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Mini-open and Conventional-open Transforaminal Lumbar Interbody Fusion Augmented by Pedicle Screw Fixation: Comparisonal Result of Clinical, Perioperative Parametric, Functional and Radiological Assessments

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Abstract

Background: Despite numerous reports on mini-open transforaminal lumbar interbody fusion (TLIF), there exists a few studies to compare directly mini-open TLIF and conventional-open TLIF procedures. This study evaluated the usefulness and safety of mini-open TLIF for degenerative lumbar diseases and instabilities.

Material and methods: Sixty-eight patients underwent TLIF with pedicle screw fixation for degenerative disc disease or spondylolisthesis with more than 12 months follow-up; 22 patients underwent mini-open TLIF and 46 patients underwent conventional-open TLIF. Data of incision, perioperative parameters, complications, fusion rate, and clinical data were reviewed.

Results: The length of incision was shorter in mini-open TLIF group (p=0.04), but satisfaction rate of incision was not statistically different (p=0.18). The VAS and mODI were significant lower in mini-open TLIF (p=0.037, 0.031, respectively) at postoperative 7 days. Less estimated blood loss and less change in hemoglobin and blood pressure during operation was observed in mini-open TLIF group than conventional-open TLIF group. The fusion rate was also not statistically different. The complication including the pedicle screw fracture, bony spur, adjacent level instability was observed in 14% in the mini-open TLIF group and 10% in the conventional-open TLIF group (p=0.63).

Conclusion: The mini-open TLIF with pedicle screw fixation provides excellent clinical results and may be an operation of choice for lumbar spinal fusion. The long-term clinical, functional and radiological results were similar in the mini-open and conventional-open TLIF. But, the mini-open TLIF is a viable alternative to the conventional-open TLIF with advantage of lesser blood loss, less change of hemoglobin and blood pressure, shorter incision, and lesser postoperative pain.

Keywords: Minimal invasive; Transformational lumbar interbody fusion; Clinical outcome; Radiological outcome

Introduction

Harms and Rolinger first introduced the transforaminal lumbar interbody fusion (TLIF) technique in 1982 [1]. This TLIF procedure involves the placement of bone graft and an interbody spacer via a posterolateral transforaminal route into a distracted disc space with a supplemental pedicle screw construct. A TLIF can be performed via a standard convention approach with a midline lumbar incision in a mini-open fashion by using working tubes and percutaneous pedicle screws [2]. The first minimally invasive TLIF was described by Foley et al. in 2003 with the purpose of minimizing paraspinous muscle injury and other tissue trauma without sacrificing effectiveness in spinal fusion [3]. Whereas conventional-open TLIF requires direct visualization of anatomic landmarks with significant muscular dissection, mini-open TLIF limits tissue dissection by taking advantage of minimal invasive techniques. Despite numerous reports on mini-open TLIF [4-9], there exist a few studies to compare directly mini-open and conventional-open TLIF procedures. The purpose of this study is to compare the clinical outcomes, operative data, operation time, complications, fusion rate between patients undergoing mini-open TLIF and conventional-open TLIF by using single center data with >1 year of follow-up, and to review the advantages of mini-open TLIF by using comparative studies review in the discussion.

Material and Methods

Patient population

A series of 70 patients who underwent single-level TLIF for degenerative lumbar disease and instability between 2006 and 2010 were retrospectively reviewed. All patients underwent TLIF with pedicle screw fixation by a neurosurgeon (SHY). No specific guidelines or indications were used in dividing the patients into mini-open and conventional-open TLIF groups; all patients before March 2008 were underwent the conventional-open TLIF, and all patients after April 2008 were underwent alternately the mini-open or conventional-open TLIF. Herein, 23 patients underwent mini-open TLIF and 47 patients underwent conventional-open TLIF were enrolled in this study, and 2 patients (each 1 patient in two group) were excluded from this study to follow-up loss. The indications for surgery were the presence of unstable isthmic spondylolisthesis Grade I or II, or degenerative spondylosis including degenerative spondylolisthesis, foraminal stenosis with central stenosis, degenerative disc disease, and recurrent disc herniation with chronic and persistent radiculopathy despite nonsurgical treatment.

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Outcome assessment

Data of estimated blood loss, hemoglobin change during operation, length of incision, satisfaction about incision, complications, fusion rate, Visual Analog Scale (VAS; score range: 0 to 10, with 0 reflecting no pain), and modified Oswestry Disability Index (mODI; the question about sex life was not included) were analysis. Satisfaction about operation wound rates were assessed by a single question during follow-up concerning "How would you rate the overall satisfaction of the operation wound you received?" Responses thereto were graded on a scale of one to five, with a score of one representing "never satisfaction" and five representing "very successful, almost completely satisfaction". Satisfaction with the operation was defined as a score of 3 or more, and satisfaction rates for each group were calculated by dividing the number of satisfied cases by the total number cases in each group. Bone fusion was assessed using flexion-extension lateral radiographs and/or computer tomography. If there was less than 5 degrees of movement in the fixed segment on the lateral view in flexion-extension, and there was continuity of the trabecular bony bridging across the disc space the outcome was classified as fusion status. If there was any movement seen on the lateral view in flexion-extension or discontinuity in the trabecular bony bridging it was classified as non-fusion status.

Surgical technique of mini-open TLIF

Fluoroscopy was used to determine the operative level in mini-open TLIF technique. The mini-open TLIF procedure was performed on the side of radicular symptoms. If both the legs were symptomatic, the approach was from the side of more severe pathology and contralateral lamina and foramina decompressed by a unilateral exposure. An incision was made 3 to 4 cm off midline. Sequential soft tissue dilators were inserted through the incision down to the facet complex until the desired working diameter was achieved. A facetectomy was then performed using a high-speed drill from lateral to medial side to expose the posterolateral aspect of the disc. Intradiscal distraction and disc space preparation were done using standard interbody fusion instruments. Cartilaginous material was removed from the endplates using the endplate scraper. An interbody graft was then placed in a direction anterior and contralateral to the annulotomy within the interbody space. Autograft was not used in any cases. Fluoroscopy was used to ensure satisfactory placement of the graft. When necessary, the contralateral ligamentum flavum was resected to expose the contralateral exiting and traversing nerve roots. If needed, the tubular retractor was angled contralaterally so that a more extensive boney decompression could be done. The tubular retractor was then removed and percutaneous pedical screws placed immediately above and below the interbody segment to be fused. Under fluoroscopic guidance, a Jamshidi needle was inserted into the pedicles. A K-wire was then passed through the Jamshidi trocar into the pedicles. Using cannulated instruments, a bone tap followed by cannulated screw was advanced over the K-wire. The rod was then placed percutaneously to connect the screws. Compression was applied to the construct before final tightening, providing compression of the bone graft and maximizing lordosis. All wounds were copiously irrigated and the wounds were closed in layers.

Surgical technique of conventional-open TLIF

A midline skin incision was used in conventional-open TLIF. The fascia was incised and the paravertebral muscles were dissected from the spine. Radiographs were used to check the appropriate level. Bilateral pedicle screw rod constructs were inserted and laminectomy and unilateral facetectomy was then performed at that level. This was followed by unilateral anulotomy, discectomy, and placement of the interbody graft. Similar to the mini-open TLIF approach, cartilaginous material was removed from the endplates using the endplate scraper. Interbody graft was then placed anteriorly and contralateral to the annulotomy within the interbody space. For posterior-lateral arthodesis, local autogenous bone with or without bone extenders was used for bone grafting. The wound was copiously irrigated and closed in layers.

Statistical Analysis

We used Statistical Package for the Social Sciences software (SPSS 12.0K) for analysis. Data were analyzed using the student t-test. Statistical significance was accepted for p-values of <0.05.

Results

Total 68 patients underwent TLIF with more than 12 months follow-up enrolled in this study. The mean age with sex ratio (male %) in each group were 53.4 ± 13.2 years with 43% in mini-open TLIF and 55.6 ± 11.8 years with 35% in conventional-open TLIF, and there were no statistically significant difference in age and sex ratio between the groups (Table 1). The composition of disease category and the level of operative level were also not different. Preoperative laboratory test, VAS and mODI were also not different. The mean follow-up was 25 months for the mini-open TLIF group and 28 months for the conventional-open TLIF group.

Compared result between mini-open and conventional-open TLIF were shown in table 2. The estimated blood loss was 163 ± 51 ml for the mini-open TLIF group and 412 ± 123 ml for the conventional-open TLIF group (p<0.01). Hemoglobin change were less affected in mini-open TLIF group (p=0.019), but platelet change were similar between the groups (p=0.977). The blood pressure (systolic and diastolic pressure) was similar in preoperative status between two groups, but statistically significant high systolic or diastolic pressure in conventional-open TLIF group within postoperative 2 days. The difference of blood pressure was dismissed in postoperative 7 days. The satisfaction rate of incision was not statistically differenced (59% in mini-open TLIF and 53% in conventional-open TLIF, p=0.18), although the length of incision was 84 ± 9 mm for the mini-open TLIF group and 97 ± 13 mm for the conventional-open TLIF group (p=0.04). The complication including the pedicle screw fracture, bony spur, adjacent level instability was observed in 14% in the mini-open TLIF group and 10% in the conventional-open TLIF group (p=0.63). The fusion rate was also not statistically different (90.5% in the mini-open TLIF group and from 91.2% in the conventional-open TLIF

	Mini-open TLIF	Conventional-open TLIF	P-value
No of cases	22	46	-
Degenerative disc disease	8	26	0.120
Spondylolisthesis	14	20	
Age	53.4 ± 13.2 years	55.6 ± 11.8 years	0.501
Male percentage	45.5%	34.8%	0.525
Spondylosis	16	33	0.932
Spondylolisthesis	6	13	
Level of L4-L5	10	21	0.987
Level of L5-S1	12	25	
Preoperative hemoglobin	13.8 ± 1.6	13.8 ± 1.8	0.777
Preoperative platelet count	285.6 ± 67.7	263.4 ± 56.1	0.143
Preoperative VAS	7.0 ± 2.7	7.1 ± 3.2	0.519
Preoperative mODI	51.2 ± 21.7	55.5 ± 25.3	0.495

Table 1: Patients characteristics of mini-open and conventional-open transforaminal lumbar interbody fusion (TLIF).

group). Initial postoperative VAS and mODI were more improved in mini-open TLIF group (p=0.037 in postoperative 7 days VAS, p=0.048 in postoperative 1 month VAS, and p=0.031 in postoperative 7 days mODI), but no statistically significant difference were observed in VAS and mODI improvement between the groups after postoperative 6 months.

Discussion

The advent of minimally invasive surgery had provided surgeons new techniques for treating clinical disease [10]. Minimally invasive spine surgery aims to reduce approach related morbidity, while producing clinical outcomes comparable to its open predecessors [10]. One important example of this is the development of minimally invasive techniques for lumbar interbody fusion, including TLIF [10,11]. The mini-open TLIF technique, has displayed comparable outcomes to conventional-open TLIF, while adding the benefits of less approach related morbidity, decreased intraoperative blood loss, and shorter hospital stays [3]. However, critics of the technique have noted that the mini-open TLIF has longer operative times and exposes patients to increased fluoroscopic radiation. Over the past decade mini-open TLIF has been shown to have a number of benefits, especially with regard to perioperative outcomes. However, it may have its own unique challenges and potential morbidity. Ultimately, comparing the known literature of a traditional, conventional-open TLIF approach to published reports on mini-open TLIF will identify the unique risks and benefits associated with each. This understanding may help guide improved clinical decision making for patients presenting with lumbar degenerative disc disease. In the review of Habib et al. [4], there was a paucity of data comparing mini-open and conventional-open TLIF. But, after then, the data was more accumulated over time. The recent results of studies that directly compare these two techniques were shown in table 3. In this paper, we presented our data of single surgeon and single academic teaching hospital, and evaluate the literature to examine the efficacy of mini-open TLIF compared to its open counterpart according to the main interest such as clinical result, perioperative parameters, radiation exposure, fusion rate, soft tissue injury, complications, hospital stay, and cost.

Clinical Results

The clinical result between mini-open and conventional-open TLIF were usually compared by VAS, ODI and quality of life. The clinical comparison results were shown in table 4. Most study was reported the similar or superior VAS result of mini-open TLIF similar to recent result [13-15]. The comparison result of ODI also similar or superior in mini-open TLIF [18-22]. In this study, initial postoperative VAS and ODI were more improved in mini-open TLIF group, but no statistically significant difference were observed in VAS and ODI improvement between the groups. These clinical results were closely related to the quality of life. Many studies compared the quality of life between mini-open and conventional-open TLIF, and these also presented the similarity or superiority of mini-open TLIF [4,12,13,16,18,19]. Although this study was designed as a retrospective review, the immediately postoperative clinical outcomes were not assessed, but as the VAS and mODI in postoperative 7 days were more excellent in mini-open TLIF. In future study, the author suspected that this immediate postoperative clinical course within 7 days is also interesting to spine surgeons.

Perioperative Parameters

Many study reported the various perioperative parameters to compare the result between mini-open and conventional-open TLIF, such as blood loss, postoperative drainage, transfusion, wound size,

Variables		Mini-open TLIF	Conventional-open TLIF	P-value
Blood Loss during Operation		163 ± 51 ml	412 ± 123 ml	0.007
Hemoglobin change during Operation		1.56 ± 0.62	2.19 ± 1.24	0.019
Platelet during Operation		56.85 ± 28.52	57.05 ± 28.16	0.977
Blood Pressure (Systolic/Diastolic pressure)	Preoperative	134 ± 18/82 ± 14	137 ± 14/83 ± 11	0.438/0.759
	POD 1day	118 ± 4/74 ± 7	127 ± 19/82 ± 13	0.019/0.007
	BP change	-17 ± 21/-17 ± 17	-10 ± 18/17 ± 16	0.182/1.000
	POD 2days	118 ± 20/74 ± 12	120 ± 11/80 ± 9	0.471/0.017
	BP change	-9 ± 14/0 ± 13	-1 ± 14/+2 ± 15	0.045/0.674
	POD 7days	130 ± 21/83 ± 17	135 ± 18/84 ± 13	0.317/0.644
	BP change	-1 ± 14/0 ± 8	+1 ± 13/0 ± 7	0.891/0.948
Incision length		84 ± 9mm	97 ± 13mm	0.043
Satisfaction rate about incision		59.10%	52.20%	0.189
Fusion rate		90.50%	91.20%	0.746
Reduction rate (n=34)		44.0% (n=14)	32.9% (n=20)	0.386
Complications		14%	11%	0.136
VAS	Preoperative	7.0 ± 2.7	7.1 ± 3.2	0.519
	POD 7days	4.3 ± 2.7	5.1 ± 3.1	0.037
	POD 1 month	4.1 ± 2.7	4.9 ± 2.7	0.048
	POD 6 month	3.1 ± 1.9	3.5 ± 2.2	0.265
	POD 12 month	2.7 ± 2.2	3.0 ± 2.5	0.194
	POD 24 month	2.6 ± 2.5	2.8 ± 2.6	0.233
Modified ODI	Preoperative	51.2 ± 21.7	55.5 ± 25.3	0.495
	POD 7days	39.5 ± 27.7	45.3 ± 30.1	0.031
	POD 1 month	34.1 ± 21.4	36.9 ± 31.1	0.439
	POD 6 month	32.7 ± 20.2	34.7 ± 27.7	0.377
	POD 12 month	23.1 ± 18.1	23.3 ± 25.1	0.871
	POD 24 month	21.1 ± 20.8	23.9 ± 23.9	0.635

Table 2: Comparisonal data of mini-open and conventional-open transforaminal lumbar interbody fusion (TLIF).

Year	Journal	Study design	Author	No of cases		
				Total	mini	open
2008	J Neurosurg Spine	Retrospective	Dhall et al. [15]	42	21	21
2009	Spine	Prospective	Peng et al. [6]	58	29	29
2010	Eur Spine J	Prospective	Wang et al. [7]	85	42	43
2010	Surg Neurol Int	Retrospective	Villavicencio et al. [14]	139	76	63
2011	Chin Med J	Prospective	Wang et al. [8]	79	41	38
2011	World Neurosurg	Prospective	Parker et al. [16]	30	15	15
2011	J Neurosurg Spine	Retrospective	McGirt et al. †[17]	5170	1436	3734
2011	J Spinal Disord Tech	Retrospective	Adogwa et al. [9]	30	15	15
2012	Eur Spine J	Prospective	Lee et al. [10]	144	72	72
2012	J Spinal Disord Tech	Prospective	Wang et al. ‡[11]	82	43	39
2012	Zhonghua Wai Ke Za Zhi	Retrospective	Wang et al. [12]	371	172	199
2012	Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi	Retrospective	Liang et al. [13]	87	42	45
2013	J Spine	Retrospective	Oh et al.	68	22	46

†: retrospectively reviewed hospital discharge and billing records from the Premier Perspective Database of posterior/transforaminal lumbar interbody fusion cases;
‡: prospective control study involving obese patients

Table 3: Directly comparison studies of mini-open and conventional-open transforaminal lumbar interbody fusion (TLIF).

Assessment	Category	Comparison	Authors
VAS	VAS (<6month)	Superior in mini-open TLIF	Peng et al. [6], Wang et al. [7]
		Similar between groups	Villavicencio et al. [14], Oh
	VAS (>6month)	Superior in mini-open TLIF	Wang et al. [8], Liang et al. (backpain) [13]
		Similar between groups	Peng et al. [6], Adogwa et al. [9], Lee et al. [10], Wang et al. [11], Wang et al. [12], Liang et al. (leg pain) [13], Wang et al. [7], Oh
ODI		Superior in mini-open TLIF	Liang et al. [13]
		Similar between groups	Peng et al. [6], Wang et al. [7], Wang et al. [8], Adogwa et al. [9], Lee et al. [10], Wang et al. [11], Wang et al. [12], Oh
QOL	Pt's satisfaction	Superior in mini-open TLIF	Villavicencio et al. [14]
	Narcotics use	Superior in mini-open TLIF	Adogwa et al. [9], Lee et al. [10],
	Return to work	Superior in mini-open TLIF	Adogwa et al. [9]
	mPS	Similar between groups	Dhall et al. [15]
	SF-36	Similar between groups	Peng et al. [6], Lee et al. [10],
	EuroQol-5D	Similar between groups	Adogwa et al. [9]
	QALY	Similar between groups	Parker et al. [16]

QALY: Quality-Adjusted Life Years; †: Back Pain VAS; ‡: Leg Pain VAS; VAS: Visual Analog Scale; ODI: Oswestry Disability index; QOL: Quality of Life

Table 4: Comparison of clinical result between mini-open and conventional-open transforaminal lumbar interbody fusion (TLIF).

and operation time (Table 5). All preoperative parameters except the operation time were superior of mini-open TLIF than of conventional-open TLIF. In this study, we also assessed the preoperative parameter such as blood loss, wound size, blood pressure change and hemoglobin change. The result of blood loss and wound size were superior in mini-open TLIF as other study presented [4,12-15,19-22]. But, interestingly, satisfaction rate of incision was not statistically differenced in this study (59% in mini-open TLIF and 53% in conventional-open TLIF, p=0.18). Indeed, this study first reported about the comparisonal results about blood pressure change and hemoglobin change. Hemoglobin change were less affected in mini-open TLIF group (p=0.019). The blood pressure change (systolic and diastolic pressure) was also similar in preoperative status between two groups, but statistically significant high systolic or diastolic pressure within postoperative 2 days. This result must be driven from the immediate postoperative lesser pain. Not different blood pressure difference in postoperative 7 days added the reliability about this explanation.

Radiation Exposure and Soft Tissue Injury

Unfortunately we could not check the radiation hazard and the amount of soft tissue injury during the operation. But the many literature already reported about this topic [13-15,19-21]. All authors reported that radiation hazard is less effective in mini-open TLIF, and concluded the main disadvantage of mini-open TLIF. The reported articles were demonstrated in table 6. Soft tissue injury is suspected more effective in mini-open TLIF compare to conventional-open TLIF by minimal invasive technique. The studies used the parameter such as T2 relaxation time in multifundus muscle by magnetic resonance image, electromyography, enzymes (C-reactive protein, leucocyte count, and creatine kinase), and the atrophy of multifidus muscle (Table 7). All result showed the superiority in mini-open TLIF.

Fusion Rate

In this study, the fusion rate was not statistically different (90.5% in the mini-open TLIF group and from 91.2% in the conventional-open TLIF group). In this study, the fusion criteria were bony bridge and/or dynamic stabilization lesser than 5° in lateral flexion and extension radiographs. Although many reported using the different criteria about the bone fusion, but all reported studies concluded the fusion rate between two TLIF technique is similar (Table 8) [4,13,19,20].

Complications

The comparisional result about the complication rate is very obscure as presented in table 9. Some reported the similarity or superiority of mini-open TLIF, and others reported the inferiority of mini-open TLIF. Each articles reported different type of complication by these two TLIF methods, and concluded the overall complication rate differently.

Assessment	Comparison Result	Authors
Blood loss	Superior in mini-open TLIF	Dhall et al. [15], Peng et al. [6], Wang et al. [7], Wang et al. [8], Lee et al. [10], Wang et al. [11], Wang et al. [12], Liang et al. [13], Villavicencio et al. [14], Oh
Postoperative drainage	Superior in mini-open TLIF	Lee et al. [10], Liang et al. [13],
Transfusion	Superior in mini-open TLIF	Wang et al. [7]
Blood pressure change	Superior in mini-open TLIF	Oh
Hemoglobin change	Superior in mini TLIF	Oh
Wound size	Superior in mini TLIF	Liang et al. [13], Oh
Operation time	Superior in mini-open TLIF	Wang et al. [7]
	Similar between groups	Lee et al. [10], Wang et al. [12],
	Inferior in mini-open TLIF	Peng et al. [6], Liang et al. [13], Villavicencio et al. [14], Dhall et al. [15]

Table 5: Comparison of perioperative parameters between mini-open and conventional-open transforaminal lumbar interbody fusion (TLIF).

Year	Study design	Author	Comparison Result
2009	Prospective	Peng et al. [6]	Inferior in mini-open TLIF
2010	Prospective	Wang et al. [7]	Inferior in mini-open TLIF
2011	Prospective	Wang et al. [8]	Inferior in mini-open TLIF
2012	Prospective	Lee et al. [10]	Inferior in mini-open TLIF
2012	Prospective	Wang et al. [11]	Inferior in mini-open TLIF
2012	Retrospective	Wang et al. [12]	Inferior in mini-open TLIF

Table 6: Comparison of radiation hazard between mini-open and conventional-open transforaminal lumbar interbody fusion (TLIF).

Year	Author	Assessment	Comparison Result
2011	Wang et al. [8]	T2 relaxation time in multifundus muscle	Superior in mini-open TLIF
2011	Wang et al. [8]	Electromyography	Superior in mini-open TLIF
2012	Liang et al. [13]	C-reactive protein, leucocyte count, and creatine kinase	Superior in mini-open TLIF
2012	Liang et al. [13]	Multifidus muscle atrophy	Superior in mini-open TLIF

Table 7: Comparison of soft tissue injury between mini-open and conventional-open transforaminal lumbar interbody fusion (TLIF).

Year	Study design	Author	Assessment	Comparison
2009	Prospective	Peng et al. [6]	Bridwell classification	Similar
2010	Retrospective	Villavicencio et al. [14]	Trabecular bone bridging, <5 angluar motion	Similar
2012	Prospective	Lee et al. [10]	Bridwell classification	Similar
2012	Prospective	Wang et al. [11]	Trabecular bone bridging, <3 angluar motion	Similar
-	Retrospective	Oh et al. 2013	Trabecular bone bridging, <5 angluar motion	Similar

Table 8: Comparison of fusion rate between mini-open and conventional-open transforaminal lumbar interbody fusion (TLIF).

Year	Author	Assessment	Comparison Result
2008	Dhall et al. [15]	List of complications	Similar between groups
2010	Villavicencio et al. [14]	Neurological deficit	Inferior in mini-open TLIF
2010	Villavicencio et al. [14]	Overall complication rate	Similar between groups
2010	Wang et al. [7]	List of complications	Similar between groups
2011	McGirt et al. [17]	Surgical site infection 1-level fusion	Similar between groups
2011	McGirt et al. [17]	Surgical site infection 2-level fusion	Superior in mini-open TLIF
2012	Lee et al. [10]	Asymptomatic cage migration	Similar between groups
2012	Wang et al. [11]	Overall complication rate	Inferior in mini-open TLIF
2012	Wang et al. [12]	Complication	Similar between groups
-	Oh et al. 2013	Overall complication rate	Similar between groups

Table 9: Comparison of complication rate between mini-open and conventional-open transforaminal lumbar interbody fusion (TLIF).

But most articles were concluded to similar result of two methods. Among these articles, a report by McGirt et al. [17] showed interesting result about surgical site infection by fusion level. The surgical site infection rate is similar between groups in 1 level fusion operation, but the surgical site infection in 2-level fusion is superior in mini-open TLIF. And the authors concluded that this surgical site infection also contribute about the hospital stay and cost. Unfortunately in this study, we could not compared the results of hospital stay and cost between two different TLIF techniques, many literature reported about this topic (Table 10). Many authors reported that hospital stay and cost is more advantage in mini-open TLIF except the infection condition [17].

Conclusion

The use of the mini-open TLIF with pedicle screw fixation provides

Year	Author	Assessment	Comparison Result
2008	Dhall et al. [15]	Hospital stay	Superior in mini-open TLIF
2009	Peng et al. [6]	Hospital stay	Superior in mini-open TLIF
2010	Villavicencio et al. [14]	Hospital stay	Superior in mini-open TLIF
2010	Wang et al. [7]	Hospital stay	Superior in mini-open TLIF
2011	Adogwa et al. [9]	Hospital stay	Superior in mini-open TLIF
2012	Lee et al. [10]	Hospital stay	Superior in mini-open TLIF
2011	McGirt et al. [17]	1-level fusion (including SSI cost)	Similar between groups
2011	McGirt et al. [17]	2-level fusion (including SSI cost)	Superior in mini-open TLIF
2011	Parker et al. [16]	2 years cost saving	Similar between groups

Table 10: Comparison of hospital stay and cost between mini-open and conventional-open transforaminal lumbar interbody fusion (TLIF).

excellent clinical results and may be an operation of choice for lumbar spinal fusion. The mini-open TLIF is a viable alternative to the conventional-open TLIF with significantly reduced estimated blood loss and the length of incision wound. The clinical, functional and radiological results were similar in the mini-open and conventional-open TLIF.

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Conflict of Interest

The authors declare that they have no proprietary, commercial, or financial interests that could be construed to have inappropriately influenced this study.

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