Original Article

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Functional outcome of surgical management of thoracolumbar spine fractures using pedicle screw and rod system-A prospective study

Veerabhadra Javali[1], Anirudh C Kulkarni[2], Rajeev T V[3], Eshwar B Patel[4], Vishalakshi[5], Remya[6], Sreekantha[7]

Navodaya Medical College, Hospital and Research Center, Raichur. 1,2-Assistant professor, Department of Orthopaedics. 3- Senior Resident, Department of Orthopaedics. 4- Junior Resident, Department of Orthopaedics. 5- Assistant professor, Department of Anaesthesiology. 6- Assistant Professor/Lecturer, Department of Anatomy, KSHEMA, Nitte University, Mangalore.
7- Professor of Biochemistry, RIMS, Raichur.

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Corresponding Author:
Dr.Sreekantha, Professor of Biochemistry, RIMS, Raichur.
E-mail: grsreekantha@gmail.com

Abstract:

Background and objectives: The spinal trauma is one of the leading problems in Orthopaedic practice more so in modern era where the individuals are more at risk due to high energy. It is one of the grave injuries that cause infinite morbidity and disability to the patient. Thoracolumbar spinal segment is the 2nd most commonly involved segment after the cervical segment in spinal injuries, about 30 to 60% of all spinal injuries. **Materials and Methods:** This is a prospective study of 21 cases of unstable thoracolumbar spinal injuries treated by posterior instrumentation in Navodaya Medical College, Hospital and Research Centre, Raichur between 2012 to 2014. Medically unsuitable and patients not willing for surgery were excluded from the study. **Results:** In this series 20 (95.3%) patients were male and 1 (4.7%) were female patients. In this series there were 13 (65%) of type A fractures, 5 (25%) of type B and 2 (10%) with type C fractures. In this series we had 10 (47.6%) patients with fractures at the thoracic level and 11(52.4%) patients with fractures at lumbar level. The T11 - L2 fractures contributed to 18 (86%) of the cases and were the most common fractures were at T12 (23.81%), L1(28.57%). . In this study 11 (52.38%) of patients were of grade A, 7 (33.33%) were grade B, 3 (14.4%) were grade C at admission. All patients showed at least one ASIA grade improvement at latest follow-up. At 3 months follow up 9(42.85%) were of grade D & E, at 1 year 13 (62%) of patients were of grade D and E. **Conclusion:** From this sample study, we consider that pedicle screw fixation is an excellent treatment for spine fractures. Pedicle screw fixation should be done as early as possible in order to facilitate neurological recovery, help in good nursing care and mobilization of the patient and to prevent deterioration of the neurological status. Pedicle screw instrumentation provides less surgical exposure, correction of deformity and better stabilization of one motion segment above and below fracture.

Key words: Pedicle screw, Thoracolumbar spine, Treatment

Introduction

The spinal trauma is one of the leading problems in Orthopaedic practice, more so in modern era where the individuals are more at risk due to high energy. It is one of the grave injuries that cause infinite morbidity and disability to the patient. The hopelessness and helplessness experienced by patient and doctors until the present time has been expressed by writer Edwin Smith Papyrus. By symptoms of numbness and palsy of the arms, the urine and the excreta coming against their will and knowledge, you may for tell that death is at hand for reason that the spinal marrow is hurt. Having made such a prognostic, you may make an incision and take forth the splinters of the broken vertebra in cases where the neural arch was injured which was driven in and press the spinal marrow and nerves thereof [1].Thoracolumbar spinal segment is the 2nd most commonly involved segment after the cervical segment in spinal injuries, about 30 to 60% of all spinal injuries. Thoracolumbar injuries in trauma are concentrated at the thoracolumbar junction region, 60% occurring between T12 and L2. 15 to 20% patients with fracture at thoracolumbar level have associated neurological injury [2]. The treatment options for unstable thoracolumbar spine fractures and fracture dislocations have long been controversial. Many authors, advised non-operative treatment, but later report emphasized the advantage of Open reduction internal fixation with posterior instrumentation [3,4]. Most authors agree that neurological improvement is independent of treatment modality. But the advocates of surgical decompression point at advantages of surgery in improving neurological deficits. Lately consensus is evolving around the world for stabilization of spine, with fusion and instrumentation in unstable fracture [5,6].Historically, thoracolumbar fractures have been treated with recumbency i.e. to bed rest for a period of 8-12 weeks. This mode of treatment is accompanied with complication due to recumbency. It is very labor intensive, cost of therapy in terms of hospital hours used, bed occupancy and care by trained personnel is very high. In a country like ours, where there is acute shortage of hospital facilities and trained manpower, conservative management, more often than not, end up as benign neglect, so there is an urgent need for exploring possibilities of surgical stabilization, early mobilizations and rehabilitation of patients. Internal fixation and stabilization of spinal lesion allows early mobilization of all patients, regardless of neurological deficit, while protecting the neurological structures from further injury and enhancing their recovery [7].Surgical treatment can be anterior, posterior or anteroposterior. As most Orthopaedic and spinal surgeons are more experienced in posterior approach and at the same time this approach requires less operative time with less blood loss, hence a safe alternative [6].If an incomplete neurological deficit exists, significant residual neural compression is documented and when treatment is carried out 3 weeks later anterior approach can be considered. Historically, Harrington hook rod construct or its modifications have been extensively studied [7-9]. their main disadvantage is that it spans 5-6 spinal segments [10]. Hence, newer options, especially pedicle screw plate or rod constructs which provide short segment immobilization have gained popularity [11].The goals of surgery are to achieve stability, to correct deformity, early mobilization, to expedite post-operative recovery and to decrease pseudoarthrosis. The pedicle screw plate or rod construct helps to achieve all these [12]. In Variable screw placement the fixation achieved is more rigid as the screw is passed through the "force nucleus" of the vertebrae[13]. This is the post through which five anatomical structures - the superior facet, the inferior facet, the lamina, the pedicle and the transverse process, channel all posterior forces that are transmitted to the body[14].In this study, we have stabilized cases of thoracic and lumbar unstable spinal lesions with pedicle screw and rod fixation. Pedicle screw system has gained much popularity in recent times. We have evaluated all patients for maintenance of spinal correction and neurological improvement after posterior instrumentation in thoracic and lumbar spinal fractures and clinical outcome in terms of spinal scoring system called as Denis work and pain scale.

Materials and Methods:

This is a prospective clinical study of unstable thoracolumbar spinal injuries by posterior instrumentation (pedicle screw and rod fixation in thoracic, lumbar, and thoracolumbar spinal fractures).In all, a total of 21 cases were evaluated and assessed during the period from 2012 to 2014. The study was conducted in the Department of Orthopaedics, Navodaya Medical

College Hospital & Research Centre, Karnataka. All the patients underwent treatment, as per a specific treatment plan. All the patients were initially assessed in the outpatient department or casualty according to their presentation and then they underwent a detailed evaluation of their hemodynamics, spine, neurological status and other injuries if associated with trauma. The patients were interviewed; their epidemiological, historical, subjective and physical findings were noted. After initial investigations and hemodynamic stabilization, patients were assessed neurologically in detail. A neurological chart was maintained for each patient. All the patients had routine X-rays of thoracolumbar and lumbar spine in both anteroposterior and lateral views. In all the patients CT was done, MRI was done for affordable patients. The pre-operative neurological status was graded on the basis of ASIA grading. It was also used to assess post-operative recovery and follow-up. The indication for the surgery was instability for which instrumentation was needed to restore spinal stability or to protect neurological elements.

Inclusion criteria:

1. Unstable fractures with neurological deficits.
2. Unstable fractures with incomplete neurological deficits to decompress the nerve tissue.
3. Unstable fractures with greater than 20 degree kyphotic deformity and 50% decrease in vertebral height collapse without neurological deficits.
4. Patients with complete spinal cord injury for the purpose of stabilization.
5. Contiguous fractures of thoracolumbar spine.
6. Thoracolumbar fractures of traumatic etiology.

Exclusion criteria:

1. Pathological fractures.
2. Those managed conservatively.
3. Patient age more than 60 years.
4. Patients not willing for surgery.
5. Medically unfit for surgery.

Preoperative work up

1.Plain radiograph (static and dynamic wherever necessary):Anteroposterior views, Lateral views. To assess extent of degeneration, instability, mechanism of injury, fracture pattern and its severity and canal compromise or deformity.

2 .Magnetic resonance imaging (MRI) was useful in determining the condition of the spinal cord following trauma, Any soft tissue encroachment (intervertebral disc) of the spinal cord, the following measurements were taken using plain X rays of the injured Spine.

a. Sagittal Angle: This was calculated by drawing two lines. One line joining the inferior margins of the upper vertebral body adjoining the disc space above the affected disc space on the lateral view and another line joining the disc space below the affected disc space. Perpendiculars are dropped on these two lines equidistant from the posterior borders of the respective vertebrae. The angle between the two perpendicular lines gives the sagittal angle positive in Kyphosis and negative in lordosis.

b. Sagittal Index : This is also calculated from the lateral x ray film. This is a ratio between anterior and posterior heights of the fractured vertebra.

Procedure:

Prophylactic intravenous antibiotics were given preoperatively. In supine position general anaesthesia with endotracheal intubation was administered. The patient was put in prone position on a 4 poster frame encouraging more lordosis. Care being taken to keep the nipples in females and the scrotum in males from free from pressure. This position avoids venous stasis and decreases intra-abdominal pressure, thus reducing venous bleeding. All bony prominences were padded. The skin, subcutaneous tissues, and paraspinal muscles down to the level of lamina were infiltrated with 1:50000 epinephrine solution to minimize bleeding. A posterior midline incision was made centering over the involved spinal unit and extending 2 levels above and below. The incision was deepened to expose posterior elements of the vertebrae one level above and one below the injury. The dissection was carried laterally to the tips of the transverse processes, maintaining meticulous hemostasis. The pedicles were identified, by identifying the point of convergence of a horizontal line along centre of transverse process and vertical line along centre of superior facet. Using a rongeur cortical bone was removed around the pedicle entry point. Pilot hole is made with use of sharp

trocar with stopper. Centralizers or Blunt kirschner wires were placed into the pedicle and their position was confirmed under image intensifier on both anteroposterior and lateral views. Pedicle probe was passed with rotating it over 30 degrees clockwise and anticlockwise so it entered the pedicle at the region of least resistance which is the centre of the pedicle. The depth of the pedicle was confirmed with probe by the markings on it and confirming its position by passing it to 80% of its depth. Now the pedicles were tapped with 5.5mm or 6.25mm taps depending on appropriate size. The pedicle was probed in all four quadrants with a pedicle sound to make sure that solid tube of bone exists and violation of pedicle cortex has not occurred and the screws of appropriate lengths were selected and inserted into the pedicles with help of monoaxial or polyaxial inserter depending on the implant used. During insertion the positions of the screws were checked with image intensifier in both anteroposterior and lateral views. A rod contouring template is placed into the slots of the implants. The template is shaped to reflect the natural curve of spine. A contoured rod was used to create distraction-extension assembly. The appropriate sized rods (10mm) were selected and contoured using cam action bending instrument to match the template. The rods were held with self-locking, long rod holder and aligned and placed over the slots on the implant placed. A rod pusher straight or curved can be used to push the rod into implant slots. The rod is fixed by inserting the inner screw and outer nut with help of combined insertion device for inner screw and outer nut by gently aligning the inner screw with inner threads of the screw. Use 1-2 counter clockwise turns to engage inner threads. A slight click will confirm proper alignment of screws. The inner screw is rotated clockwise to engage 2-3 threads and is not tightened at this stage. Holding the inserter for inner screw in position the inserter for the outer nut is disengaged from the ball catch holding it and outer nut is lowered and aligned and inserted by rotating clockwise to engage 2-3 threads only and is not tightened, the combi inserter is disengaged by lifting it clean and the assembly is inspected to ensure the threads are properly engaged. All outer and inner screws are similarly inserted over the implant and the assembly is constructed. Using angled spreader, distraction is applied by placing the prongs of spreader straddling the rod and in contact with the head of the implant. Adequate distraction is applied for correction of deformity and the inner screw is tightened with long hex screw driver. A thorough hemostasis was achieved and the wound was closed in layers over drain. Clean dressing was applied.

Post-operative treatment : All the patients were given post op intravenous antibiotics (third generation cephalosporin + aminoglycoside) for 5 days. They were switched over to oral antibiotics till suture removal. Intravenous dexamethasone 4 mg IV was given for 3 days. Physiotherapy was started from first day post operatively. Sutures were removed on eleventh day. On the second day patients were allowed to roll from side to side. They were allowed to sit up and were mobilized on a wheel chair after application of thoracolumbar belt on third or fourth post-operative day. A close watch was kept for any improvement or deterioration in the neurological status. Patients wore spinal jacket for about 6 weeks. Those with incomplete neurological deficits were given physiotherapy and gradually ambulated. Patients with complete neurological deficits were given physiotherapy and ambulated on wheel chair. Routine postoperative X-rays were taken prior to discharge Fig(1). The neurological grading and radiological parameters were recorded on 3rd day of the operation.

Follow up:

All the patients were followed up in OPD every 4th week after surgery for 6 months and at each follow up clinical, radiological & neurological examination was done to assess spinal stability. At the end of 6 month of follow up the patients were evaluated clinically by using Denis work and pain scale.

Results

In this series 20 (95.3%) patients were male and 1 (4.7%) were female patients. 1 (4.7%) patient was below 20 years, 10(47.8%) were in the 20-30 age group and 10 (47.8%) were in the 30-40 age group. In this series there were 13 (65%) of type A fractures, 5 (25%) of type B and 2 (10%) with type C fractures Fig(2). In this series we had 10 (47.6%) patients with fractures at the thoracic level and 11(52.4%) patients with fractures at lumbar level. The T11 -

L2 fractures contributed to 18 (86%) of the cases and were the most common fractures were at T12 (23.81%), L1(28.57%). In this series we had 12 (60%) patients having fall from height as the most common mode of injury, 5 (25%) due to road traffic accidents and in 3 (15%) of patients mode of injury was fall of a heavy object. In this study 11 (52.38%) of patients were of grade A, 7 (33.33%) were grade B, 3 (14.4%) were grade C at admission Fig(3). All patients showed at least one ASIA grade improvement at latest follow-up. At 3 months follow up 9(42.85%) were of grade D & E, at 1 year 13 (62%) of patients were of grade D and E. This shows that the posterior spinal stabilization with indirect decompression with pedicle screw and rod system was directly related to the neurological recovery. In our series 16 (76%) patients were administered preoperative steroids and in 5 (24%) of cases preoperative steroid was not administered. In our series the mean kyphotic angle was 20.9° at admission, 6.9° at 3 months follow up and 7.30° at 1 year follow up with a standard deviation of 3.63 at admission, 1.83 at 3 months of follow up, and 2.39 at 1 year follow up. ANOVA test gave significant difference of the pairs. Tukey's pair wise analysis test was applied to compare the variables and significant pairs were 1 and 2, 1 and 3. A significant correction in kyphotic deformity after posterior spinal stabilization with pedicle screws and rod system was observed. In this series the duration from time of injury to time of admission showed a mean of 1.76 days, duration from time of injury to time of surgery showed mean of 4.66 days. The number of patients admitted <72 hours were 15 (71.42%) and >72 hours were 6 (28.57%) of the cases. 13 (61.9%) of patients underwent surgery <= 4 days and 8(38.09%) of patients underwent surgery >4 days. 19 (90.47%) of patients had hospital stay ranging from 20-40 days and 2 (9.52%) patient >40 days. In this series 6 (28.57%) patients polyaxial pedicle screws were used with transverse connector in 2 (9.52%) patients and in 15 patients (71.42%) patients monoaxial pedicle screws were used Fig(4). In our series 2 (9.52%) patients had pressure sores and were treated accordingly. 2(9.52%) patient had superficial wound infection which subsided on appropriate antibiotic cover. In our series 3 (14.5%) patients returned to previous employment or physically demanding activities. 10 (47.5%) were able to return to previous employment to heavy labor with some restriction. 6 (28.5%) were unable to return to previous employment but worked full time at new jobs. 2 (9.5%) were unable to return to full time work.12 (57%) had no pain, 8 (38.25%) patients had occasional minimal pain with no need for medication Fig(5). 1(4.75%) had moderate to severe pain, occasional absence from work and change in activities of daily living.

Discussion:

In our study we had 95% males and 5% female patients. The average age was 28.3 years and more common in the second and third decade. Gregory F. Alvine et al [15] in their study found that average age was 31 years, with a male predominance. Nasser M .G et al [18] in their study found that average age was 28.8 years with a male predominance. Rick C. Sasso et al [16], in their study had 77% males and 23% females with a mean age of 34 years . Razak M, et al [17] in their study found that average was 30 years with a male predominance. In our study we noted fall from a height in 81% patients as the most common mode of injury and was mainly the result of work injury. Road traffic accident was the second commonest cause 19% of patients. Nasser M.G et al [18] in his study noted that the main cause of injury was fall from a height and road traffic accident was the second commonest. Gregory F. Alvine, et al [15] noted that in 52% of patients injuries resulted from fall from a height, in 39% patients due to road traffic accidents and 9% due to fall of heavy objective. Razak M, et al[17] in his study noted that 69% of injuries were caused from fall from height, 31% due to road traffic accident. In our series we found 76.1% of patients with AO Type-A fractures ,4.2% with AO Type-B fractures and 9.7% with AO Type-C fractures. Nasser M.G. et al[18], in their study noted 76% of patients with Type -A, 8% with Type-B and 16% with Type-C. Rick C.Sasso et al. [16], noted that 62.5% had AO Type –B and 37.5% had AO Type-A fractures. Gregory F.Alvine et al [15] noted that Type –B fractures were seen in 57.5% of patients Type-A in 22.5% and 20% Type-C. In our series we had 86.1% of patients with fractures between T11-L2 levels.9.52% with fractures between T1-T10,4. 5% with fractures between L3-L5 levels. Nasser M.G. et al. [18], in their study noted that the commonest vertebra to be fractured was L1 comparable to our study. Gregory F Alvine et al [15], noted that in 72.5% of cases the injury was at level of T11-L2. Rick C.Sasso et al [16], noted that in 80% of

cases the injuries were at T11-L2 levels. Razak M et al [17], noted that in 92% of cases the injuries were at the L1 and L2 vertebral levels. In our study we had of patients with 52.3% ASIA Grade-A, 33.3 % with GradeB,and14.4 % with Grade-C at admission and at latest follow up showed at least 1 ASIA Grade improvement. Nasser M.G. et al. [18], noted that patients who had neurological deficits showed at least 1 grade improvement at latest follow up. Gregory F Alvine et al [15]., noted that neurological improvement was seen in 50% of cases with 40% improving with 1 grade and 20% with 2 grades and none had decrease in neurological level. Rick C.Sasso et al. [16], in their study noted that all patients with incomplete neurological deterioration improved at least by 1 grade. Razak M et al [17], noted that 64.4% of those with incomplete lesions showed an improvement of at least 1 grade. Khan I et al [19], noted that 20 grade improvement in 18 patients (1.1 Grade improvement). In our series the mean kyphotic angle by Cobb's method was 21° on admission, 8.3° post operatively and 7.3° at latest follow-up. Nasser M.G et al[18]., noted the kyphotic angle was 23.6° on admission, 7° post – operatively and 11.5° at latest follow-up. Gregory F. Alvine et al [15]., noted that sagittal plane angulation was 12° pre operatively, 1° post operatively and 6° at follow-up Rick C.Sasso et al [16]., noted that the kyphotic angle was 17.6° pre operatively, 3.5° postoperatively and 11.6° at latest follow up. Razak M. et al. [17], noted that the average kyphotic angle was 20° pre operatively, 7° post operatively and 9° at latest follow up. In our series the duration from injury to a admission was a mean of 1.76 days, from injury to surgery was 4.66 days and average hospital stay was 28.4 days. Rick C.Sasso et al [16] , noted in their study that average time interval between time of injury to time of surgery was 4 days and mean hospital stay was 16 days. Razak M et al [17], noted that average time duration to surgery was 5.6 days and average hospital stay was 24 days. In our study we had 2 patients with pressure sores and 2 patient with superficial wound infection. No case of hardware loosening and no misplacement of pedicle screws were noted. Khan. I et al [19]., in their study noted that there was 1 patient with superficial wound infection, and 1 patient with deep vein thrombosis. Razak M et al [17], noted 2 instances of hardware loosening and 3 misplaced pedicle screws.

Summary

Twenty one cases of thoracic and lumbar spine fractures with or without paraplegia were treated surgically with pedicle screw and rod system in Department of Orthopaedics, Navodaya Medical College Hospital & Research Centre, Karnataka, between 2012 and 2014. Most number of patients with thoracic and lumbar spine fractures were in the 2nd and 3rd decade of life with an average age of 28.3 years. There was a significant male predominance with 19(95%) male patients. In the present study the most common mode of injury fall from height 17(81%), RTA 4 (19%) . In our study we had 16 (76.1%) patients with AO Type A fractures, 3(14.2%) with AO Type B fractures and2 (9.52%) with AO Type C fractures. Our study had 17(82.1) patients with fractures between T11-L2 levels with or without paraplegia.

In our study pre-operative steroids were administered in 16(76.1%) patients. Our study noted that patients with neurological deficit improved by at least 1 ASIA grade improvement. Our study noted that mean kyphotic angle improved from 21deg on admission to 8.38 deg Post operatively and to7.38 deg at latest follow up. In our study mean time interval between injuries to surgery was 4.66 days. All cases were followed up at regular interval and findings were recorded accordingly. Results were based on the Denis work scale and Denis pain scale. Good results with pain relief were achieved in 57% of the cases, fair results in 38% and poor results in 5 % of cases. Complications included pressure sores in 2 (9.52%) patients, and superficial wound infections were noted in 2 (9.52%) patients and were treated accordingly.

Conclusion:

This study was conducted to assess the Radiological, Neurological and Clinical outcome of surgical management of thoracolumbar fracture spine with pedicle screws and rod system. We conclude: Thoracic and lumbar spine fractures are more common in the 2nd and 3rd decade of life with male predominance due to outdoor activities. The commonest mode of injury was fall from a height. Management of thoracic and lumbar spine fractures requires careful pre-operative planning, patient selection, neurological evaluation and meticulous intra-operative care and post- operative rehabilitation including counseling for good functional outcome. Still, neurological recovery after dorso-lumbar spinal injuries pose at challenge to Orthopaedic surgeons. Severity of the primary cord damage at the time of accident is a

major factor in the neurological recovery of the patients. Earlier the intervention and less number of transfer of patients from place to place (less secondary neurological damage) gives good prognosis. The posterior midline approach provides adequate exposure and direct visualization. Pedicle screw fixation should be done as early as possible in order to facilitate neurological recovery, help in good nursing care and mobilization of the patient and to prevent deterioration of the neurological status. The administration of pre-operative steroids have shown to have a beneficial effect on the final neurological outcome. Pedicle screw instrumentation provides less surgical exposure, correction of deformity and better stabilization, of one motion segment above and below fracture.

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Conflicts of Interest: None

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Figure 1: Pre & Post Operative

Figure 2 Type Of Fractures

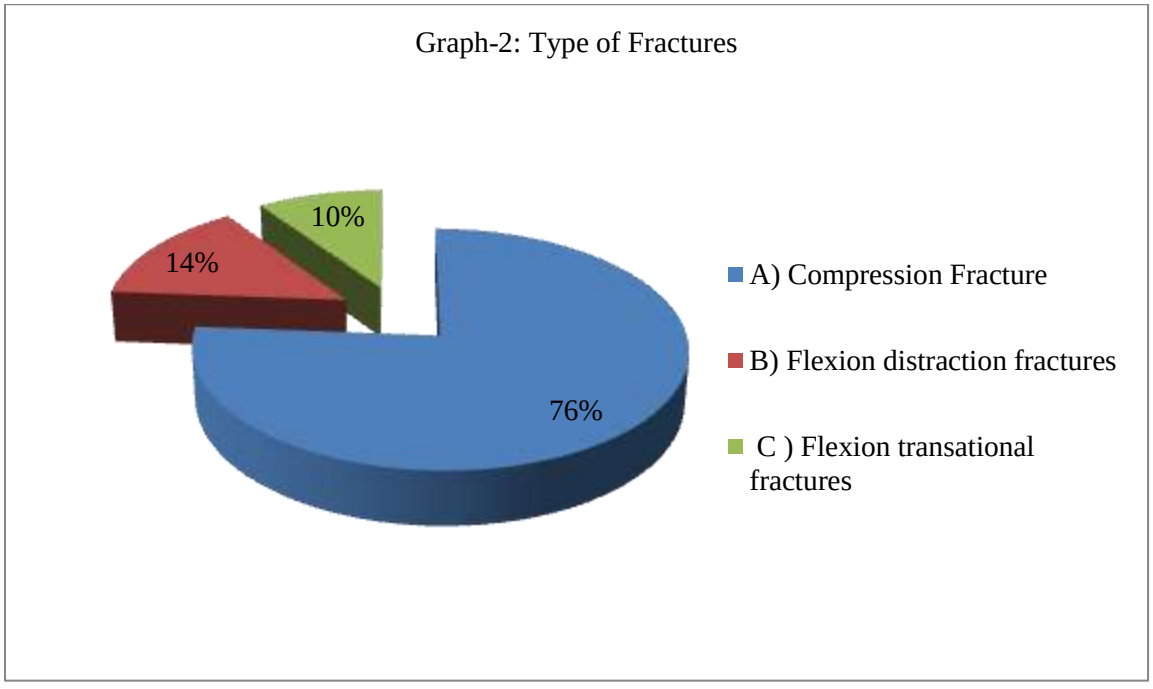

Figure 3: Neurological Status

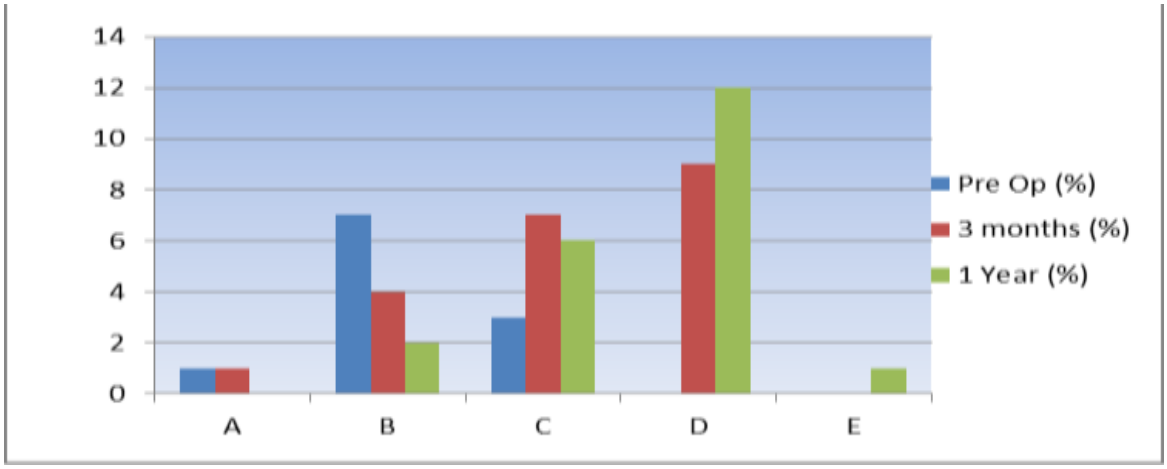

Figure 4: Type Of Implants

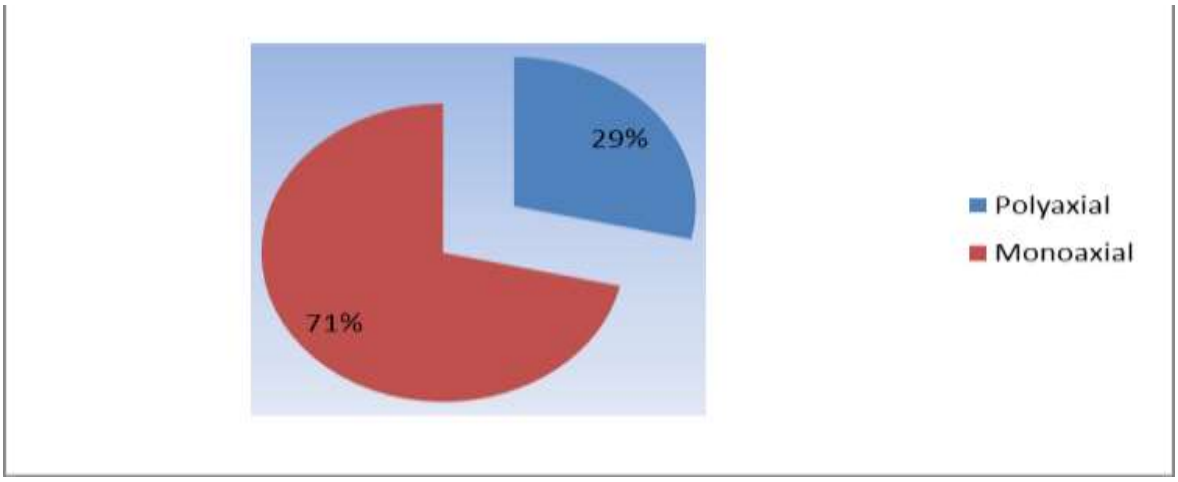

Figure 5 Denis Pain Scale