Original Article

NOAJ Jan-July 2013|Vol 3| Issue 1

Percutaneous Pedicle Screw and Rod Insertion for the Treatment of Thoracic and Lumbar Spine Fracture

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ABSTRACT

Introduction: Standard techniques for lumbar pedicle screw and rod fixation involve open exposure and extensive muscle dissection. Percutaneous pedicle screw system minimises the morbidity associated with traditional open approaches without compromising the quality of spinal fixation. A preliminary experience with this device has been encouraging. The purpose of this study was to demontrate operative techniques and experiences with percutaneous lumbar pedicle screw and rod insertion for internal fixation of the lumbar spine without use of Zig.

Methods: It was hospital based retrospective interventional study done at the department of Orthopaedics, B.P.Koirala Institute of Health Sciences, Dharan,Nepal over a period of 2 and half years. The study enrolled 30 patients aged 18-55 years who had presented with traumatic fracture of thoracic and lumbar spine. All thirty patients underwent percutaneous pedicle screw and rod fixation and successful percutaneous single/two level fusions. The follow up period ranged from 6 to 24 months.

Results: The study comprised of 25 males and 5 females. Average patient's age was 36.5 years (range 18-55 years). The common mode of injury was fall from height, road traffic accident, physical assault followed by sports related injury. All patients were having unstable spine fracture without neurological deficit. Operation time, loss of blood, post operative pain was less in percutaneous method. Post operative rehabilitation was easier. Spinal fusion was achieved in all patients in 6 months to 1 year time. There was no post-operative neurological deficit, infection, implant failure.

Conclusion: Our early experiance suggests that Minimally invasive approaches for performing lumbar fusion, is able to achieve the same clinical results as conventional open procedures.

Keywords: Percutaneous Surgery; Lumbar Spine, Pedicle Screw Fixation

INTRODUCTION

The uses of pedicle screws for spinal stabilisation have become increasingly popular worldwide. Pedicle screw system engages all three columns of the spine and can resist motion in all planes. Several studies suggest that pedicle screw fixation is a safe and effective treatment for many spinal disorders [1,2]. Standard techniques for pedicle screw placement require extensive tissue dissection to expose entry points and to provide lateral-to-medial orientation for optimal screw trajectory. Open pedicle screw and rod fixation have been associated with wide paraspinal muscle dissection, extensive blood loss, lengthy hospital stays, and high cost [3]. Mager[14], who used an external fixator, first described percutaneous fixation of the lumbar spine. Mathews and Long[5] first described and performed percutaneous lumbar pedicle fixation technique in which they used plates as the longitudinal connectors. Lowery and Kulkarni[6] subsequently described a similar technique in which rods were placed. Although the latter authors reported high success rate, Mathews and Long noted a significant rate of non-union. In all cases, the longitudinal connectors were placed either externally[4] or superficially, just beneath the skin [5-7]. This has several potential disadvantages. First, the superficial hardware can be irritating and requires routine removal[6]. Second, longer screws are required, producing a less effective biomechanical stabilisation than that achieved using standard pedicle fixation systems and leading to a higher potential for implant failure. The use of the percutaneous pedicle screw and rod fixation system offers several distinct advantages over conventional pedicle screw fixation. The system eliminates the need for a large midline incision and significant paraspinous muscle dissection. Both the pedicle screws and the pre contoured rods are placed through stab incisions. The paraspinal muscles are bluntly split rather than divided, leading to shorter periods of hospitalisation and recovery[7,8,9]. Blood loss and tissue trauma are minimised. An ideal lateral-to-medical screw trajectory is much more easily accomplished, especially in larger patients, as significant paraspinous tissue retraction is avoided[10]. The aim of the study was to demonstrate

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operative techniques and preliminary experiences with percutaneous pedicle screw fixation without use of any Zig in terms of: Pain, Operative time, Radiation time, Blood loss and Post-operative complications (Infection, Post operative neurological deficit).

METHODS

It was hospital based retrospective interventional study done at the department of Orthopaedics, B.P.Koirala Institute of Health Sciences, Dharan,Nepal over a period of 2 and half years. The study enrolled 30 patients aged 18-55 years who had presented with traumatic fracture thoracic and lumbar spine. All thirty patients underwent percutaneous pedicle screw and rod fixation and successful percutaneous single/two level fusions. The followed up period ranged from 6 to 24 months. Operation time, radiation time, loss of blood, post operative pain, infection, post operative rehabilitation was evaluated to objectify possible advantages for the percutaneous operation technique. Patients were also evaluated for exposure related morbidity. patients with Stable spine injury, Degerative disc disease, Tuberculosis of spine, Spondylolisthesis and Pathological fractures were excluded from this study.

1. Operative Room set up, anaesthesia and

Patient positioning

The percutaneous posterior fixation of the dorsolumbar spine is performed under general anaesthesia. The patients were positioned prone, on top of chest and pelvic rolls with the abdomen free, knee chest position was avoided. Fluoroscopic images of the pedicles were obtained in both an AP and lateral view before proceeding. position was adjusted and securely fixed.

2. Initial Skin Incisions and Pedicle Identification and fixation.

After having a good orientation of pedicle in image intensifier in anteroposterior view a stab incision [Fig:1a,b,c] was given on the lateral border(margin) of pedicle. Soft tissues were dissected with the help of artery forceps. 1.8/2mm K-wire [Fig:1a] was used to verify the appropriate location of the pedicle. The K-wire was positioned on the skin incision directly over lateral border of the pedicle on an AP image. The needle was then pushed down till the medial border of pedicle was reached and it was confirmed on lateral view in which K-wire should just touching the posterior border of vertebra, it should not voilet the medial border of pedicle in AP image. Both AP and lateral images should confirmed that the appropriate starting place has been determined. K-wire was then removed and hole was made in the pedicle with the help of pedicle awl. Tapping was done with bone tap and pedicle screw of adequate diameter and length was put in the pedicle hole. The process was repeated for the second screw on the same side. After inserting both, the screw assemblies were made approximately of the same height and the entire process was repeated for the contra lateral side. Precontoured or contoured rods were placed on either side of screw slot by retracting skin, spine can be either compressed or distracted and finally tightening of inner screw (set screw) was done. All these procedure were performed without the help of Zig.

The final construct can then be viewed with AP and lateral fluoroscopy [Fig 3 a, b, c, d]. Closure was accomplished with a few interrupted stitches in the fascia, subcuticular skin suture and dressing was done.

Figure 1. Skin Incision and K-wire placement in pedicle under image

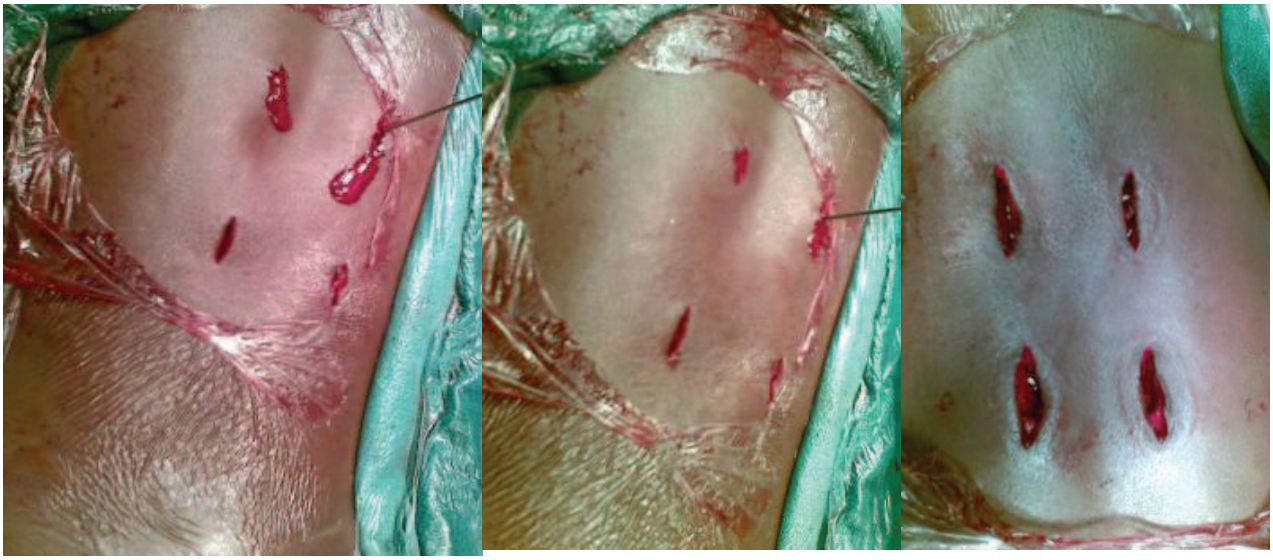


Fig:2 Pre-operative X-rays

RESULTS

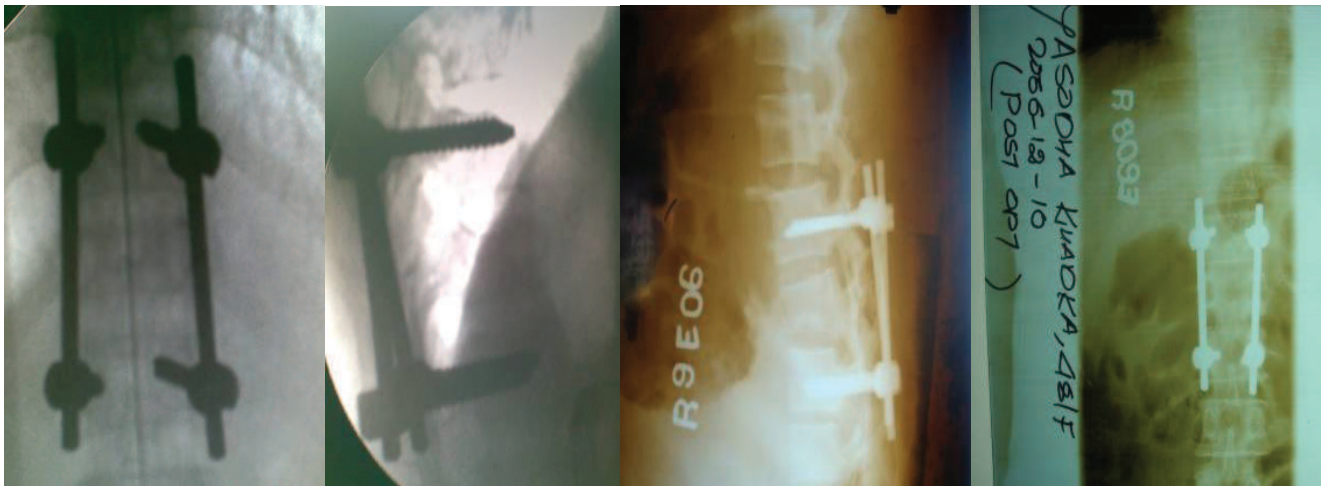
The study comprised of 25 males and 5 females. Average patient's age was 36.5 years (range: 18-55 years). The common mode of injury was fall from height, road traffic accident, physical assault, sports related injury etc. All patients were having unstable spine fracture without neurological deficit. Operation time, loss of blood, post operative pain was less in percutaneous operation. Post operative rehabilitation was easier. Intra operative exposure with radition was more in percutaneous technique in early phase of learning curve most probably due to lack of experience in part of surgeon about this new technique and unavailability of expert image technician. Spinal fusion was achieved in all patients in 6 months to 1 year time. There was no post-operative neurological deficit, infection, implant failure.

DISCUSSION

Lumbar spinal fusion was first performed by Albee[10] and Hibbs[11] in the early 1900's for the surgical management of spinal deformity related to Pott's disease. Due to its initial success, the indications for this technique were later expanded to include traumatic injuries and scoliosis.

Boucher[12] first described the pedicle screw in 1959 and Roy-Camille et al[13] reported a dorsal construct consisting of a pedicle screw and plate several years later. Spinal pedicle screw fixation has continued to undergo modifications since its inception. Its effectiveness in the management of a variety of spinal disorders has made it a mainstay in the armamentarium of most spine surgeons.

Fig:3 Post Operative x-ray



However, an undesired consequence of this technique is the iatrogenic paraspinal muscle injury that occurs during the exposure for screw placement. A number of authors\ have described the deleterious effects of the extensive muscle stripping and retraction that occur during lumbar fusion surgery [14-19].

Gejo et al[14] analysed postoperative MRI and trunk muscle strength following lumbar surgery in 80 patients. They determined that damage to the low back muscles was directly related to the muscle retraction time during surgery. The incidence of low back pain was also significantly higher in those who had long muscle retraction times.

These conclusions support the studies of Kawaguchi et al[15-16] who examined the effects of retractor pressure on the paraspinal muscles during lumbar surgery. They found that muscle injury, as demonstrated by elevated serum levels of creatine phosphokinase MM isoenzyme, is directly related to the retraction pressure and duration.

Similarly, Styf et al[17] reported that the retractor blades may in fact increase intramuscular pressure in the paraspinous muscles to ischemic levels.

Rantanen et al[18] concluded that patients with poor outcomes following lumbar surgery are more likely to have persistent pathological changes within the paravertebral muscles. Percutaneous lumbar fixation was designed, in part, to minimize the paravertebral muscle injury that occurs with conventional open procedures.

Mager[14] first reported the use of percutaneous pedicle screw combined with an external fixator in 1982. The most obvious limitation of this technique was the risk of infection, not to mention the discomfort of an external appliance. Matthews et a[15] described the use of percutaneous pedicle screws with longitudinal connectors placed under direct vision in the suprafascial, subcutaneous space. This superficial instrumentation was uncomfortable to the patient and associated with a significant non-union rate as well, perhaps secondary to the long lever arms of the hardware. The system allows for placement of percutaneous screws and rods through paramedian stab incisions. The conventional anatomic position of the construct avoids the instrumentation-related discomfort that was associated with earlier versions of percutaneous fusion.

There are several distinct advantages of the system compared to standard open lumbar pedicle fixation. The paraspinal muscles are bluntly separated rather than stripped from their attachments and are minimally retracted using a sequential dilation technique as described by Foley and smith[9] for micro endoscopic discectomy. This results in significantly less intraoperative blood loss, less iatrogenic muscle injury, and less postoperative pain.

Patients are therefore able to ambulate and mobilize much more quickly, resulting in a decreased cost[20]. From a

technical perspective, it is also easier to achieve the desired lateral to medial pedicle screw trajectory as there is not a wall of soft tissue that limits the angulation of the instruments (as can be encountered in the open surgery). This is particularly helpful in obese patients, as more extensive exposure and retraction can be avoided.

Operative time is also significantly lessened; it takes only one hour for the surgeon to place four screws and two rods.

CONCLUSION

The clinical utility of system appears promising, as our early experience suggests that the system is able to achieve the same clinical results as conventional open procedures while significantly reducing the exposure related morbidity.

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