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Original Research Paper

Full Endoscopic Trans-Kambin Trans-SAP Lumber Interbody Fusion with Expandable Cage: Our Technique with Rectangular Dilator and Experience with 32 Cases

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ABSTRACT:
Techniques in spine surgery have changed, with Endoscopic spine surgery (ESS) becoming a major surgical technique. ESS has advantages such as less soft tissue dissection and no collateral tissue damage, reduced blood loss, less epidural scarring, reduced hospital stay, and earlier functional recovery, Despite these advantages, endoscopic procedures have been a steep learning curve and is constantly evolving . Endoscopic interbody fusion is a highly effective technique for treating a variety of disorders of lumbar spine. Because the technique involves disc removal, cage placement, interbody height restoration, and intersegmental fusion, numerous pathologies can be treated, including segmental instability, mild deformity, and vertical foraminal stenosis. However, certain modifications are necessary when using endoscopic approach. Most critically, since the access is through Kambin's triangle, care must be taken to avoid injury to the exiting nerve root. In addition, because the facet removal is incomplete, the use of expandable interbody cage is generally necessary. The operating room setup typically involves a single fluoroscopic machine. An Anteroposterior (AP) endplate view of the caudal index-level vertebral body is obtained showing the endplate as a single line on fluoroscopy, and the spinous process precisely centered. For Transforaminal endoscopic lumbar interbody Fusion, the approach corridor is typically in the plane of the disc in order to reach the contralateral side as well as to place the cage appropriately. The skin incision is planned 8 to 10 cms off midline along the projection of the index-level disc space. The distance to the midline is influenced by several factors including the size of the patient, size of the facet joint, and the spinal segment treated. A 12mm transverse skin incision using a no.11 blade is made and an 12-G Tomshidi needle is advanced into the Kambin's triangle. In cases of overgrown facet joints or small foramen, a trans-superior articular process (trans-SAP) corridor may be utilized to gain access to the foraminal annular window. Advancing successive dilators over the needle/guidewire system allows for final port of 8-10 mm in diameter. Ports of larger diameter can also be used, but it increases the risk of impingement of the dorsal root ganglion of the exiting nerve root.In the setting of an interbody fusion, the patient benefits from the effects of indirect decompression. Restoring interbody disc space height can achieve both central canal decompression and bilateral neuroforaminal decompression in select cases. This beneficial effect is particularly seen in patients with spondylolisthesis. Because one of the major goals of the procedure is achieving a successful arthrodesis, the preparation of the graft site is critical. To assist with adequate disc clearance, we utilize specialized tools like disc shaver, curettes and steel brushes. We typically restore the disc height using a specially designed rectangular dilator. The endplate preparation can be inspected directly using the endoscope. After preparation of the disc space, we insert osteobilogics and intervertebral expandable cage device. The use of expandable cages can also enhance interbody height restoration and allow for the most efficient indirect decompression. Percutaneous screw placement is followed by sub-muscular rod passage to create a screw-rod construct to enhance stabilization and facilitate arthrodesis. 32 followed-up patients is given in table-1. There were 20 males and 12 females. The average age of the patients is 51 years and the mean duration of symptoms was 25.22 months. 14 patients had degenerative Grade-1 spondylolisthesis and 18 had prolapsed disc with segment instability or severe narrowing of disc space, 2 out of which had 2 level involvement. The pre-operative VAS of

6.78 decreased to 0.83 at 2 years follow-up which is statistically significant (P<0.05). The mean pre-operative ODI score decreased from 42.27 to 10.66 at 2 years follow-up which again is statistically significant (P<0.05) .Our study shows that when combined with posterior stabilization using percutaneous pedicle screws and rods, it is stable enough in avoiding intervertebral collapse and screw failure. Limitation of our study can be the smaller study group size, no control group. The rectangular dilator further facilitates the cage insertion safely without enlarging the skin incision. This technique has several advantages over the standard open or MIS techniques including paraspinal muscle trauma, better intra-operative visualization and end plate preparation, lower risk of nerve root injury, decreased blood loss, shorter ambulatory time and hospital stay and better patient acceptance. Because of constantly evolving and steep learning curve, endoscopic- Fusion is still a challenging procedure. Further scope in improvements and development of instrumentation and cage design is definitely there in future.

Keywords: Endoscopic, Trans-SAP, Lumber Interbody Fusion

INTRODUCTION:

With increased life expectancy, busy work schedules lack of exercise and many other lifestyle factors have led to increase in number of spine related diseases. Hence need for spinal surgery has grown many folds over past decade with busy lifestyle and need for early rehabilitation there is increased demand for minimally invasive spine surgery (MISS) and Endoscopic spine surgery (ESS). Concomitantly, ESS has been recognized as an important technique in spine surgery [2]. Elderly patients with spinal diseases typically have many comorbidities and medical problems, and therefore the surgeon's burden increases. ESS is now used to treat many degenerative spine diseases, including massive herniated discs and spinal stenosis [4]. With constant improvements in technology, Endoscopic Spinal Surgical procedures are gradually replacing the traditional open spinal surgeries. Numerous randomized trials (1-4) and meta-analysis (5-8) have demonstrated the effectiveness of Endoscopic Spinal Surgeries which include percutaneous endoscopic discectomies and decompression for lumbar disc herniations and lumbar canal stenosis. But with the advancements in technology and techniques, the endoscopic spinal procedures are gradually being utilized for endoscopic spinal fusion and endoscopic assisted fusion (9-10). Transforaminal trans-kambin lumbar interbody fusion is a well-established technique for spinal fusion with the advantage of restoring the disc height and thereby enlarging the neural foramen, segment stabilization, restoration of sagittal alignment with appropriate anterior load bearing besides decompressing central canal and exiting roots. Conventional open TLIF has the disadvantages of long skin incisions and muscle stripping resulting in greater blood loss, epidural fibrosis, higher chances of nerve root injuries leading to post-operative pain and morbidity. Endoscopic spinal surgeries on the other hand are less destructive cause less muscle and epidural fibrosis. Therefore are associated with least post-operative pain, better cosmesis, shorter hospital stay and faster rehabilitation. Patient is back to daily routine in lesser time leading to better quality of life (9-11). Despite these advantages, endoscopic procedures have been a steep learning curve and is a constantly evolving .In most full endoscopic spinal fusion studies (15-16), the cage is inserted over the guide wire alone without any tubular retractor to protect the tissues and the exiting nerve root. In our study, we primarily focused on Full Endoscopic Transforaminal Lumbar Inter-body Fusion through Kambin's triangle utilizing a specially Designed rectangular Dilator with similar approach to percutaneous endoscopic transforaminal discectomy. This rectangular Dilator creates the required space for smooth insertion of the cage without collateral tissue damage.

MATERIALS AND METHODS:

To carry out full endoscopic-Fusion, first the foramen is prepared, spinal canal is decompressed followed by disc removal .Preparation of the end plate is done endoscopically and then the fusion cage is inserted through the Trans SAP or Trans-kambin approach under fluoroscopy and confirmed endoscopically. Percutaneous placement of the screws and rods are done afterwards under fluoroscopy.

32 patients were treated with endoscopic Trans-Kambin, trans-SAP approach. And were followed up for a period of 2 years. Patients with segmental instability in addition to lumbar disc prolapse or severe disc space narrowing and patients with degenerative spondylolis thesis with radicular symptoms were included in the study. Patients with severe osteoporosis, revision surgery, with other pathologies like infection and tumors or having more than 3 segment involvement were excluded from the study. The patients were evaluated for baseline demographics, operative time, incision length, intra-operative blood loss, peri-operative complications, length of hospital stay and post-operative ambulatory time. Clinical evaluation was done using Visual analog scale (VAS) pre-operatively, immediately after surgery, at 6 months and at 1 and 2 years follow-up, with Oswestry disability index (17) (ODI) scores pre-

operatively, at 6 months, 1 year and 2 years. Paired t-test was done to compare the clinical outcome.

PROCEDURE:

The patients were placed in prone position on spinal table attachment with abdomen free and C-arm placed on the opposite side of planned approach. An Anteroposterior (AP) endplate view of the caudal index-level vertebral body is obtained showing the endplate as a single line on fluoroscopy, and the spinous process precisely centered. For Transforaminal endoscopic lumbar interbody Fusion, the approach corridor is typically in the plane of the disc in order to reach the contralateral side as well as to place the cage appropriately. The skin incision is planned 8 to 10 cms off midline along the projection of the index-level disc space. The distance to the midline is influenced by several factors including the size of the patient, size of the facet joint, and the spinal segment treated. A 12mm transverse skin incision using a no.11 blade is made and an 12-G Tomshidi needle is advanced into the Kambin's triangle. In cases of overgrown facet joints or small foramen, a trans-superior articular process (trans-SAP) corridor may be utilized to gain access to the foraminal annular window. Advancing successive dilators over the needle/guidewire system allows for final port of 10-12 mm in diameter. Ports of larger diameter can also be used, but it increases the risk of impingement of the dorsal root ganglion of the exiting nerve root. The 2mm guide wire is inserted through the needle after removing the stylus. Sequential tissue dilation is done and working cannula inserted. A controlled for aminotomy through trans-SAP approach is done using bone reamers or burr taking care not to cross medial pedicular line under fluoroscopy. This aids in enlargement of neural foramen to create space for the final implant. The annulus is opened using annular cutter and a primary discectomy done. The end plates are prepared endoscopically by shaver and curettes. The endoscope is retracted and rotated to inspect the foramen and exiting nerve root followed by inspection and decompression of the extra-foraminal region. The guide wire is re-inserted under direct visualization of endoscope followed by removal of endoscope. The rectangular dilator is inserted over the guide wire. Position of the dilator is confirmed under fluoroscopy. Size of cage is determined by utilizing the dimensions of rectangular dilator. The cage and disc space is then stuffed with osteobilogics and expandable cage is mounted on the cage inserter. Over the rectangular dilator 12 mm cannula is inserted as close to the prepared disc space and kept in that position before removal of the rectangular Dilator. Cage inserter along with cage is advanced through the 12 mm cannula and hammered into the place under AP and Lateral fluoroscopic control, the final position being in the center of disc space in AP and Lateral X-ray views. The cage inserter is unscrewed and removed. The endoscope is re-inserted and cage placement viewed. Any remaining residual tissue is removed and exiting and traversing roots visualized for complete decompression. Cage position again checked under fluoroscopy and the working 12 mm cannula is removed. The pedicle screws are inserted under fluoroscopy in routine manner. Appropriate sizes rods inserted and tightened. Pedicle screws are occasionally placed prior to the endoscopic cage insertion in selective patients with spondylolis thesis where reducing the vertebrae to anatomical alignment is deemed difficult. Patients are discharged the next day and are encouraged to perform light activities with lumbar orthosis for first 6 weeks and gradually resuming day to day activities over 6 weeks post-operatively. Heavy and excessive work is prohibited for first 3 months after the surgery.

RESULTS:

Table –I Gender of Patients

Male	20	62.6%
Female	12	37.4%
Total	32	

Table –II Age of Patients

01-25yrs	2
25-50yrs	7
50-75yrs	5
>75	4

Image1

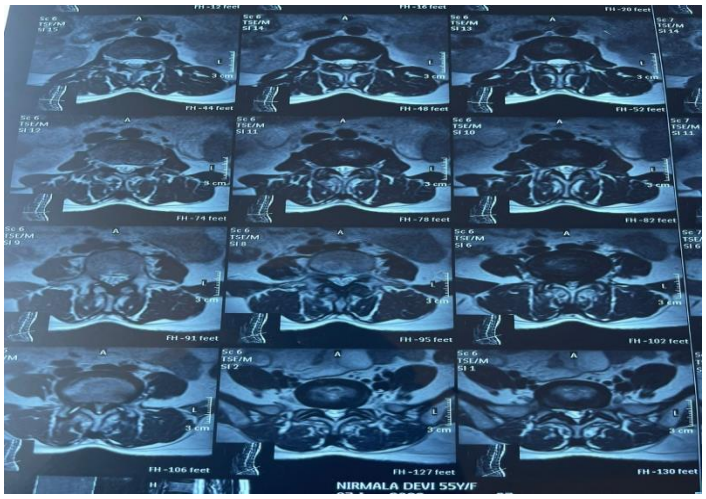


IMAGE-2

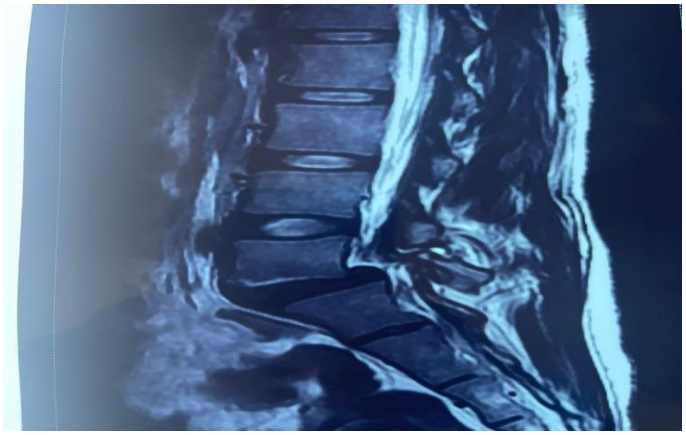
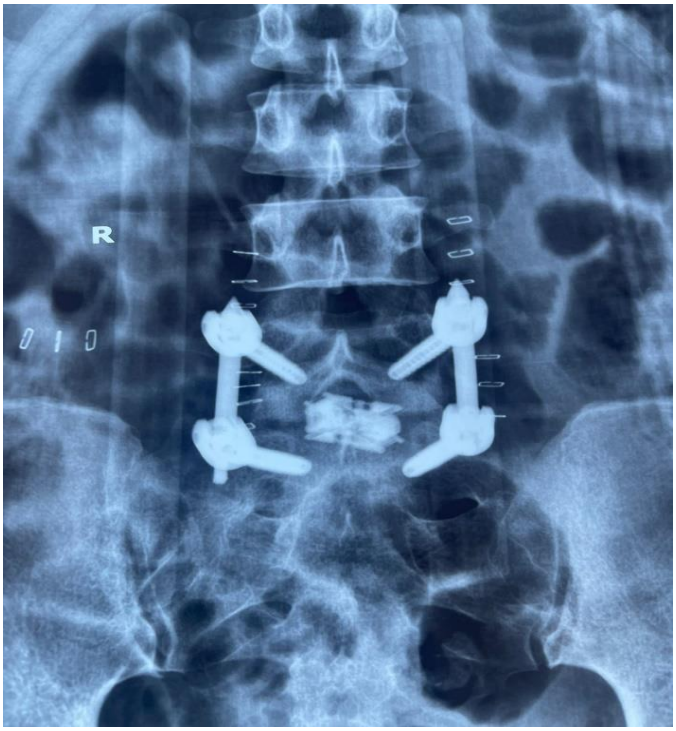


Image-3



The baseline and demographic characteristics of the 32 followed-up patients is given in table-1. There were 20 males and 12 females. The average age of the patients is 51 years and the mean duration of symptoms was 25.22 months. 14 patients had degenerative Grade-1 spondylolisthesis and 18 had prolapsed disc with segment instability or severe narrowing of disc space, 2 out of which had 2 level involvement. Two patients underwent 2 level endoscopic Trans-SAP TLIF and all others underwent single level surgery. All patients showed improvement in neurological symptoms immediately after surgery which persisted during the further follow-up. The mean operative time was 102.18 (92-113) minutes for single level surgery and 162.5 minutes for 2 level surgery. Mean intra-operative blood loss was 70 (60-90) ml and 125ml for 2 levels. The mean time to ambulation was 20.5 hours. All patients showed bony fusion at 2-year follow-up. No loosening of screws, rod breakage, or other implant failure was found during postoperative follow-ups. The pre-operative and post-operative clinical assessment was done and compared at 1 year and 2 years of follow-up. The pre-operative VAS of 6.78 decreased to 0.83 at 2 years follow-up which is statistically significant ($P<0.05$). The mean pre-operative ODI score decreased from 42.27 to 10.66 at 2 years follow-up which again is statistically significant ($P<0.05$).

DISCUSSION:

Endoscopic-Fusion is a newer evolving technique which is traditionally done through Kambin's triangle. The working area is approached percutaneously through sequential dilation of the tissues, thereby minimizing trauma to muscles. It involves very less bone removal as compared to open and even MIS-TLIF, therefore offers the advantages of being less invasive, less blood loss, early recovery and shorter duration of hospital stay, and the possibility of performing the surgery under local anesthesia (13, 18, 19). In our study, we demonstrated our clinical experience with 32 patients treated with endoscopic-Fusion under regional anesthesia and followed-up for 2 years post-surgery. Additionally, we used a specially-designed rectangular Dilator for safe insertion of the cage thereby further decreasing the risk of muscle and exiting nerve root injury. Choi et al in their study found that the mean distance between the exiting root and the anterior border of facet joint was less than 2mm at the upper disc margin and less than 7mm at the lower margin of the disc (20).We therefore routinely performed the partial facetectomy of the SAP (Trans-SAP approach) to create sufficient working space. Few other studies have reported technique and results of endoscopic-Fusion with significant advantages to open or MIS techniques (13 ,14, 18 ,19, 21, 22). In these studies, the cage is inserted over the guide wire under fluoroscopy without any working tube putting the tissues and exiting nerve at risk of injury. We in our technique are using a specially designed rectangular Dilator which protects the tissues during cage insertion without enlarging the skin incision. The mean skin incision in our study was 15mm. Shunwu F et, al in their study of posterior MIS-TLIF reported an incision of 30mm, mean time for ambulation after surgery was 3.2 days and an average of 9.3 days of hospital stay (23). In our study, the mean operative time was 102.18 minutes, all patients were made ambulatory the next day (mean ambulation time being 20.5 hours) and the mean intra-operative blood loss was 70ml. So, our study like other studies involving endoscopic-Fusion demonstrated the similar benefits offered by the endoscopic techniques. Additionally, in our study no post-operative worsening of neurological symptoms or fresh neural injury was reported, thus, indicating the specially designed rectangular Dilator provides additional safety while inserting the cage. In our study, the mean operative time for a single level fusion was 90.18 minutes which is lower than most other studies indicating that the working tube facilitates the surgical procedure, thus further decreasing the operating time. Approaching through Kambin's triangle we avoid exposing central dura or intra-abdominal dissection. So, in our study, no general post-operative complications including DVT, pulmonary embolism, CSF leak or post-operative hematoma were observed. In our study, we used an 8mm Expandable interbody fusion cage (which can expand up to 12mm) in all cases under fluoroscopic and endoscopic monitoring. No cage migration was observed at 2 years follow-up. The fusion rate of 100% was achieved as all 32 patients demonstrated bony fusion at 2 years follow-up. Thus, our study indicated that the use of Expandable cage in endoscopic-Fusion is an effective method of treatment. The percutaneous pedicle screws further add to the vertebral stability (24, 25). A larger cage having a larger weight bearing surface can reduce the load on the pedicle screws by sharing the weight across the endplates, thereby increasing vertebral stability. Narrow cage on the other hand cannot share excessive stress across the fused segment which may cause endplate collapse putting more stress on the posterior fixation system. This stress if exceeds the maximum limit can lead to the failure of posterior fixation (26). Controversy still remains regarding the smallest acceptable width of the fusion cage for effective lumbar inter-body fusion. Fogel et al (27) in their study could use a 9mm single fusion cage in some of their patients due to limited working space and demonstrated good results when combined with pedicle screw fixation. Considering the physical characteristics of Indian

population, we used 8mm expandable cage which on expansion goes to 12mm. This Expandable fusion cage is suitable for endoscopic implantation. And our study shows that when combined with posterior stabilization using percutaneous pedicle screws and rods, it is stable enough in avoiding intervertebral collapse and screw failure. Limitation of our study can be the smaller study group size, no control group. Multicenter prospective studies of similar fashion can address this issue.

CONCLUSIONS:

Endoscopic-Fusion utilizing an Expandable fusion cage combined with posterior stabilization is an effective and feasible technique. The rectangular Dilator further facilitates the cage insertion safely without enlarging the skin incision. This technique has several advantages over the standard open or MIS techniques including paraspinal muscle trauma, better intra-operative visualization and end plate preparation, lower risk of nerve root injury, decreased blood loss, shorter ambulatory time and hospital stay and better patient acceptance. Because of constantly evolving and steep learning curve, endoscopic-Fusion is still a challenging procedure. Further scope in improvements and development of instrumentation and cage design is definitely there in future. Further studies with larger sample size and longer follow-up will help in further determining advantages, disadvantages and improvements needed in the technique.

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