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ORIGINAL ARTICLE

Operative Outcomes of minimally invasive trans-foraminal lumbar interbody fusion in treatment of degenerative lumbosacral spine diseases

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ABSTRACT

Keyword: Minimally Invasive Trans-foraminal Lumbar Interbody Fusion, MI-TLIF, Failed back surgery syndrome.

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Background: Degenerative lumbar spine disease is one of the most prevalent disease. The treatment available can relieve radicular symptoms but it has limited potential in relieving back pain. **Objective**: to evaluate the operative outcomes of MI-TLIF in treatment of degenerative lumbosacral spine diseases. **Methods**: This is a prospective interventional study conducted on patients presented to Aswan university hospital with any of the degenerative lumbosacral spine diseases. **Results**: we included 30 participants with mean age 55 ± 8 years, of them 18 were males and about 50% of participants didn't have any comorbidities. The mean operative time was 152 ± 23 minutes, the mean C-arm duration was 213 ± 29 seconds while the mean essential blood loss was 199 ± 108 ml. The only operative complication was two cases with Dural tear and another case had both root injury and Dural tear. **Conclusion**: MI-TLIF is a reliable and effective surgical technique, with reasonable operative duration, and low incidence of complications.

INTRODUCTION

Degenerative lumbar spine disease is a prevalent disease with a prevalence of 30% (1). Symptomatology of this disease categorized into low back pain, radicular symptoms in the lower extremities and in some cases neurogenic claudication. Whereas radicular symptoms can be relieved by decompression, discectomy or laminectomy at the appropriate location, these techniques have limited potential in relieving back pain. (2)

The evolution of the spinal fusion procedures has seen remarkable development in the last century which includes: ALIF (Anterior Lumbar Interbody Fusion) by Burs (3), PLIF (Posterior Lumbar Interbody Fusion) by Cloward (4), pedicle screws by Roy-Camille (1970) and TLIF (Trans-foraminal Lumbar Interbody Fusion) by harms and Rolinger. (5)

Although the goals of all lumbar fusion surgeries whether open or minimally-invasive- remain the same: i) Adequate neural decompression, ii) Restoring spinal alignment and iii) Preventing abnormal motion with fusion, but excellent results were obtained with open TLIF. However, there was significant morbidity seen due to soft tissue and muscle injury that occurs with subperiosteal paraspinal muscle stripping and prolonged retractor application. (6)

The unique set of symptoms attributed to the deleterious effect of surgical exposure in posterior spinal fusion procedures came to be known as "the fusion disease" and manifested as postoperative back pain, delayed recovery and ambulation, decrease trunk muscle strength and poorer long term outcomes (7). Aiming to provide a better or at least non-inferiority results, MI-TLIF was described by Foley. (8)(9)

The current study aims to evaluate the operative outcomes including operative time, C-arm duration, essential blood loss and operative complications of Minimally Invasive Trans-foraminal Lumbar Interbody Fusion (MI-TLIF) in treatment of degenerative lumbosacral spine diseases presented to Aswan university hospital during the period between January 2021 to January 2022.

PATIENTS AND METHODS

This is a prospective case series interventional study conducted on 30 patients presented to outpatient clinic with any of the degenerative lumbosacral spine diseases.

The study included patients with Degenerative disc disease, Recurrent disc herniation, Low grade spondylolisthesis (Grade1 and 2), post-laminectomy instability or Trauma requiring interbody fusion. No specific age or gender is included.

Patients without clinical fracture signs or coincident pathologies which had to be treated primarily, who revealed severe osteoporosis, distorted anatomy, major vertebral deformities or with contraindications for procedures at spine region as Coagulation disturbances were excluded.

Patients were identified and demographic characteristics such as age, gender, smoking, duration of symptoms and location of the diseased segments were collected. Radiological investigations such as antero-posterior, lateral X-rays and dynamic view radiographs are done to visualize the anatomical location of affected segment. Computed Tomography (CT) was done to confirm the diagnosis and to evaluate facet joints. Also, MRI was done to demonstrate the correct location of affected segment and detecting concomitant diseases.

Operative Work Up: Patients are positioned prone on a radiolucent frame table after induction with general anesthesia. Then ensure that the abdomen is hanging free to avoid engorgement of epidural venous plexuses. The patient is then prepared and draped. A Small 2-3cm paramedian skin incisions was done under C-arm guidance, just lateral to the lateral border of the pedicles typically 5 cm from the midline. The incision was carried further down through the subcutaneous tissue and the underlying fascia. The planes are split further to create a" surgical corridor" for percutaneous screw insertion **Error! Reference source not found.**.

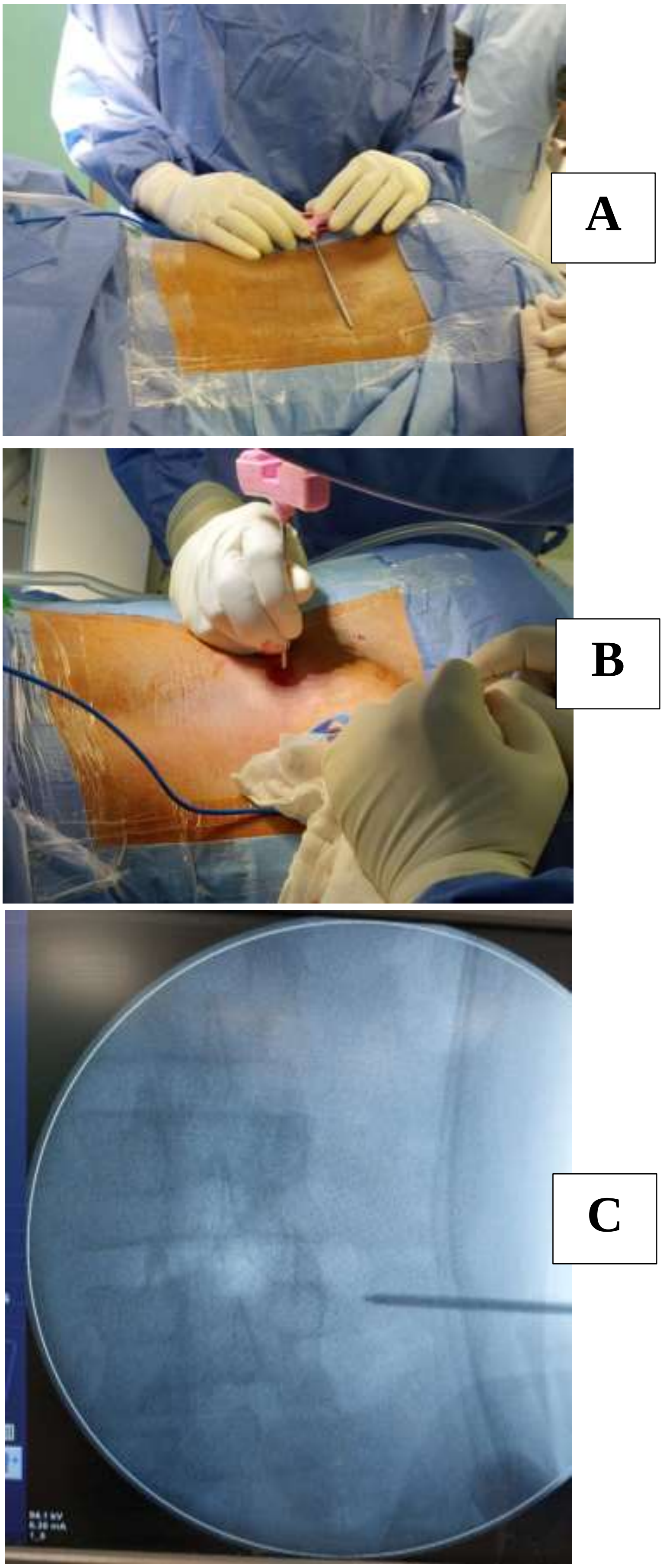

Figure 1: Incision and localization: A) localization, B) incision, C) C-arm image after introduction of the probe

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Jamshidi needles are inserted through these ‘corridors’ and parked at the junction of the transverse process and superior facet. Fine adjustments of the needle position are made under AP fluoroscopy guidance. Each needle is advanced roughly 2 cm inside the pedicle taking care not to pass beyond the medial border of the pedicle projection on AP fluoroscopy. Following this, the trocar from the Jamshidi needle is taken out and a guidewire is inserted through the needle. The Jamshidi needle is removed while holding the guidewire in place. Sequential dilators follow the guidewire and finally the percutaneous pedicle screw, loaded with long, radiolucent soft tissue retractors are inserted over the guidewire with or without prior tapping. Next, a pre-contoured rod of appropriate size in inserted, typically on the side opposite to that of patient's radicular symptoms. Using a special insertion handle, the rod is inserted underneath the fascia from the end where the pedicle head is closer to the skin (the cranial end). **Error! Reference source not found.**

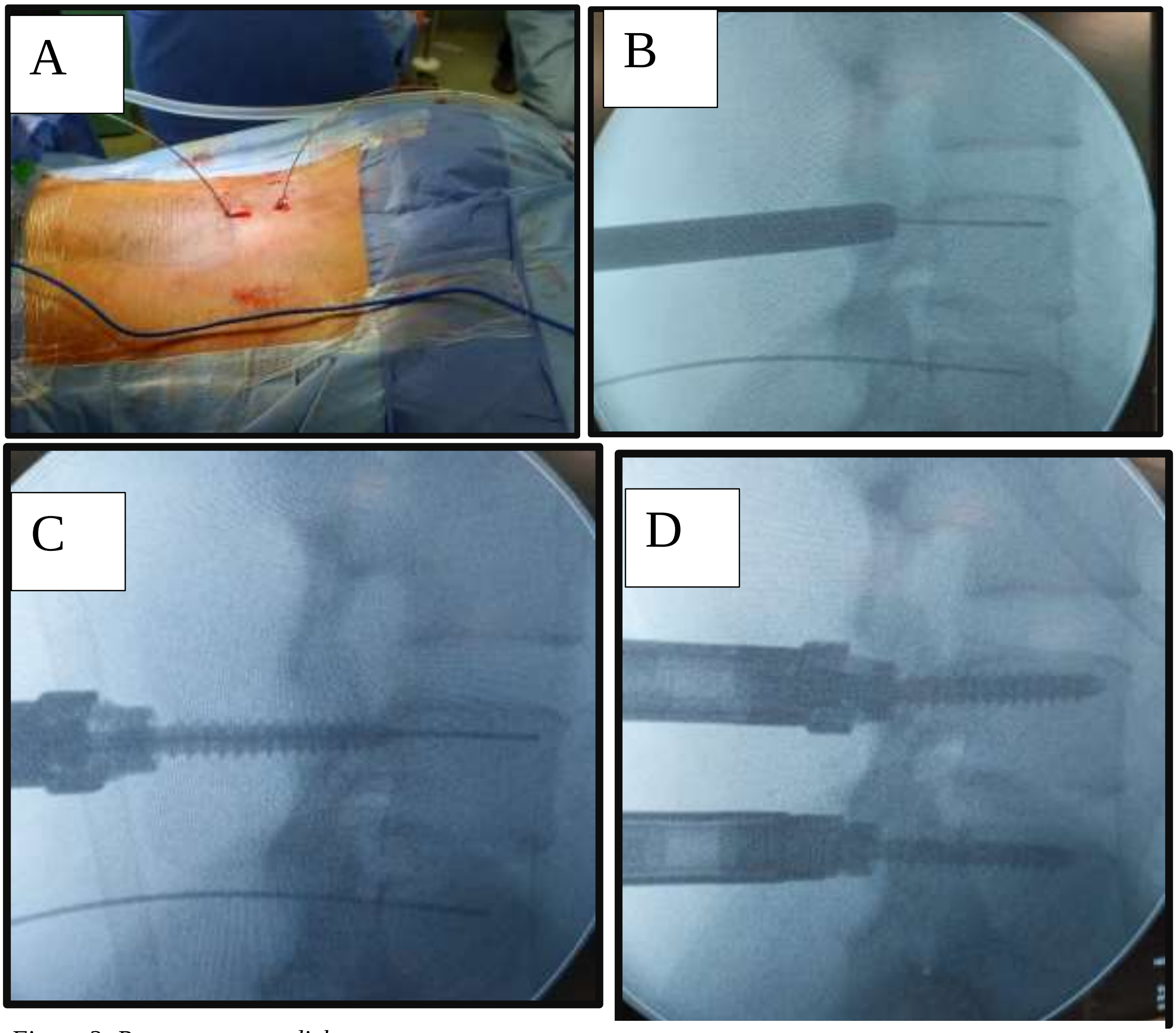

Figure 2: Percutaneous pedicle screw

A: inserting trans-pedicle guide wire. B: sequential dilatation of soft tissue
C: inserting the proximal screw D: inserting the distal screw

Before proceeding to resection of bone, temporary distraction is done over the contralateral

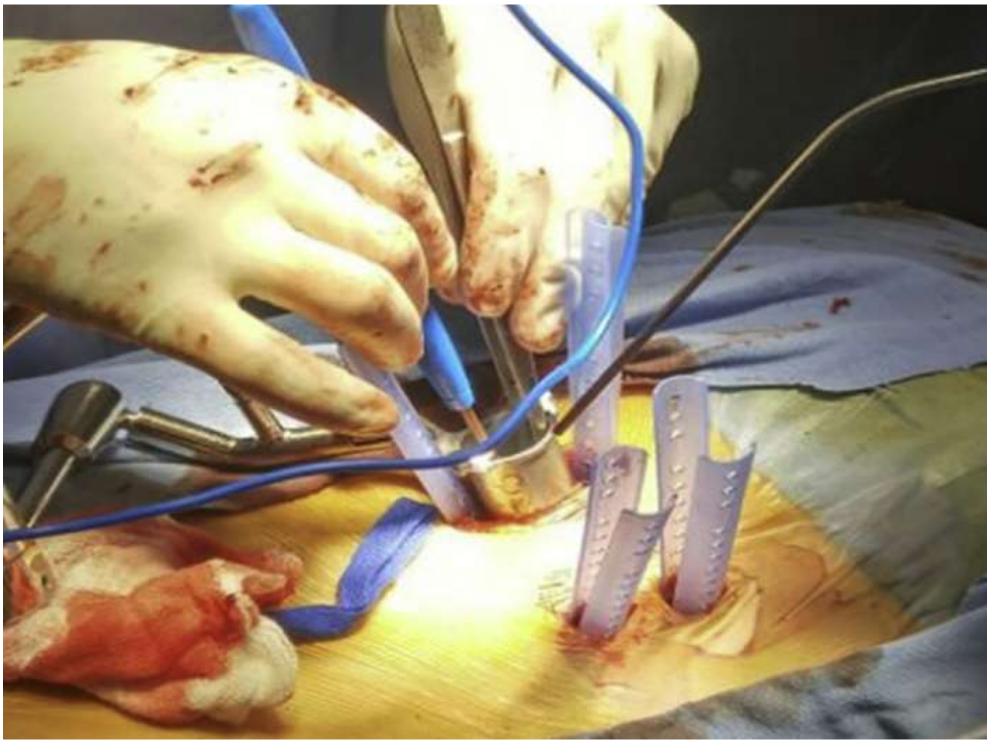

Figure 3: Bony decompression

rod. Next, a guide pin is inserted - most appropriately - on the ipsilateral facet joint and tubular dilators are passed sequentially until a final expandable dilator is in place. After coagulating the soft tissue and vasculature, the pars interarticularis is identified and exposed. The resection of bone essentially involves ipsilateral hemilaminectomy and near complete facetectomy (whole of inferior facet and upper part of superior facet). **Error! Reference source not found.**

Next step involves removal of disc material and cartilaginous end plates. Then the space is partially packed with morcelized locally harvested bone graft meant to lodge in the anterior space. A cage (PEEK /titanium) of an appropriate size is then chosen. The cage is positioned in the disc space using an impactor so that it lies in the centre-anterior portion of the disc space resting on the anterior ring apophysis. A pre-contoured rod is inserted on the opposite side to complete the surgical procedure. The previously applied temporary distraction is released so that the cage gets impacted well on both superior and inferior vertebral surfaces. Further compression is done over the rod bilaterally. Postoperative bracing will not be used.

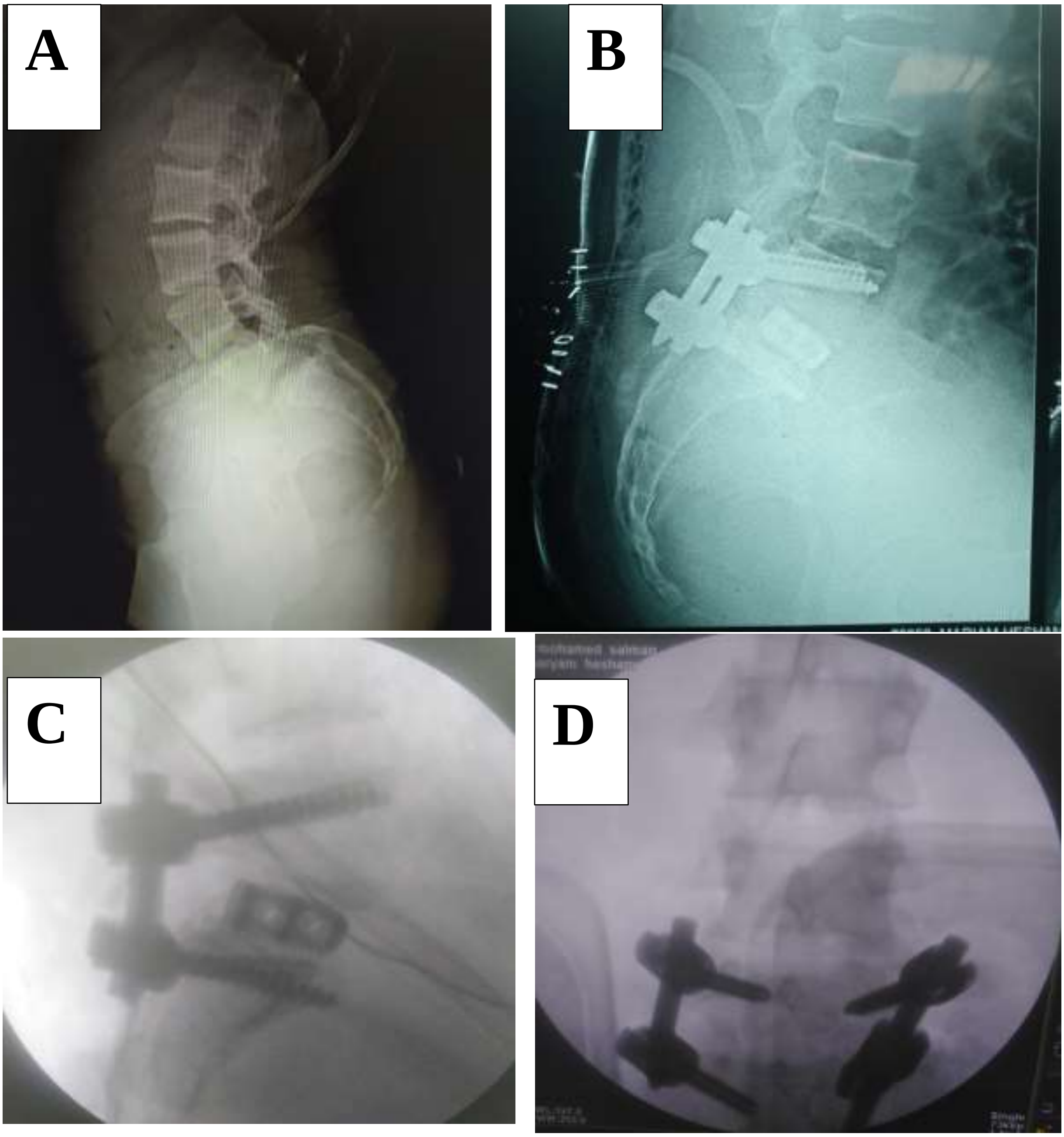

Figure 4: A: Pre-operative lateral view x-ray showing the spondylolisthesis. B, C and D: post-operative x-rays

Statistical Analysis: Data was collected, coded, and entered using Microsoft Excel software. Data analyses were done using SPSS version 25.0. According to the type of data, qualitative data represent as number and percentage, quantitative data represent by mean ± SD. P- value was considered significant if it was < 0.05.

RESULTS

In this prospective interventional study, 30 participants were enrolled and were operated at trauma unit of orthopedic department of Aswan University Hospitals.

There were 18 males and 12 females with mean ± SD age 55 ± 8 years, and the body mass index was 27 ± 3. There were 26.7% of the included participants cigarette smokers.

Table 1: Baseline characteristics of categorical data

		Frequency (%)
Gender	Male	18 (60.0%)
	Female	12 (40.0%)
Smoking	Yes	8 (26.7%)
	No	22 (73.3%)
Comorbidity	HTN	12 (40.0%)
	DM	8 (26.7%)
	IHD	1 (3.3%)
	CVS	2 (6.7%)
	No comorbidity	14 (46.6%)
Previous Back surgery	No	29 (96.7%)
	Yes	1 (3.3%)
Low back pain	No	1 (3.3%)
	Yes	29 (96.7%)
Radiculopathy	RT	13 (43.3%)
	LT	12 (40.0%)
	Both	5 (16.7%)

Table 2: baseline characteristics table for continuous data

	Mean ± SD	Median [min-max]
Age (years)	55 ± 8	55 [26-69]
BMI	27 ± 3	27 [22-34]
Duration of symptoms (months)	9 ± 4	8 [2-17]

Regarding the clinical presentation, only one patient reported to have a history of previous Failed back surgery, while 13 patients of them complained from right side radiculopathy, 12 patients had left side radiculopathy while 5 patients suffered from bilateral radiculopathy. The mean ± SD duration that the patient complained from the symptoms (months) was 9 ± 4 months. Table 2

The duration of operation ranged from 122 minutes to 211 minutes with mean ± SD operative time was 152 ± 23 minutes. Regarding the C-arm duration it ranged from 87 to 238 minutes, with mean duration 213 ± 29 seconds while the mean ± SD essential blood loss was 199 ± 108 ml which ranged from 100 to 700 cc [Table 3]. The only operative complication was two cases with Dural tear that repaired primary, and another case had both root injury and Dural tear that was repaired primary. Table 5

Table 3: descriptive statistics of operative data

	Mean ±SD	Median [Minimum-Maximum]
Operative time (min)	152 ± 23	151.5 [122-211]
C-arm duration (sec)	213 ± 29	217 [87-238]
Essential blood loss (ml)	199 ± 108	178.5 [100-700]

		Frequency (%)
Operative complications	No	27 (93.1%)
	Dural tear	2 (6.9%)
	Root injury	1 (0.0%)
	malposition hardware	0 (0.0%)

Table 4: incidence of operative complications

DISCUSSION

Degenerative lumbar spine disease is still a worldwide healthcare problems, that's characterized by low back pain and lower extremities radicular symptoms. Whereas radicular symptoms can be relieved by decompression, discectomy or laminectomy at the appropriate location, these techniques have limited potential in relieving back pain. (2)

The evolution of the spinal fusion procedures has seen remarkable development in the last century. Excellent results were obtained with open TLIF, however, there was significant morbidity seen due to soft tissue and muscle injury. (6) Outcomes with a smaller "surgical foot-print", MI-TLIF was described by Foley. (8)

The current study aims to evaluate the operative **outcomes of MI-TLIF** in treatment of degenerative lumbosacral spine diseases.

We included 30 participants with mean ± SD age 55 ± 8 years and mean ± SD BMI 27 ± 3. There were 18 males and 46.6 % of participants didn't have any comorbidities. In our study we found that the mean ± SD operative time was 152 ± 23 minutes. Regarding The C-arm duration in our study the mean ± SD of C-arm duration of MIS-TLIF procedures done was 213 ± 29 seconds. In our study we found the mean ± SD essential blood loss for MIS-TLIF procedures was 199 ± 108 ml. Our study shows that the only operative complication occurred was two cases with Dural tear and another case had both root injury and Dural tear.

Regarding the operative time our results was in line with Fan et al., 2010 (10) and Brodano et al., 2015 (11) who reported that the mean ± SD operative time for MIS-TLIF procedures 159.2 ± 21.7 minutes and 144 minutes respectively.

Meanwhile Chen et al., 2019 (12) had reported longer operative time for MIS-TLIF than our results with mean ± SD about 217.62 ± 33.00 minutes. Also Peng et al., 2020 (13) found that the mean ± SD operative time for MIS-TLIF procedures was 201.67 ± 29.15 minutes.

The difference between our results and literature can be explained by variation in level of procedures, number of levels, experience of surgeons, and sampling error and demographic difference as age, BMI, ethnicity, and severity of each case. Moreover, our results show some variation ranged from 122 minutes to 211 minutes. This can be explained by increasing the learning curve, and the experience of surgeons.

The C-arm duration in our results was longer than Peng et al., 2009 (14) who reported mean C-arm duration about 105.5 seconds and Ge et al., 2019 (15) who reported that the mean ± SD C-arm duration of MIS-TLIF procedures was 83 ± 69 seconds. Moreover, Gu et al., 2014 (16) reported c-arm duration was 45.3±11.7 while Seng et al., 2013 (17) found that the mean c-arm duration 55.2 ±11.3.

Longer C-arm duration is inherited in MIS TLIF technique, and this is one of the shortages of this technique, especially when compared to the standard open TLIF. Peng et al., 2009 (14) reported mean ± SD radiation time in MIS-TLIF and open TLIF groups (105.5 sec and 35.2 sec respectively) the difference was statistically significant. Seng et al., 2013 (17) had shown statistically significant higher mean ± SD radiation exposure time in MIS-TLIF group (55.2 ±11.3 sec) than open TLIF group (16.4 ±2.1 sec). The higher radiation exposure in MIS-TLIF group could be explained by the longer duration of surgery when compared to the open TLIF group.

The essential blood loss for MIS-TLIF procedures was In line with our results, Ge et al., 2019 (15) who reported that the mean ± SD essential blood loss in was 197 ± 223 ml. Also Brodano et al., 2015 (11) reported similar results regarding mean ± SD essential blood loss in MIS-TLIF procedures which was 230 ml

In contrast with our study Schizas et al., 2009 (18) and Lee et al., 2016 (19) who reported mean ± SD essential blood loss in MIS-TLIF procedures equals 456 ml and 527 ml respectively

While Peng et al., 2020 (13) and Terman et al., 2014 (20) had reported less amounts of essential blood loss in MIS-TLIF procedures with mean ± SD equals 88.33 ± 23.57 ml and 100 ml respectively

On the contrary of the c-arm duration, blood loss in our technique is one of the advantages as the intraoperative blood loss lesser than the open TLIF.

In Gu et al., 2014 (16) the mean ± SD intraoperative blood loss (248.4±94.3 ml) for the MIS-TLIF group was statistically significant lower than the mean ± SD for the open TLIF group (576.3±176.2 ml).

Our study shows that the only operative complication occurred was two cases with Dural tear and another case had both root injury and Dural tear. Which is was higher than Terman et al., 2014 (20) reported 2 cases of dural tear among MIS-TLIF patients.

Also reported 3 cases of dural tear and 5 cases of excessive blood loss among open TLIF participants

Peng et al., 2020 (13) had reported 3 cases of device malposition in MIS-TLIF groups which didn’t occur in our study and 13 cases in open TLIF groups this difference is statistically significant.

We acknowledge that the present study has some limitations. The study was limited to patients presented to Aswan university hospital only and therefore the results cannot be generalized to the population. Other limitation are small sample size and no follow up, and lack of comparison with open-TLIF, so we recommend conducting randomized clinical trials that compare MIS with open TLIF with larger sample size to overcome these shortages.

CONCLUSION

We concluded that MIS is a reasonable technique, with reasonable operative duration, and low incidence of intraoperative complications.

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Conflict of Interest: The Authors declare that there is no conflict of interest

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