Original Article

“NIMS technique” for minimally invasive spinal fixation using non-fenestrated pedicle screws: A technical note

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Abstract

Study Design: Case series. Objective: To reduce the cost of minimally invasive spinal fixation. Background: Minimally invasive spine (MIS) surgery is an upcoming modality of managing a multitude of spinal pathologies. However, in a resource-limited situations, using fenestrated screws (FSs) may prove very costly for patients with poor affordability. We here in describe the Nizam’s Institute of Medical Sciences (NIMS) experience of using routine non-FSs (NFSs) for transpedicular fixation by the minimally invasive way to bridge the economic gap. Materials and Methods: A total of 7 patients underwent NFS-minimally invasive spine (MIS) surgery. Male to female distribution was 6:1. The average blood loss was 50 ml and the mean operating time was 2 and 1/2 h. All patients were mobilized the very next day after confirming the position of implants on X-ray/computed tomography. Results: All 7 patients are doing well in follow-up with no complaints of a backache or fresh neurological deficits. There was no case with pedicle breach or screw pullout. The average cost of a single level fixation by FS and NFS was `1, 30,000/patient and `32,000/patient respectively ($2166 and $530, respectively). At the end of 1-year follow-up, we had two cases of screw cap loosening and with a displacement of the rod cranio-caudally in one case which was revised through the same incisions. Conclusions: Transpedicular fixation by using NFS for thoracolumbar spinal pathologies is a cost-effective extension of MIS surgery. This may extend the benefits to a lower socioeconomic group who cannot afford the cost of fenestrated screw (FS).

Key words: Cost-effective, fenestrated screws, minimally invasive, non-fenestrated screws, pedicle fixation

INTRODUCTION

Traditionally, traumatic thoracolumbar fractures are treated with open technique of spinal fixation. The open techniques of treating these pathologies have given way (in certain indications) to minimally invasive spine (MIS) surgery in recent times.
modulated.\cite{1} Periosteal pain is believed to be the most severe as the periosteum has the lowest pain threshold nerve fibers of the deep somatic structures.\cite{2,3} There has been a paradigm shift in treating these fractures through MIS surgery with less tissue damage due to direct trajectory and minimal tissue dissection and hence, minimal surgical inflammatory response (inflammatory mediators such as interleukins, cytokines, and prostaglandins) compared to conventional surgery.\cite{4} However, the cost of such instrumentation is still high and hence, MIS surgery may not be a viable option at many places in the world where cost does matter.

The background of this work is the observations made by the senior author (AR) during a minimally invasive fixation with fenestrated screws (FSs). Accidental removal of the guide wire was the basis for this serendipitous discovery/invention of new technique. We herein describe the indigenous method of spinal fixation in a minimally invasive fashion with routine pedicle screws thus, cutting down the cost of treatment enormously.

**MATERIALS AND METHODS**

All 7 patients underwent percutaneous pedicle screw fixation with non-FSs (NFS) for traumatic fractures involving thoracolumbar junction between 2011 and 2014 at our institute were included in the study. Neurological status was assessed using the classification system set forth by the American Spinal Injury Association’s (ASIA) standard neurologic classification of spinal cord injury, ranking neurologic status from A (complete neurologic injury) to E (completely neurologically intact).

**Surgical technique**

The patients were operated in prone position, rested over bolsters with padding over the pressure points and lax abdomen. The levels of surgery were marked using fluoroscopy [Figure 1]. The pedicle entry points were identified on true anteroposterior (AP) view. The skin was incised with a stab and pedicles were tapped with pedicle access kit from the lateral pedicular margin until it reached the medial margin of pedicle in AP view. The position of the tip was then confirmed on lateral view to have crossed the pedicle-body junction [Figure 2]. After confirming the same, the needle was advanced further and was threaded with a guide wire. The pedicle needle was removed keeping the guide wire in situ. The soft tissue track was dilated with serial dilators [Figure 3]. With the last dilator and guidewire in situ, the pedicle and body were tapped with FS driver of diameter 5 mm less than that of the intended screw thickness. This was done as a precautionary measure to have a tight but still negotiable track. The screwdriver and the dilator were removed and the trajectory and the angle were observed. Until this point the procedure is the same as any standard minimally invasive pedicle screw fixation. The guide wire is the removed and an NFS is threaded into the pedicle hole along the trajectory [Figure 4]. The guiding forces for correct placement of the screw without the guidewire were the fluoroscopy in lateral view and the bony tactile sensation while threading the screw (Note: The very interesting finding we noticed serendipitously was that with the narrow path created directly over the pedicle entry point, there is no place for a screw.
to go except for the path created. It is something akin to single key slot in the door which can only take in the key). We used fixed angle screws which were coded externally for the direction of the hub for rod placement. Percutaneous tunneling was done and the connecting rod en routed through the subcutaneous tunnel, using free hand technique [Figure 5]. Screw caps were placed under direct visualization. For reduction, manual pressure was applied over the affected spinous process by the assistant and the screw caps were tightened simultaneously on one side, each acting as counter-torq for the other. Postoperative X-ray/computed tomography was used to confirm the position of the hardware [Figures 6 and 7]. The radiation exposure was approximately 90 shots (2 min, 15 s) which have to be taken into account and can be reduced.

RESULTS

All the patients included in the study had suffered trauma and presented with persisting back ache even after 1-2 months post injury. There was no gross subluxation/instability noted. The mean age of presentation was 29 years. The mean body mass index was 23.5 kg/m². All patients were ASIA Grade E having wedge compression fractures of the dorsolumbar junction. They underwent bilateral non-fenestrated percutaneous pedicle screw placement (D12-3, L1-3, respectively). Patients having L1 wedge compression fracture underwent D12-L2 and D12 fracture underwent D11-L1 percutaneous transpedicular fixation, respectively. Preoperative visual analog scale (VAS) score in 60% of patients was 6, compared to postoperative VAS score of 2. All patients were mobilized the following day and mean length of hospital stay was about 4 days. No patient experienced a worsening radiculopathy or new neurological deficit that could be attributed to screw malposition. The average cost of a single level fixation by FS and NFS was ₹1, 30,000/patient and ₹32,000/patient, respectively ($2166 and $530, respectively). The postoperative hospital stay was same for both categories, and there were no major complications including wound healing. At 1-year follow-up, we had 1 patient who had loosening of the screw head and subsequent displacement of rod on one side. The wound was re-explored from the previous incisions, rods readjusted, and screw caps replaced under general anesthesia [Figure 8].

DISCUSSION

The most common site of injury to the spine is the thoracolumbar junction which is the mechanical transition junction between the rigid thoracic and the more flexible lumbar spine. The use of pedicle screw fixation has been the conventional treatment for spinal stabilization. Standard midline posterior spinal approaches have been shown to cause significant muscle morbidity resulting from iatrogenic muscle denervation (particularly with exposure lateral to the facet), increased intramuscular pressure, ischemia, and revascularization injury. All of these effects can lead to paraspinal muscular atrophy, scarring, and decreased extensor strength and endurance. Kim et al. compared trunk
muscle strength among patients treated with open posterior instrumentation versus percutaneous instrumentation. Patients undergoing percutaneous instrumentation displayed more than 50% improvement in extension strength.\(^6\) Minimally invasive fixation of the lumbar spine was first described by Magerel\(^9\) and later Lowery and Kulkarni.\(^{10}\) described a percutaneous lumbar pedicle screw fixation device using rods as longitudinal connectors. Pedicle screws engage all the three columns of spine thus providing better stability. Minimal manipulation is required to place the rods in a standard submuscular position and the need for direct visual feedback is avoided. The medial angulation is easily achieved, because extensive soft tissue and muscle retraction is avoided. Since the first documented case by Foley and Gupta.\(^{11}\) in 2002, several clinical case series using this system in traumatic fractures have been described in the literature. There has been no study until date comparing fenestrated, and NFSs and this study though limited by numbers reflects upon the path-breaking use of NFSs in MIS surgeries. The procedure is completed within minutes and the operative time, blood loss, and hospital stay are also significantly shortened. A traditional open surgery may be an overtreatment in all these cases, considering blood loss, possible complications, hospital stay, and delayed functional recovery. The surgeon relies more on his tactile sensation than imaging and the facet and transverse process junction can be easily felt intraoperatively. Once initial access through the pedicle is made, normal screws can easily follow the same trajectory. This is confirmed on fluoroscopy. The accuracy of screw placement is similar to that reported for other techniques and the disadvantages associated with standard open approaches are also reduced.\(^{12}\) Some of the advantages of this minimally invasive surgery include small skin incisions, minimal paraspinal muscle dissection, sparing the posterior elements, that is, lamina, spinous process, supraspinous ligaments, and paravertebral muscles, less intraoperative bleeding, superior postoperative muscle strength, less exposure to anesthetic drugs, quick recovery, early mobilization, and shorter hospitalization stay.

**Limitations**

Our initial experience is limited to a small number of thin patients who had undisplaced fractures who were stabilized across a vertebral body, without the requirement of bony decompression/fusion. The radiation exposure is bit high which can be brought down by consciously reducing them or by using neuronavigation (if affordable).

**CONCLUSIONS**

It may be a poorman’s alternative for open approaches or minimally invasive surgeries using regular non-fenestrated screws. The accuracy of screw placement is similar to that reported for other techniques.

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**Conflicts of interest**

There are no conflicts of interest.

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