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ORIGINAL ARTICLE

Minimally Invasive Intermuscular Pedicle Screw Fixation Approach in Management of Lumbar Spondylolithesiss

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ABSTRACT

Background: A More elegant muscle-preserving procedures have been developed aiming to minimize soft tissues trauma and preserve neurovascular bundle, In contrast to conventional traditional subperiosteal procedures , intermuscular techniques create a working corridor to perform a various decompression, instrumentation, and bony fusion procedures while minimizing dissection of muscles and keeping neurovascular and tendon integrity. The aim of this work was evaluation of intermuscular pedicle screw fixation approach in treatment of lumbar spondylolithesiss.

Methods: A prospective study design that was carried out in Zagazig University Hospitals, Neurosurgery Department from 2019 to 2023. The sample size was 30 patients with lumbar spondylolithesiss attending the out-patient clinic and will be treated surgically by using intermuscular pedicle screw fixation and fusion approach.

Results: Intermuscular pedicle screw fixation procedure , has proved to be a technique with a high accuracy and reliability, with results comparable to those reported in studies with the classical conventional lumbar fixation regarding to the clinical condition,marked reduction of vas score(back) preoperative (6.3±1)and postoperative(2.53±0.9) and 6 months follow up(1.07±1)scores but superior with regard to less muscle injuiry and damage as no statistically significant difference between pre op cross section area of multifidus muscle (1085,6 ± 260.2) and post op (982.6 ± 212.4) p>.oo5 .

Conclusions: Intermuscular pedicle screw fixation procedure is a valid technique, safe corridor, and effective procedure for lumbar spondylolithesiss.

Keywords: IM Intermuscular MISS Minimal invasive spine surgery,

INTRODUCTION

Spondylolisthesis defines as a forward displacement of the vertebral body above in reference to the underlying adjacent vertebral body, making segmental instability, that usually occurs in the mid lumbar spine and lumbosacral junction. Once surgery is indicated, the open procedure with lumbar pedicle screw is the standard technique. Recently, minimally-invasive technique aiming minimalism can be applied [1,2].

Spinal fusion term(spondylodesis), is a surgical technique that joins two or more vertebrae. There are many forms of spinal fusion and each technique include either using bone graft(from patient himself) or artificial bone substance to help bones heal together (through osteo induction and conduction with mechanichal support). Additional hardware instruments (screws, cages or plates) is often used to keep the bones in place while the bone graft fuses the two vertebrae together [1,2]. . The standard surgical approach to the thoracolumbar spine involves subperiosteal multifidus muscle stripping and retraction of the soft tissues to access the neural elements and vertebrae . [1,2]. This commonly used technique is safe and effective and requires a little knowledge of the anatomy of the back soft tissues.However, this corridor leads to unintended disruption of the facet joints and neurovasculature of the soft tissues contributing to muscular atrophy and devitalization[1,2]. .More elegant muscle-sparing procedures have been developed aiming to minimize trauma to the soft

tissues. After Watkins in 1959 1st description of the paraspinal surgical corridor for posterolateral lumbar fusion, techniques and approaches were developed to use the normal natural avascular planes through or between large muscle groups to access the different lumbar spine structures[3,4]. .Enthusiasm for these techniques has been driven aiming to achieve the same surgical objectives as the open conventional midline exposures but with the advantage of preserving lumbar muscle function and improving clinical outcome. In contrast to subperiosteal approaches, the intermuscular techniques create a working corridor for performing various neural decompression technique, instrumentation, and spinal fusion while minimizing muscle dissection and preserving tendon integrity and neurovascular structures[3,4]. All this procedures aiming to minimalism which defined as To do what is needed Harm minimising ,Improve clinical outcomes andtissue preservation[3,4]. Surgical anatomy:Exploration of the of the major posterior lumbar muscules anatomy shows a high complex architecture and structure of complex muscles groups and associated other neurovascular structures[5,6]. The major groups of the lumbar spine can be divided into two major groups (anterior and posterior groups) divided by an imaginary plane that connect both transverse processes. The ant muscle group consists of both quadratus lumborum and psoas major muscles. [5,6].The posterior musculature group comprises 2 major muscle fascicles: the multifidus medially and the erector spinae complex located laterally (Fig. 1). The multifidus muscle is a complex arrangement of muscle fibers with multiple origins and insertions. They arise from the spinous process and adjacent lamina and radiate caudally in an oblique direction to be inserted on the superior articular processes of level or multiple below.This unique pathway help to be amajor dynamic stabilizing factor[5,6]. The erector spinae complex includes both the lumbar part of iliocostalis and longissimus muscles, which arise from the transverse and accessory processes respectively, radiating dorsally to be inserted on the superomedial part of the iliac crest. The neurovascular structures shows a segmental anatomy, passing along the transverse processes of same level and superior facets. This provides a normal natural avascular plane of separation between these two muscle groups, which allows a more dissection to the lateral aspect of facet joint and the transverse process[5,6].

Each muscle have a discrete neurovascular supply. The pars interarticularis artery course just medial to the intertransversarius muscle groups. Intermuscular spaces identification through different lumbar paraspinal muscles is critically an important issue for the use of paramedian intermusclar-splitting corridor to the lumbar spine structues. As such, it is very important to identify the intermuscular spaces within the different lumbar paraspinal muscle groups by utilizing recent different medical imaging techniques like computed tomography (CT) and magnetic resonance imaging (MRI) (Fig. 2) [5,6]. Transforaminal surgical corridor has been -from along time- evolved from just an intradiscal procedure to be a true foraminal and extra-foraminal epidural procedure where both a targeted aggressive discectomy and further cage insertion and bony fusion and foraminal decompression can be achieved . Triangular working zone (kambin triangle). Medially : facet joint, triangular working zone,Superiorly : The exiting nerve root and neural foramen.Inferiorly : The transverse process [5,6].

METHODS

This study was interventional study **(prospective study)** carried out in Zagazig University Hospitals, Neurosurgery Department during the year from 2019 to 2023.The sample size will be 30 patients with lumbar spondylolithesiss will be treated surgically using intermuscular pedicle screw fixation and fusion**. Inclusion criteria:** Age of patients (middle aged),Patients with lumbar spondylolithesiss evident by clinical presentation and neuro-radiological images.**Exclusion criteria:** Patients older than 60 years old age. Patients with spondylodiscitis .Malignancy **and** Patients with psychological affections**. .**

Surgical procedure:

The patient is positioned prone on the operating table, with the aid of fluoroscopic help to determine the spinal level [7,8]. Skin Incision either a single midline skin incision can be used or a Paired skin incisions equidistant from the midline are used[7,8].Dorsal lumbar fascia incision: Either divided horizontally or vertically Fig (3): After skin incision and dorsolumbar fascia exposure. Inter muscular splitting with a careful blunt dissection by a finger, dissector, or speculum[7,8]. Fig (4): Inter muscular spilitting and dissection.Identification of bony landmarks:Under operating microscope or loupe magnification and headlight, the muscular attachments are freed from the bones, and then intertransverse ligament is incised.Exposure:Either lateral or medial exposure[7,8]. Pedicle screw insertion:An optimal screw entry point is usually close to the rostral margin of the accessory process and just

lateral to the mammilloaccessory notch.Insertion of a pedicle screw from this point reduces the risk of muscle insertions and facet joint compromization. In addition, it minimizes the risk of disrupting the medial dorsal ramus branch of the nerve where it traverses the mammilloaccessory notch [7,8]. Placement of the screw-rod construct: The rod is placed along the screw heads such that the rod lieswithin the intermuscular plane, followed by distraction between the pedicular screws [7,8]. Identification of working zone:Total lateral facetectomy is performed by Kerrison rongeur. Excision of SAP also done.The exiting root is then mobilized lat and superiorly to gain better visualization and wider safe working field [7,8]. Far Lat Discectomy and Fusion: Aggressive far lat discectomy is done to prepare intervertebral disc space for fusion with both bone graft and interbody cage insertion. Fig (5): Identification of exiting nerve root, discectomy, pedicle screw and cage insertion.Closure:Finally closure of the dorsolumbar fascia. The skin can be closed by an intracutaneously dissolving stitches tightly [7,8]. All patients will be followed up for at least 6 months. The patients will be monitored in the post operative period for the following:Clinical follow up: Back pain (visual pain analogue), sciatica improvement (visual pain analogue) . Neurological examination, return to work and performance ,hospital stay and ODI . Image follow up: MRI scan and plain lumbosacral x-ray.

Statistical analysis

Data were tested and evaluated using SPSS (Microsoft Excel software. Inc., Chicago, Illinois, USA), version 23 for data processing. Qualitative variables were stated as number and percentage, whereas quantitative data were stated as mean ±SD. The comparison was done using Wilcoxon signed-rank test to check paired data before and after a time and $\chi 2$ test to explain the association between row and column variables. P value of < 0.05 indicates significant results.

RESULTS

Vas back score and follow up: There is a significant difference regarding clinical evaluation between both preoperative , postoperative and 6 months follow up scores in all patients **(Table 1).**

Operative data: Including operative duration and blood loss **(Table 2).**

Comparative results: Regarding clinical outcome (performance and quality of life) There is a significant difference regarding clinical outcome (ODI score) **(Table 3).**

Table (1) Comparative results regarding Vas back score and follow up

	Intermuscular approach Group(n=30)				
	pre – operative	**Post -operative**	**After three months**	**After six months**	**P**
Back VAS					
Mean ±SD (minimum-maximum)	5.3±1 (4-6)	2.53±0.9 (2-4)	2±0 (2-2)	1.07±1 (0-2)	0.0001(S)
Leg VAS					
Mean ±SD (minimum-maximum)	7.2±1 (6-8)	1.73±1.3 (0-4)	1.07±1 (0-2)	0.27±0.7 (0-2)	0.00001(S)

Table (2) Statistics of operative data

	Intermuscular approach Group(n.=30)
Operative_Duration per minute Mean ±SD (minimum- maximum)	68±27 (40-130)
Operative_Blood_Loss per cc Mean ±SD (minimum- maximum)	82.9±41 (40-180)

Table (3) Comparative results regarding clinical outcome (performance and quality of life)

	Intermuscular approach Group(n.=30)			P
	pre - operative	**Post - operative**	**After six months**	0.0001(S)
ODI				
Mean ±SD (minimum-maximum)	66.7±13 (40-80)	20.7±6 (10-30)	12±8.6 (0-30)	

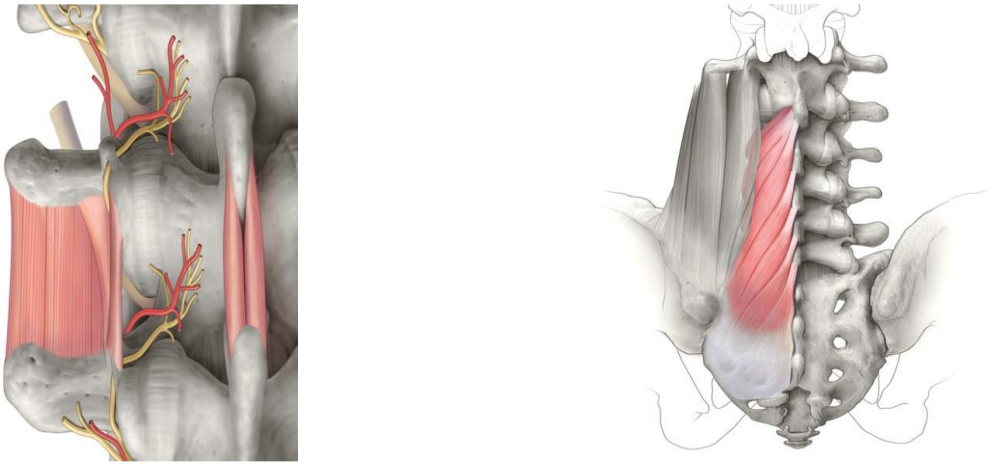

Fig (1): Anatomical landmarks of back muscles and neurovascular structure

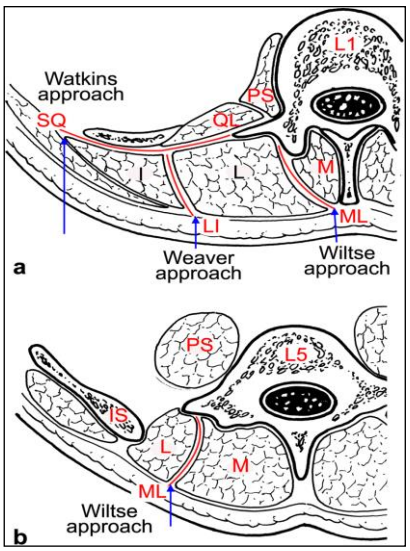

Fig (2): diagram of different intermuscular spaces

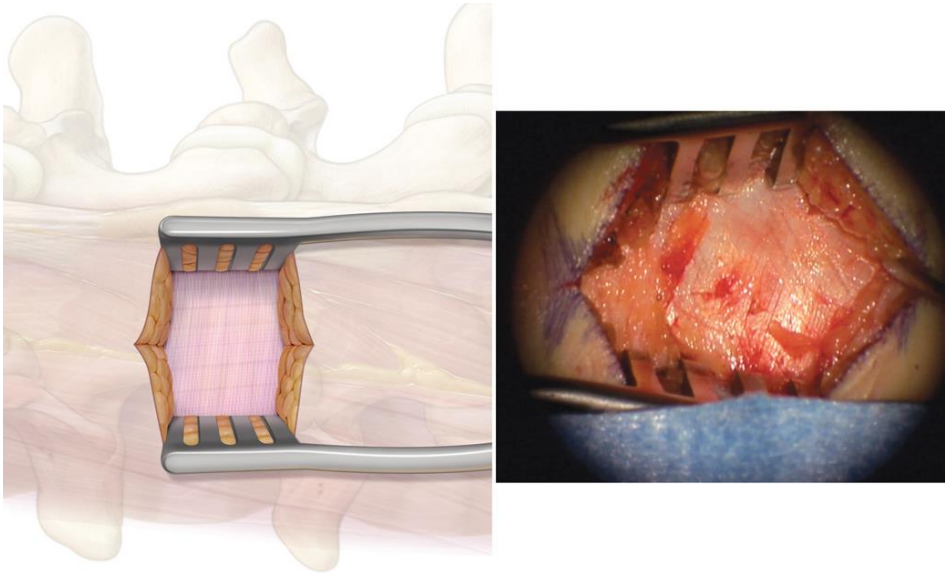

Fig (3): After skin incision and dorsolumbar fascia exposure

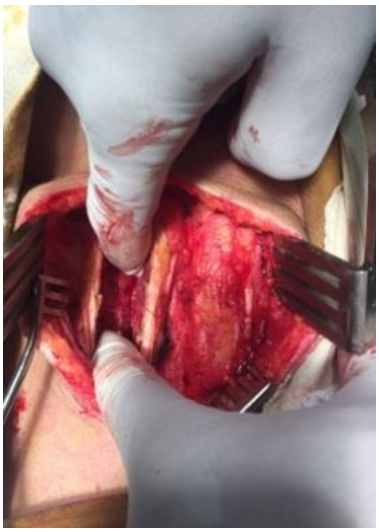

fig (4):inter muscular spilitting and dissection

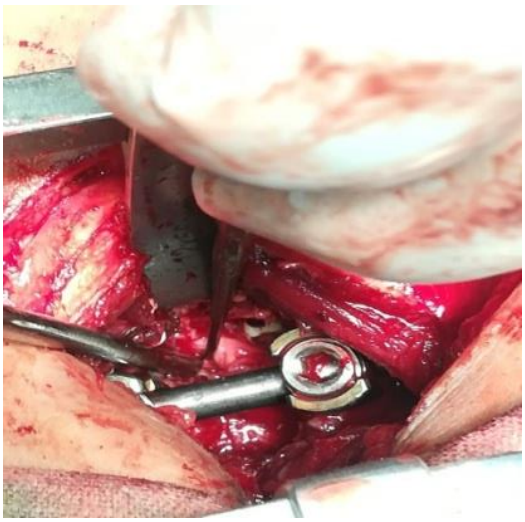

Fig (s1):identification of exiting nerve root, discectomy, pedicle screw and cage insertion

DISCUSSION

The conventional posterior approach is considered to be the classical usual method for thoracolumbar spine fixation with a satisfactory clinical outcomes. However, the traditional approach damages the multifidus muscle bound, which of course affects the muscles function and limit the waist torsion, leaving the patient have a difficult to stand alone and so increasing the risk of other complication reducing the surgical outcome especially pain relief and return to work [9, 10]. *Regarding the postoperative clinical evaluation(Vas score back):*We find a significant difference between both preoperative (6.3±1)and postoperative(2.53±0.9) and 6 months follow up(1.07±1)scores in all patients, Anand 2007 show that it was (9,3,2) respectively which matching with our results. *Regarding the* pre and post-oprative multifidus muscle cross-sectional areas*:*We find that no statistical difference between pre op cross section area of multifidus muscle (1085,6 ± 260.2) and post op (982.6 ± 212.4)which can be explained by lack of subperiosteal muscle splitting, dissection which preserve the muscle. These results are in agreement with Kim et al. [11] who documented that the pre and post-oprative multifidus muscle cross-sectional areas (1058.6 ± 274.4) and (929.8± 254.0) respectively revealed no statistically significant differences in the intermuscular plane techniques group, in contrast to the conventional usual posterior group (1162.4 &634.6), muscle atrophy was obviously significant. And so, minimally invasive

procedures have been widely used in spinal surgery aiming targeting and preservation[11]. Behairy [7] assumed that pedicle screw fixation produces a good and firm fixation device by using intermuscular approach. This plane is an oblique one which leads to the correct trajectory for appropriate insertion of screws and avoids nerve injury. It reduces hospital stay, ensures an earlier ambulation and reduces markedly the postoperative back pain and so improves the clinical outcome [7].

CONCLUSIONS

Intermuscular pedicle screw fixation approach in appropriate cases should be an optional surgical procedure and technique which can achieve a favorable outcome (pain free status) in management of lumbar spondylolithesiss .Benefits:The least amount of tissue trauma, faster recovery and faster return to work. No much more bony resection, no extensive neural tissue retraction, no epidural adhesion or fibrosiss. A wide access to lateral foraminal region and doesn't burn any bridges for future revision once needed.

Limitations: Limited access to midline the canal, difficult to excise the far sequestrated disc and anatomical barriers

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Conflict of interest: None.

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