the treatment of thoracolumbar fractures: Current trends and future directions. Injury. 2013 Jun; 44(6):703–12.

6. Scheer JK, Bakhsheshian J, Fakurnejad S, Oh T, Dahdaleh NS, Smith ZA. EvidenceBased Medicine of Traumatic Thoracolumbar Burst Fractures: A Systematic Review of Operative Management across 20 Years. Glob Spine J. 2015 Feb;5(1):73–82.

7. Mataliotakis GI, Tsirikos AI. Spinal cord trauma: pathophysiology, classification of spinal cord injury syndromes, treatment principles and controversies. Orthop Trauma. 2016 Oct; 30(5):440–9.

8. Ambrozaitis KV, Kontautas E, Spakauskas B, Vaitkaitis D. [Pathophysiology of acute spinal cord injury]. Med Kaunas Lith. 2006; 42(3):255–61.

9. Braakman R. Mechanism and pathophysiology of spinal and spinal cord injury. Neurocirugía. 1991; 2(3):232–244.

10. Gnanenthiran SR, Adie S, Harris IA. Nonoperative versus Operative Treatment for Thoracolumbar Burst Fractures without Neurologic Deficit: A Meta-analysis. Clin Orthop Relat Res. 2012 Feb; 470(2):567–77.

11. Saifuddin A, Noordeen H, Taylor BA, Bayley I. The role of imaging in the diagnosis and management of thoracolumbar burst fractures: current concepts and a review of the literature. Skeletal Radiol. 1996 Oct 1; 25(7):603–13.

12. Atlas SW, Regenbogen V, Rogers LF, Kim KS. The Radiographic Characterization of Burst Fractures of the Spine. : 8.

13. McAfee PC, Yuan HA, Fredrickson BE, Lubicky JP. The value of computed tomography in thoracolumbar fractures. An analysis of one hundred consecutive cases and a new classification. J Bone Joint Surg Am. 1983 Apr; 65(4):461–73.
14. Parizel PM, van der Zijden T, Gaudino S, Spaepen M, Voormolen MHJ, Venstermans C, et al. Trauma of the spine and spinal cord: imaging strategies. Eur Spine J. 2010 Mar; 19(S1):8–17.
15. Khurjekar K, Kulkarni H, Kardile M. Treatment Algorithm For Unstable Burst Fracture. : 6.
16. Rouanet C, Reges D, Rocha E, Gagliardi V, Silva GS. Traumatic spinal cord injury: current concepts and treatment update. Arq Neuropsiquiatr. 2017 Jun; 75(6):387–93.
17. Denis F, Armstrong GW, Searls K, Matta L. Acute thoracolumbar burst fractures in the absence of neurologic deficit. A comparison between operative and nonoperative treatment. Clin Orthop. 1984 Oct ;(189):142–9.
18. Krompinger WJ, Fredrickson BE, Mino DE, Yuan HA. Conservative treatment of fractures of the thoracic and lumbar spine. Orthop Clin North Am. 1986 Jan; 17(1):161–70.
19. Reid DC, Hu R, Davis LA, Saboe LA. The nonoperative treatment of burst fractures of the thoracolumbar junction. J Trauma. 1988 Aug; 28(8):1188–94.
20. Wood K, Buttermann G, Butterman G, Mehbod A, Garvey T, Jhanjee R, et al. Operative compared with nonoperative treatment of a thoracolumbar burst fracture without neurological deficit. A prospective, randomized study. J Bone Joint Surg Am. 2003 May; 85-A(5):773–81.
21. Weinstein JN, Collalto P, Lehmann TR. Thoracolumbar “burst” fractures treated conservatively: a long-term follow-up. Spine. 1988 Jan; 13(1):33–8.
22. Stadhouder A, Buskens E, Vergroesen DA, Fidler MW, de Nies F, Oner FC. Nonoperative treatment of thoracic and lumbar spine fractures: a prospective randomized study of different treatment options. J Orthop Trauma. 2009 Sep; 23(8):588–94.
23. Bailey CS, Urquhart JC, Dvorak MF, Nadeau M, Boyd MC, and Thomas KC, et al. Orthosis versus no orthosis for the treatment of thoracolumbar burst fractures without neurologic injury: a multicenter prospective randomized equivalence trial. Spine J Off J North Am Spine Soc. 2014 Nov 1; 14(11):2557–64.
24. Shen W-J, Liu T-J, Shen Y-S. Nonoperative treatment versus posterior fixation for thoracolumbar junction burst fractures without neurologic deficit. Spine. 2001; 26(9):1038–1045.
25. Willén J, Anderson J, Toomoka K, Singer K. The natural history of burst fractures at the thoracolumbar junction. J Spinal Disord. 1990 Mar; 3(1):39–46.

26. Farcy JP, Weidenbaum M, Glassman SD. Sagittal index in management of thoracolumbar burst fractures. Spine. 1990 Sep; 15(9):958–65.

27. Xing D, Chen Y, Ma J-X, Song D-H, Wang J, Yang Y, et al. A methodological systematic review of early versus late stabilization of thoracolumbar spine fractures. Eur Spine J. 2013 Oct; 22(10):2157–66.

28. Kato S, Murray J-C, Kwon BK, Schroeder GD, Vaccaro AR, Fehlings MG. Does Surgical Intervention or Timing of Surgery Have an Effect on Neurological Recovery in the Setting of a Thoracolumbar Burst Fracture?: J Orthop Trauma. 2017 Sep; 31:S38–43.

29. Mirza SK, Krengel WF, Chapman JR, Anderson PA, Bailey JC, Grady MS, et al. Early versus delayed surgery for acute cervical spinal cord injury. Clin Orthop. 1999 Feb;(359):104–14.

30. Cengiz SL, Kalkan E, Bayir A, Ilik K, Basefer A. Timing of thoracolomber spine stabilization in trauma patients; impact on neurological outcome and clinical course. A real prospective (rct) randomized controlled study. Arch Orthop Trauma Surg. 2008 Sep; 128(9):959–66.

31. Bourassa-Moreau É, Mac-Thiong J-M, Li A, Ehrmann Feldman D, Gagnon DH, Thompson C, et al. Do Patients with Complete Spinal Cord Injury Benefit from Early Surgical Decompression? Analysis of Neurological Improvement in a Prospective Cohort Study. J Neurotrauma. 2016 Feb 1;33(3):301–6.

32. Benzel EC, Larson SJ. Functional recovery after decompressive operation for thoracic and lumbar spine fractures. Neurosurgery. 1986 Nov;19(5):772–8.

33. Kaneda K, Taneichi H, Abumi K, Hashimoto T, Satoh S, Fujiya M. Anterior decompression and stabilization with the Kaneda device for thoracolumbar burst fractures associated with neurological deficits. J Bone Joint Surg Am. 1997 Jan;79(1):69–83.

34. Hitchon PW, Torner J, Eichholz KM, Beeler SN. Comparison of anterolateral and posterior approaches in the management of thoracolumbar burst fractures. J Neurosurg Spine. 2006 Aug;5(2):117–25.

35. Shono Y, McAfee PC, Cunningham BW. Experimental study of thoracolumbar burst fractures. A radiographic and biomechanical analysis of anterior and posterior instrumentation systems. Spine. 1994 Aug 1;19(15):1711–22.

36. Xu GJ, Li ZJ, Ma JX, Zhang T, Fu X, Ma XL. Anterior versus posterior approach for treatment of thoracolumbar burst fractures: a meta-analysis. Eur Spine J. 2013 Oct;22(10):2176–83.

37. AMARESH N, SIKDAR J, JOSHI A, PANDEY L. STABILIZATION OF THORACOLUMBAR SPINAL INJURIES. Med J Armed Forces India. 2001 Jan;57(1):3–7.

38. Boucher HH. A method of spinal fusion. J Bone Joint Surg Br. 1959 May;41B(2):248–59.

39. Tezeren G, Kuru I. Posterior fixation of thoracolumbar burst fracture: shortsegment pedicle fixation versus long-segment instrumentation. J Spinal Disord Tech. 2005 Dec;18(6):485–8.

40. Aly TA. Short Segment versus Long Segment Pedicle Screws Fixation in Management of Thoracolumbar Burst Fractures: Meta-Analysis. Asian Spine J. 2017;11(1):150.

41. McCormack T, Karaikovic E, Gaines RW. The load sharing classification of spine fractures. Spine. 1994 Aug 1;19(15):1741–4.

42. Assunção Filho CA, Simões FC, Prado GO. THORACOLUMBAR BURST FRACTURES, SHORT X LONG FIXATION: A META-ANALYSIS. Coluna/Columna. 2016 Mar;15(1):78–84.

43. Guven O, Kocaoglu B, Bezer M, Aydin N, Nalbantoglu U. The use of screw at the fracture level in the treatment of thoracolumbar burst fractures. Clin Spine Surg. 2009;22(6):417–421.

44. Anekstein Y, Brosh T, Mirovsky Y. Intermediate screws in short segment pedicular fixation for thoracic and lumbar fractures: a biomechanical study. J Spinal Disord Tech. 2007 Feb;20(1):72–7.

45. Zhao QM, Gu XF, Yang HL, Liu ZT. Surgical outcome of posterior fixation, including fractured vertebra, for thoracolumbar fractures. Neurosciences. 2015 Oct;20(4):362–7.

46. Alanay A, Acaroglu E, Yazici M, Oznur A, Surat A. Short-segment pedicle instrumentation of thoracolumbar burst fractures: does transpedicular intracorporeal grafting prevent early failure? Spine. 2001;26(2):213–217.

47. Cho D-Y, Lee W-Y, Sheu P-C. Treatment of thoracolumbar burst fractures with polymethyl methacrylate vertebroplasty and short-segment pedicle screw fixation. Neurosurgery. 2003 Dec;53(6):1354–60; discussion 1360-1361.

48. Shen Y, Zhang P, Zhao J, Xu W, Fan Z, Lu Z, et al. Pedicle screw instrumentation plus augmentation vertebroplasty using calcium sulfate for thoracolumbar burst fractures without neurologic deficits. Orthop Surg. 2011 Feb;3(1):1–6.

49. Liao J-C, Chen W-P, Wang H. Treatment of thoracolumbar burst fractures by short-segment pedicle screw fixation using a combination of two additional pedicle screws and vertebroplasty at the level of the fracture: a finite element analysis. BMC Musculoskelet Disord [Internet]. 2017 Jun 15 [cited 2018 Aug 10];18. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5472982/

50. Danisa OA, Shaffrey CI, Jane JA, Whitehill R, Wang GJ, Szabo TA, et al. Surgical approaches for the correction of unstable thoracolumbar burst fractures: a retrospective analysis of treatment outcomes. J Neurosurg. 1995 Dec;83(6):977–83.

51. P. Oprel P, Tuinebreijer WE, Patka P, den Hartog D. Combined Anterior-Posterior Surgery Versus Posterior Surgery for Thoracolumbar Burst Fractures: A Systematic Review of the Literature. Open Orthop J. 2010 Feb 17;4:93–100.

52. Been HD, Bouma GJ. Comparison of two types of surgery for thoraco-lumbar burst fractures: combined anterior and posterior stabilisation vs. posterior instrumentation only. Acta Neurochir (Wien). 1999;141(4):349–57.

53. Tian N-F, Wu Y-S, Zhang X-L, Wu X-L, Chi Y-L, Mao F-M. Fusion versus Nonfusion for Surgically Treated Thoracolumbar Burst Fractures: A Meta-Analysis. Tonn J-C, editor. PLoS ONE. 2013 May 21;8(5):e63995.

54. Yang M, Ding GZ, Xu ZJ. Surgical Outcome in Thoracolumbar Fractures Managed by Short-segment Pedicle Instrumentation. 2014;43(1):9.

55. Rajasekaran S. Thoracolumbar burst fractures without neurological deficit: the role for conservative treatment. Eur Spine J. 2010 Mar;19(S1):40–7.

56. Scheer JK, Bakhsheshian J, Fakurnejad S, Oh T, Dahdaleh NS, Smith ZA. Evidence-Based Medicine of Traumatic Thoracolumbar Burst Fractures: A Systematic Review of Operative Management across 20 Years. Glob Spine J. 2015 Feb; 5(1):73– 82.

57. Khurjekar K, Hadgaonkar S, Kothari A, Raut R, Krishnan V, Shyam A, et al. Demographics of Thoracolumbar Fracture in Indian Population Presenting to a Tertiary Level Trauma Centre. Asian Spine J. 2015 Jun;9(3):344–51.

58. Aligizakis A, Katonis P, Stergiopoulos K, Galanakis I, Karabekios S, Hadjipavlou A. Functional outcome of burst fractures of the thoracolumbar spine managed nonoperatively, with early ambulation, evaluated using the load sharing classification. Acta Orthop Belg. 2002; 68(3):279–287. 59. Şentürk S, Öğrenci A, Gürçay AG, Abdioğlu AA, Yaman O, Özer AF. Classification of Radiological Changes in Burst Fractures. Open Access Maced J Med Sci. 2018 Feb 14; 6(2):359–63.

60. Hur J-W. A Comparative Analysis of the Efficacy of Short-Segment Pedicle Screw Fixation with that of Long-Segment Pedicle Screw Fixation for Unstable Thoracolumbar Spinal Burst Fractures. Clin Med Res. 2015;4(1):1.

61. Ge C-M, Wang Y-R, Jiang S-D, Jiang L-S. Thoracolumbar burst fractures with a neurological deficit treated with posterior decompression and interlaminar fusion. Eur Spine J. 2011 Dec;20(12):2195–201.

62. Abudou M, Chen X, Kong X, Wu T. Surgical versus non-surgical treatment for thoracolumbar burst fractures without neurological deficit. Cochrane Bone, Joint and

Muscle Trauma Group, editor. Cochrane Database Syst Rev [Internet]. 2013 Jun 6 [cited 2018 Jul 24]; Available from: http://doi.wiley.com/10.1002/14651858.CD005079.pub3

63. Avanzi O, Meves R, Caffaro MFS, de Hollanda JPB, Queiroz M. Thoracolumbar burst fractures: correlation between kyphosis and function post non-operative treatment. Rev Bras Ortop Engl Ed. 2009;44(5):408–414.

64. Sadatsune DA, da Costa PP, Caffaro MFS, Umeta RS, Meves R, Avanzi O. Thoracolumbar burst fracture: correlation between kyphosis and function after surgical treatment. Rev Bras Ortop Engl Ed. 2012; 47(4):474–478.

Format for Informed Consent Form for Subjects

Informed Consent form to participate in a research study

Study Title: EVALUATION OF FUNCTIONAL AND RADIOLOGICAL OUTCOME OF THORACOLUMBAR BURST FRACTURES

Study Number: ____________

Subject's Initials: __________________ Subject's Name:

____

Date of Birth / Age: ___________________________

(Subject)

(i) I confirm that I have read and understood the information sheet dated ____________ for the above study and have had the opportunity to ask questions. [ ]

(ii) I understand that my participation in the study is voluntary and that I am free to withdraw at any time, without giving any reason, without my medical care or legal rights being affected. [ ]

(iii) I understand that ***the Sponsor of the clinical trial, others working on the Sponsor's behalf (delete as appropriate)***, the Ethics Committee and the regulatory authorities will not need my permission to look at my health records both in respect of the current study and any further research that may be conducted in relation to it, even if I withdraw from the trial. I agree to this access. However, I understand that my identity will not be revealed in any information released to third parties or published. [ ]

(iv) I agree not to restrict the use of any data or results that arise from this study provided such a use is only for scientific purpose(s). [ ]

(v) I agree to take part in the above study. [ ]

Signature (or Thumb impression) of the Subject/Legally Acceptable

Date: _____/_____/______

Signatory's Name: _________________________________ Signature:

Or

Representative: ___________________

Date: _____/_____/______

Signatory's Name: ____________________________________

Signature of the Investigator: __________________________

Date: _____/_____/______

Study Investigator's Name: ___________________________

Signature or thumb impression of the Witness: _____________________________

Date: _____/_____/_______

Name & Address of the Witness: ________________________________

APPENDIX D

Functional Independence Measure (FIM) Instrument

	ADMISSION	DISCHARGE	FOLLOW-UP
Self-Care			
A. Eating			
B. Grooming			
C. Bathing			
D. Dressing - Upper Body			
E. Dressing - Lower Body			
F. Toileting			
Sphincter Control			
G. Bladder Management			
H. Bowel Management			
Transfers			
I. Bed, Chair, Wheelchair			
J. Toilet			
K. Tub, Shower			
Locomotion			
L. Walk/Wheelchair			
M. Stairs			
Motor Subtotal Score			
Communication			
N. Comprehension			
O. Expression			
Social Cognition			
P. Social Interaction			
Q. Problem Solving			
R. Memory			
Cognitive Subtotal Score			
TOTAL FIM Score			

INTERNATIONAL STANDARDS FOR NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY (ISNCSCI)

ASIA — AMERICAN SPINAL INJURY ASSOCIATION

ISCOS — INTERNATIONAL SPINAL CORD SOCIETY

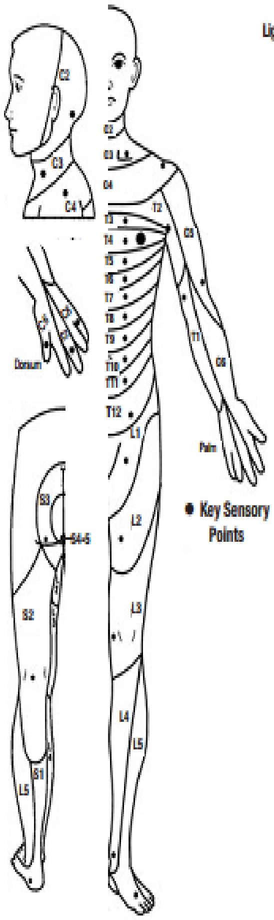
Patient Name ____________________ Date/Time of Exam ____________________

Examiner Name ____________________ Signature ____________________

RIGHT

MOTOR KEY MUSCLES		Motor	SENSORY KEY SENSORY POINTS Light Touch (LTR)	Pin Prick (PPR)
	C2			
	C3			
	C4			
UER (Upper Extremity Right) — Elbow flexors	C5			
Wrist extensors	C6			
Elbow extensors	C7			
Finger flexors	C8			
Finger abductors (little finger)	T1			
	T2			
	T3			
	T4			
	T5			
	T6			
	T7			
	T8			
	T9			
	T10			
	T11			
	T12			
	L1			
LER (Lower Extremity Right) — Hip flexors	L2			
Knee extensors	L3			
Ankle dorsiflexors	L4			
Long toe extensors	L5			
Ankle plantar flexors	S1			
	S2			
	S3			
(VAC) Voluntary Anal Contraction (Yes/No)	S4-5			
RIGHT TOTALS (MAXIMUM)		(50)	(56)	(56)

Comments (Non-key Muscle? Reason for NT? Pain?):



● Key Sensory Points

LEFT

SENSORY KEY SENSORY POINTS Light Touch (LTL)	Pin Prick (PPL)	Motor		MOTOR KEY MUSCLES
			C2	
			C3	
			C4	
			C5	Elbow flexors — UEL (Upper Extremity Left)
			C6	Wrist extensors
			C7	Elbow extensors
			C8	Finger flexors
			T1	Finger abductors (little finger)
			T2	
			T3	
			T4	
			T5	
			T6	
			T7	
			T8	
			T9	
			T10	
			T11	
			T12	
			L1	
			L2	Hip flexors — LEL (Lower Extremity Left)
			L3	Knee extensors
			L4	Ankle dorsiflexors
			L5	Long toe extensors
			S1	Ankle plantar flexors
			S2	
			S3	
			S4-5	(DAP) Deep Anal Pressure (Yes/No)
(56)	(56)	(50)		LEFT TOTALS (MAXIMUM)

MOTOR (SCORING ON REVERSE SIDE)

0 = total paralysis
1 = palpable or visible contraction
2 = active movement, gravity eliminated
3 = active movement, against gravity
4 = active movement, against some resistance
5 = active movement, against full resistance
5* = normal corrected for pain/disuse
NT = not testable

SENSORY (SCORING ON REVERSE SIDE)

0 = absent
1 = altered
2 = normal
NT = not testable

MOTOR SUBSCORES

UER [ ] + UEL [ ] = UEMS TOTAL [ ] — MAX (25), (25), (50)

LER [ ] + LEL [ ] = LEMS TOTAL [ ] — MAX (25), (25), (50)

SENSORY SUBSCORES

LTR [ ] + LTL [ ] = LT TOTAL [ ] — MAX (56), (56), (112)

PPR [ ] + PPL [ ] = PP TOTAL [ ] — MAX (56), (56), (112)

NEUROLOGICAL LEVELS
Steps 1-5 for classification as on reverse

	R	L
1. SENSORY		
2. MOTOR		

3. NEUROLOGICAL LEVEL OF INJURY (NLI) [ ]

4. COMPLETE OR INCOMPLETE? [ ]
Incomplete = Any sensory or motor function in S4-5

5. ASIA IMPAIRMENT SCALE (AIS) [ ]

(In complete injuries only)
ZONE OF PARTIAL PRESERVATION
Most caudal level with any innervation

	R	L
SENSORY		
MOTOR		

REV 11/15

INFORMATION SHEET

Burst(spine) fracture is the most common fracture in the spine. It can occur following road traffic accident or fall from height, following burst fracture it can give simple problems like pain to major problem like neurological injury. There are various methods to treat the fracture, it can treated either with bed rest, plaster jacket, special orthosis(structured non operative) or it can be treated with surgery where it has to be fixed with rods and screws. Treatment of burst fracture is controversial since no definite criteria are described. When there is neurological deficit or significant bone damage it is usually treated by surgery using rods and screws. When there is no neurological deficit or significant bone damage it is usually treated by structured non operative method . It is necessary that patient treated by any means to be observed closely to prevent post treatment complication such as persistent back ache, worsening neurological symptom ,implant breakage if treated by (surgical fixation) methods.

If you had been treated by any method mentioned above you need to be followed for complication and functional recovery to return to work. Routinely patient who had treatment for fracture spine followed up every three months on first year and every six months in the second year for above mentioned reasons. During follow up serial x rays and clinical examinations done if any complications identified might need additional investigations like (CT/MRI).If you had not followed up as mentioned above kindly do follow up

If you had treatment for burst fracture with minimum follow up of two years you will be assessed for functional outcome of the treatment either by telephone enquiry, assessed in the spine out patient department and we would like to include you for study and follow up.

OFFICE OF RESEARCH
INSTITUTIONAL REVIEW BOARD (IRB)
CHRISTIAN MEDICAL COLLEGE, VELLORE, INDIA

Dr. B.J. Prashantham, M.A., M.A., Dr. Min (Clinical)
Director, Christian Counseling Center,
Chairperson, Ethics Committee.

Dr. Anna Benjamin Pulimood, M.B.B.S., MD., Ph.D.,
Chairperson, Research Committee & Principal

Dr. Biju George, M.B.B.S., MD., DM.,
Deputy Chairperson,
Secretary, Ethics Committee, IRB
Additional Vice-Principal (Research)

February 03, 2018

Dr. Pandiyan Loganathan,
PG Registrar,
Department of Orthopaedics,
Christian Medical College,
Vellore – 632 002.

Sub: **Fluid Research Grant: New Proposal:**
Evaluation of functional and radiological outcome of thoracolumbar burst fractures.
Dr. Pandiyan Loganathan (Emp. No. 29050, PG Registrar, Orthopaedics, Dr. Venkatesh K (Emp. No. 30590), Spinal Disorder Surgery Unit, Dr. Kenny S David, Spinal Disorder Surgery, Dr. Rohit Amritanand (Emp. No. 28212), Orthopaedics, Dr. S.V Justin Arockiaraj, Orthopaedics.

Ref: IRB Min. No. 10942 [OBSERVE] dated 07.11.2017

Dear Dr. Pandiyan Loganathan,

The Institutional Review Board (**Blue**, Research and Ethics Committee) of the Christian Medical College, Vellore, reviewed and discussed your project titled "Evaluation of functional and radiological outcome of thoracolumbar burst fractures" on November 07th 2017.

The Committee reviewed the following documents:

1. IRB application format
2. Proforma
3. Information Sheet and Informed Informed Consent Form (English, Tamil, Hindi, Bengali)
4. Cvs of Drs. Pandiyan Loganathan, Venkatesh, Kenny S David, . Rohit. S.V Justin Arockiaraj
5. No. of documents 1- 4

The following Institutional Review Board (Blue, Research & Ethics Committee) members were present at the meeting held on November 07th 2017 in the BRTC Conference Hall, Biostatistics Building, Christian Medical College, Vellore 632 004.

Ethics Committee Blue, Office of Research, 1st Floor, Carman Block, Christian Medical College, Vellore, Tamil Nadu 632 002
Tel: 0416 – 2284294, 2284202 Fax: 0416 – 2262788, 2284481 E-mail: research@cmcvellore.ac.in

PROFORMA

Name :

Age :

Gender : Male (1) ☐

Female (2)

Occupation :

Diagnosis:

Dennis classification: A/B/C/D/E a

- Type A: Fracture of both end-plates. The bone is retropulsed into the canal.
- Type B: Fracture of the superior end-plate. It is common and occurs due to a combination of axial load with flexion.
- Type C: Fracture of the inferior end-plate.
- Type D: Burst rotation. This fracture could be misdiagnosed as a fracture-dislocation. The he mechanism of this injury is a combination of axial load and rotation.
- Type E: Burst lateral flexion. This type of fracture differs from the lateral compression fracture in that it presents an increase of the interpediculate distance on anteroposterior roentgenogram.

AO classification: [1]A3.1 ☐

[2]A3.2

[3]A3.3

Mode of injury : (1)Fall from height

(2)RTA

(3)Others

Date of injury :

Date of surgery :

Date of follow up:

Months of follow up:

Years of follow up :

Conservative /surgical: (1) CONSERVATIVE

(2) SURGICAL

Level of verterbra involved: D10/D11/D12/L1/L2

Surgical type : (1)anterior

(2)posterior

(3)posterior+anterior

Conservative: (1)Bed rest

(2)TK brace

(3)plaster jacket

(4)none of the above

At the time of injury At the time of follow up(48months)

ASIA (A/B/C/D/normal)

Scores

ASIA score

Load shearing classification

Radiological at injury immediate post op

at follow up

Cobbs angle

Local kyphotic angle

2 vertebral angle

3 vertebral angle

Anterior vertebral height

Posterior vertebral height

Functional outcome at follow up

Denis work scale : ☐

- W1: Return to previous employment (heavy labor) or physically demanding activities
- W2: Able to return to previous employment (sedentary) or return to heavy labor with restrictions
- W3: Unable to return to previous employment but works full time at new job
- W4: Unable to return to full time work
- W5: No work, completely disabled

Denis functional pain scale: $\square$

[1] No pain

[2] Minimum pain, without use of medication

[3] Moderate pain, with occasional use of medication

[4] Moderate to severe pain, with constant use of medication

[5] Severe pain, with chronic use of medication

FIM SCORE at injury at follow up

(in patient with neurological deficit)

<u>தகவல் அளித்தற்கான எழுத்து வடிவிலான ஒப்புதல் ஆவண படிவம்</u>

ஆய்வு எண்: ....

ஆய்வு தலைப்பு: விபத்து காரணமாக முதுகெலும்பு (நடுப்பகுதி) உடைந்த நோயாளிகளுக்கு சிகிச்சைக்கு பின் ஏற்படும் செயல்பாட்டு ரீதியான மருத்துவரீதியான மற்றும் ஸ்கேன் / X-Ray ரீதியான விளைவுகளை பற்றிய ஆய்வு.

ஆய்வு எண் :

நோயாளியின் பெயர் :

பிறந்த தேதி / வயது :

மருத்துவமனை எண் :

1) நான் மேற்கண் ஆய்வின் சம்பந்தமாக .... தேதியில் அளிக்கப்பட்ட தகவல் அறிக்கையை முழுவதுமாக படித்து புரிந்துக்கொண்டேன். எனக்கு இந்த ஆய்வினை பற்றி முழு விளக்கமும், கேள்வி கேட்க அவகாசமும் அளிக்கப்பட்டது.

2) நான் மேற்கண்ட ஆய்வில் தன்னிச்சையாக எனது முழு மனதுடன் பங்கேற்க சம்மதிக்கிறேன். இந்த ஆய்விலிருந்து நான் எப்போது வேண்டுமென்றாலும் விலகிக் கொள்ளலாம் என்றும், இதனால் எனக்கு மருத்துவ ரீதியாகவும், சட்ட ரீதியாகவும் எந்தவொரு பாதிப்பும் இருக்காது என்றும் தெரிந்து கொண்டேன்.

3) எனது மருத்துவ பரிசோதனை முடிவுகளை மேற்கண்ட ஆய்விற்காக மட்டும் பயன்படுத்திக்கொள்ள முழுமனதுடன் சம்மதிக்கிறேன். எனது சொந்த மற்றும் மருத்துவ பரிசோதனை பற்றிய விவரங்களை, ஆய்வினை சம்பந்தப்பட்டவரைத் தவிர எந்தவொரு மூன்றாம் நபருக்கும் வெளியிடமாட்டார்கள் என்று உறுதி அளிக்கப்பட்டேன். என் மருத்துவ பரிசோதனை முவுகளை நான் இந்த ஆய்விலிருந்து விலக நேரிட்டாலும், பயன்படுத்திக் கொள்ள சம்மதிக்கிறேன்.

4) இந்த ஆய்வு மூலம் வெளிப்படும் எனது தகவல்கள் மற்றும் அதன் முடிவுகளை அறிவியல் நோக்கத்திற்காக பயன்படுத்துவதில் எனக்கு எந்த தடையும் இல்லை என்று உறுதியளிக்கிறேன்.

5) நான் இந்த ஆய்வில் பங்கேற்க உடன்படுகிறேன்.

பிரதிவாதியின் கையொப்பம் / பெருவிரல் ரேகை : ....

தேதி : ....

கையொப்பமிடுபவரின் பெயர் : ....

ஆய்வாளரின் கையொப்பம் / பெருவிரல் ரேகை : Dr. Pandiyan Loganathan

தேதி : ....

கையொப்பமிடுபவரின் பெயர் : ....

சாட்சியாளரின் கையொப்பம் / பெருவிரல் ரேகை : ....

தேதி : ....

கையொப்பமிடுபவரின் பெயர் : ....

தகவல் அறிக்கை

முதுகெலும்பு முறிவு பற்றிய தகவல் அறிக்கை.

முதுகெலும்பு முறிவு சாலை விபத்து அல்லது மேலிருந்து கீழே விழுவதனால் ஏற்படலாம். இதன் விளைவாக சிறிய தொந்தரவு, வலி அல்லது பெரிய தொந்தரவு, நரம்பு பாதிப்பு ஏற்படலாம். இந்த வகையான எலும்பு முறிவை மாவுகட்டு அல்லது அறுவை சிகிச்சை மூலம் குணப்படுத்தலாம். நோயாளிகளில் யாருக்கு எலும்பு முறிவுடன் நரம்பு பாதிப்பு உள்ளதோ அவர்களுக்கு அறுவை சிகிச்சை தேவைப்படும். நரம்பு பாதிப்பு இல்லாத நோயாளிகளுக்கு மாவுகட்டு மூலம் குணப்படுத்தலாம். சிகிச்சை அளிக்கப்படும் நோயாளிகள் தொடர்ந்து மருத்துவரின் ஆலோசனைப்படி நடந்து கொள்ள வேண்டும். அறுவை சிகிச்சைக்குப்பின்பு, அறுவை சிகிச்சை செய்த இடத்தில் வலி அல்லது நரம்பு பாதிப்பு மோசமாக வாய்ப்பு உண்டு.

நீங்கள் முதுகெலும்பு முறிவுக்கு சிகிச்சை பெற்றிருந்தால், முதல் வருடத்தில் மூன்று மாதத்திற்கு ஒரு முறையும், இரண்டாம் வருடத்தில் ஆறு மாதத்திற்கு ஒரு முறையும் மருத்துவமனைக்கு வரவேண்டும். அப்போது X-Ray மற்றும் மருத்துவ ஆய்வு செய்யப்படும். மருத்துவ ஆய்வின் போது ஏதேனும் சிக்கல் இருந்தால் (CT and MRI) எடுக்கப்படும்.

நீங்கள் முதுகெலும்பு முறிவுக்கு சிசிச்சை பெற்று குறைந்தபட்சம் இரண்டு வருடம் இருப்பின் உங்கள் செயல்பாடுகள் சோதித்து பார்க்கப்படும். நீங்கள் உங்கள் மருத்துவர் ஆலோசனைப்படி ஆய்வுக்கு வரவில்லை எனில் தயவு செய்து (Spine OPD)-க்கு வருமாறு கேட்டுக்கொள்கிறோம். அப்படி நீங்கள் இரண்டு வருடம் வந்திருப்பின் உங்களை எங்கள் ஆய்வில் சேர்த்துக்கொள்ள விரும்புகிறோம்.

U R K U N D

Urkund Analysis Result

Analysed Document: thesis zotero - Copy.docx (D42662854)

Submitted: 10/17/2018 12:53:00 PM

Submitted By: pandi_arni@yahoo.co.in Significance: 3

%

Sources included in the report:

diss for plagiarism check.docx (D31209906) Thesis final copy.docx (D31630122)

https://www.duo.uio.no/handle/10852/55634

https://helda.helsinki.fi/handle/10138/33531

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2989512/

https://www.orthobullets.com/spine/2022/thoracolumbar-burst-fractures Instances where selected sources appear:

19

S.NO	NAME	HOSPITAL NUMBER	AGE	SEX	DIAGNOSIS	MODE OF INJURY	MODE OFTREATEMENT
1	RAGURAM	994557C	35	MALE	D12 BURST FRACTURE WITH ASIA A	FALL FROM HEIGHT	SURGICAL
2	CHENGALRAYA MANDIR	068018D	21	MALE	L2 BURST FRACTURE WITH INTACT NEUROLOGY	FALL FROM HEIGHT	SURGICAL
3	JAGANNATH BASKAR	975253C	43	MALE	L1 BURST FRACTURE WITH ASIA A	FALL FROM HEIGHT	SURGICAL
4	KALPANA	241251D	17	FEMALE	L1 BURST FRACTURE WITH ASIA A	FALL FROM HEIGHT	SURGICAL
5	DAMAYANTHI	264519D	47	FEMALE	D12 BURST FRACTURE WITH ASIA A	FALL FROM HEIGHT	SURGICAL
6	RAJA.P	106513D	22	MALE	L1 BURST FRACTURE WITH ASIA D	RTA	SURGICAL
7	PALANI	310023D	41	MALE	L2 BURST FRACTURE WITH ASIA D	FALL FROM HEIGHT	SURGICAL
8	SEETU	323591D	36	MALE	L1 BURST FRACTURE WTH ASIA A	FALL FROM HEIGHT	SURGICAL
9	PANNER	329590D	18	MALE	L2 BURST FRACTURE WITH INTACT NEUROLOGY	FALL FROM HEIGHT	SURGICAL

10	ELUMALAI	441141D	39	MALE	D12 BURST FRACTURE WITH ASIA D	FALL FROM HEIGHT	SURGICAL
11	KANNAYARAM	810527D	52	MALE	L2 BURST FRACTURE WITH ASIA D	FALL FROM HEIGHT	SURGICAL
12	SHIEK SARIF HOSSAIN	709947D	35	MALE	L1 BURSTFRACTURE WITH ASIA C	FALL FROM HEIGHT	SURGICAL
	POOJASINGH	922352D	18	FEMALE	L2 BURST FRACTURE WITH INTACT NEUROLOGY	FALL FROM HEIGHT	SURGICAL
14	VINOTH .M	968133D	27	MALE	L2 BURST FRACTURE WITH D12 ASIA A PARAPLEGIA	RTA	SURGICAL
15	LALITHA S	064581F	27	FEMALE	D12 BURST FRACTURE WITH INTACT NEUROLOGY	RTA	SURGICAL
16	MAGESH	159677F	32	MALE	L2 BURST FRACTURE WITH INTACT NEUROLOGY	FALL FROM HEIGHT	SURGICAL
17	MADAN MOHAN JANA	181819F	45	MALE	L1 BURST FRACTURE WITH INTACT NEUROLOGY	FALL FROM HEIGHT	SURGICAL
18	HARIKUMAR	189811F	27	MALE	L1 BURST FRACTURE WITH ASIA A	FALL FROM HEIGHT	SURIGICAL

19	JAYACHANDRAN	415183F	23	MALE	L2 BURST FRACTURE WITH ASIA B	FALL FROM HEIGHT	SURGICAL
20	LAKSHMI	227420B	45	FEMALE	L1 BURST FRACTURE WITH INTACT NEUROLOGY	FALL FROM HEIGHT	SURGICAL
21	PRABAKARAN D	429043F	42	MALE	L1 BURST FRACTURE WITH ASIA A	FALL FROM HEIGHT	SURGICAL
22	SIVAKUMAR	623741F	40	MALE	L1 BURST FRACTURE WITH ASIA B	FALL FROM HEIGHT	SURGICAL
23	PANCHARCHARAM	720595F	54	MALE	D12 BURST WITH ASIA A	RTA	SURGICAL
24	LAKSHMI	910368F	22	FEMALE	D12 BURST FRACTURE WITH L1 ASIA A PARAPLEGIA	FALL FROM HEIGHT	SURGICAL
25	DILIP KUMAR GORAI	064962G	42	MALE	L2 BURST FRACTURE WITH ASIA A	FALL FROM HEIGHT	SURGICAL
26	SRINIVASULU.V	949223F	28	MALE	L2 BURST WITH ASIA C	FALL FROM HEIGHT	SURGICAL
27	SANKAR	508242D	25	MALE	L1 BURST FRACTUE WITH INTACT NEUROLOGY	FALL FROM HEIGHT	SURGICAL
28	KESAVAN	006213C	48	MALE	D12 BURST FRACTURE WITH ASIA A	RTA	SURGICAL

29	NURMAHAMMAD SHEKH	634593F	36	MALE	L1 BURST FRACTURE	FALL FROM HEIGHT	SURGICAL
30	AGNES SELVARAJ	672725A	50	FEMALE	L1BURST FRACTURE WITH INTACT NEUROLOGY	RTA	SURGICAL
31	IMAN HUSSIAN	511979G	44	MALE	L2 BURST FRACTURE WITH INTACT NEUROLOGY	FALL FROM HEIGHT	SURGICAL
32	DHENAGARAN	831412D	43	MALE	L1BURST FRACTURE WITH INTACT NEUROLOGY	RTA	SURGICAL
33	GANASOUNDRI	889187d	44	FEMALE	D12 BURST FRACTURE WITH INTACT NEUROLOGY	FALL FROM HEIGHT	SURGICAL
34	SEKAR	831014D	49	MALE	D12 BURST FRACTURE WITH INTACT NEUROLOGY	RTA	CONSERVATIVE
35	SUNDRAMOORTHY	644233D	50	MALE	L1 BURST FRACTURE WITH INTACT NEUROLOGY	FALL FROM HEIGHT	CONSERVATIVE
36	VENKATESAN	795099D	55	MALE	L1 BURST FRACTURE WITH INTACT NEUROLOGY	FALL FROM HEIGHT	CONSERVATIVE

37	MAMTA BISWAS	978289D	32	FEMALE	L2 BURST FRACTURE WITH INTACT NEUROLOGY	FALL FROM HEIGHT	CONSERVATIVE
38	VEL	897410D	43	MALE	L1 BURST FRACTURE WITH INTACT NEUROLOGY	FALL FROM HEIGHT	CONSERVATIVE
39	PERUMAL	997630F	48	MALE	L2 BURST FRACTURE WITH INTACT NEUROLOGY	FALL FROM HEIGHT	CONSERVATIVE
40	ESWARI.C	636238C	15	FEMALE	L2BURSTFRACTUREWITH INTACT NEUROLOGY	FALL FROM HEIGHT	CONSERVATIVE
41	MD SADDAM HSIAN	174897F	21	MALE	L1 BURST WITH ASIA C	FALL FROM HEIGHT	CONSERVATIVE
42	SURESH BABU	566983G	38	MALE	D12 BURST FRACTURE WITH INTACT NEUROLOGY	RTA	CONSERVATIVE
43	VIJAYALAKSHMI	475921F	33	FEMALE	D12 BURST FRACTURE WITH INTACT NEUROLOGY	RTA	CONSERVATIVE
44	VENKATESAN	970431F	36	MALE	L2BURST FRACTRE WITH INTACT NEUROLOGY	FALL FROM HEIGHT	CONSERVATIVE
45	RAJA	963435F	44	MALE	D12 BURST FRACTURE WITH INTACT NEUROLOGY	RTA	CONSERVATIVE

46	NIHAR MISTRY	387353F	43	MALE	L1 BURST WITH ASIA A	FALL FROM HEIGHT	CONSERVATIVE
47	BABU	340328F	62	MALE	D12 BURST FRACTURE WITH INTACT NEUROLOGY	RTA	CONSERVATIVE
48	MANIKANDAN	548563G	18	MALE	L1BURSTFRACTURE WITH INTACTNEUROLOGY	FALL FROM HEIGHT	CONSERVATIVE
49	NAGESH	440492F	31	MALE	L1 BURST FRACTURE WITH INTACT NEUROLOGY	FALL FROM HEIGHT	CONSERVATIVE
50	PADMAVATHI KULATA	660846D	45	FEMALE	D12 BURST FRACTURE WITH INTACT NEUROLOGY	RTA	CONSERVATIVE
51	MANIGANDAN	558195D	15	MALE	L1 BURST FRACTURE WITH INTACT NEUROLOGY	FALL FROM HEIGHT	CONSERVATIVE
52	JAYASANKAR	516722G	45	MALE	L1 BURST FRACTURE WITH INTACT NEUROLOGY	FALL FROM HEIGHT	CONSERVATIVE
53	NIKITHA	977346F	15	FEMALE	L1BURSTFRACTUREWITH INTACT	FALL FROM HEIGHT	CONSERVATIVE

54	JIBAN CHACRABORTY	946563F	38	MALE	L1 BURST FRACTURE WITH INTACT NEUROLOGY	FALL FROM HEIGHT	CONSERVATIVE
55	GANDHI REDDY	878985D	36	MALE	L1 BURSTFRACTUREWITH INTACTNEUROLOGY	FALLFROMHEIGHT	CONSERVATIVE
56	GANGADAR	501868F	30	MALE	L1 BURST WITH INTACT NEUROLOGY	FALL FROM HEIGHT	CONSERVATIVE
57	MONJIRUL ISLAM	312455g	30	MALE	L2 BURST FRACTURE WITH INTACT NEUROLOGY	FALLFROMHEIGHT	CONSERVATIVE