Mini-open and Conventional-open Transforaminal Lumbar Interbody Fusion Augmented by Pedicle Screw Fixation: Comparative 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 paraspinal 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 facetectomy was then performed at that level. This was followed by multilateral 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 arthrodesis, local autogenous bone with or without bone extenders was used for bone grafting. The wound was copiously irrigated and closed in layers.

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

| Procedure                      | 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   |
| Spondylisis                   | 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     | 283.4±56.1             | 0.143   |
| Preoperative VAS              | 7.0±2.7        | 7.1±3.2                | 0.519   |
| Preoperative mODI             | 51.2±21.7      | 55.5±23.5              | 0.495   |

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 lamineotomy 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 arthrodesis, 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.
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,
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, the bone fusion, but all reported studies concluded the fusion rate was not statistically different (90.5% in mini-open TLIF group). In this study, the fusion rate was 90.5% in mini-open TLIF group and from 91.2% in the conventional-open TLIF group. In this study, the bone fusion was assessed by X-rays. Although many reported using the different criteria about bone fusion, but all reported studies concluded the fusion rate was similar (Table 8) [4,13,19,20].

Indeed, this study first reported about the comparisonal result 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 to 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 to be less effective in mini-open TLIF than 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 multifundus 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 bone 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 comparisonal 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.
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
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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