Journal of Clinical Neuroscience 18 (2011) 624–627

Contents lists available at ScienceDirect

Journal of Clinical Neuroscience

journal homepage: www.elsevier.com/locate/jocn

Clinical Study

Complications and perioperative factors associated with learning the technique of minimally invasive transforaminal lumbar interbody fusion (TLIF)

Darryl Lau [a], Jasmine G. Lee [a], Seunggu J. Han [a], Daniel C. Lu [b], Dean Chou [a,*]

[a] Department of Neurosurgery, University of California San Francisco, 505 Parnassus Avenue, Box 0112, San Francisco, CA 94143-0112, USA
[b] Department of Neurosurgery, University of California Los Angeles, Los Angeles, CA, USA

ARTICLE INFO

Article history:
Received 27 July 2010
Accepted 10 September 2010

Keywords:
Complications
Learning curve
Minimally invasive transforaminal lumbar interbody fusion
Open transforaminal lumbar interbody fusion
Perioperative complications
TLIF

ABSTRACT

Before the advent of minimally invasive spine surgery (MIS), open transforaminal lumbar interbody fusion (TLIF) was performed to treat spondylosis, spondylolisthesis, and spondylolysis. Minimally invasive TLIF has recently become more popular based upon the premise that a smaller, less traumatic incision should afford better recovery and outcomes. However, the learning curve associated with this technique must be considered. To analyze the perioperative factors associated with the learning curve in patients who underwent MIS TLIF *versus* open TLIF, we identified 22 patients who underwent TLIF from 2005 to 2008 within levels L4–S1 by the senior author (D.C.). Patients were subdivided into two groups according to whether they underwent: (i) MIS TLIF (10 patients, the first MIS TLIF procedures performed by D.C.); or (ii) open TLIF (12 patients). Preoperative, perioperative and postoperative factors were evaluated. Patients who underwent MIS TLIF had a statistically significant lower intraoperative transfusion rate, and rate of required postoperative surgical drains; and shorter periods of required drainage, and time to ambulation. However, the MIS TLIF group tended to have a higher rate of complications, which might have been associated with the learning curve. Both groups had a minimum of 1-year follow-up.

1. Introduction

A transforaminal lumbar interbody fusion (TLIF) has traditionally been a safe and successful way of treating degenerative lumbosacral diseases such as spondylosis, spondylolisthesis, or spondylolysis.[1] The open TLIF approach was developed by Harms and Jeszenszky as an alternative to posterior lumbar interbody fusion (PLIF).[2] TLIF presents several advantages over the PLIF approach. It decreases retraction of the thecal sac, allows more lateral exposure of the interspace, and implements a unilateral approach for a complete interspace preparation.[3–5] However, the open TLIF procedure involves the stripping of the paravertebral muscles as in many open posterior spinal procedures and may affect postoperative outcome.[6,7] Moreover, soft tissue retraction may lead to increased pain and atrophy of paraspinous muscles.[8–12]

The minimally invasive (MIS) approach is thought to be ideal in that it preserves the posterior tension band and reduces injury to the paraspinous musculature.[13] However, the MIS TLIF must be learned, and we wished to evaluate the impact of the learning curve with regards to various perioperative factors, neurological outcome, pain level, patient morbidity, and complications.

2. Materials and methods

Between 2005 and 2008, 22 consecutive patients who underwent a TLIF procedure by the senior author (D.C.) were identified. No patient was excluded from the study. The surgical indications included the diagnoses of spondylolisthesis, spondylosis, and spondylolysis. The patients in this study received a specific approach based upon the patient's request; patients who underwent open TLIF were indifferent to the approach, and patients who underwent MIS TLIF specifically requested the procedure. All surgical procedures in this study were performed at the levels of L4–S1. The technique for the MIS TLIF has been extensively described.[4,14,15]

Retrospective analysis of preoperative, perioperative, and postoperative (morbidity and outcomes) parameters included factors such as age, weight, sex, diagnosis, levels operated on, operative time, blood loss, length of stay, pain scores, surgical drainage, transfusion (intraoperative and postoperative), time before ambulation, neurological outcome and complications. Clinical follow-up was obtained for all patients in this study. Where patients did not return for a recent clinic visit after surgery, follow-up was obtained through personal telephone calls by the attending neurosurgeon (D.C.). A series of standard questions was asked to all patients regardless of whether the interview was conducted in clinic or via the telephone. The questions focused on neurological status, difficulty or ease of ambulation, pain, complications pertaining to

* Corresponding author. Tel.: +1 415 353 9095; fax: +1 415 353 3907.
E-mail address: choud@neurosurg.ucsf.edu (D. Chou).

0967-5868/$ - see front matter © 2010 Elsevier Ltd. All rights reserved.
doi:10.1016/j.jocn.2010.09.004

surgery, recurrence of symptoms, re-operations at other hospitals, and overall improvement.

The number of vertebrae fused in the surgical procedure was also taken into account in the analysis. Statistical calculations for p values were performed with a two-tailed Student t-test and two-tailed Fisher's Exact Test when appropriate to evaluate for statistically significant differences. The p values $\leqslant 0.05$ were counted as significant.

3. Results

3.1. Clinical data

Ten patients underwent MIS TLIF and 12 patients underwent an open TLIF (Table 1). Although there was no statistically significant difference in the sex ratio between two groups ($p = 0.64$), patients undergoing MIS TLIF were younger ($p = 0.017$). The mean weight of each group was similar ($p = 0.68$) (Table 1). The mean follow-up for the MIS group was 15.2 months and the open group was 12.6 months.

There was no significant difference in the distribution of diagnoses of spondylosis, spondylolisthesis, or spondylolysis between the MIS TLIF and the open TLIF groups (Table 1).

Data were also stratified to see if there was a difference in the number of patients who required a one-level fusion (either L4–L5 or L5–S1) or a two-level fusion (L4–S1) (Table 1). The MIS TLIF group had nine patients who underwent a one-level fusion, and for the open TLIF group, seven patients underwent a one-level fusion. Five patients underwent a two-level fusion (L4–S1) in the open group (Table 1). The two groups were similar in terms of number of vertebrae fused and spinal level at which surgery was performed: L4–L5 ($p = 0.66$), L5–S1 ($p = 0.11$) and L4–S1 ($p = 0.12$).

3.2. Preoperative motor score

The mean preoperative motor scores for both the MIS TLIF and open TLIF patients were similar ($p = 0.10$) (Table 1).

3.3. Perioperative factors

The mean operative time recorded for this study was defined as from the start to end of anesthesia, and tended to be longer for the MIS TLIF group than for the open TLIF group ($p = 0.33$) (Table 2). Although the amount of perioperative blood loss for the two operative groups was similar ($p = 0.26$), as was the amount of blood transfused ($p = 0.11$), more patients in the open TLIF group (78%) compared to the MIS TLIF group (25%) required perioperative transfusions ($p = 0.044$) (Table 2).

Table 1
Baseline demographics and preoperative factors of patients who underwent minimally invasive (MIS) and open transforaminal lumbar interbody fusion (TLIF) procedures.

Baseline statistics and preoperative factors	MIS TLIF (10 patients)	Open TLIF (12 patients)	p Value
Mean age (years)	46.9	56.9	0.017*
Male/female (%)	40/60	42/58	0.64
Mean weight (kg)	87.02	95.32	0.68
Mean preoperative motor score†	5	4.83	0.10
Diagnosis (no. patients)			
Spondylosis	5	6	0.66
Spondylolisthesis	4	6	0.48
Pars defect	1	0	0.45
TLIF levels (no. patients)			
L4–L5	5	6	0.66
L5–S1	4	1	0.11
L4–S1 (fusion of 3 vertebrae)	1	5	0.12

* $p < 0.05$; statistically significant.
† Scale from 1 to 5.

Table 2
Perioperative results of patients who underwent minimally invasive (MIS) and open transforaminal lumbar interbody fusion (TLIF) procedures.

Perioperative results	MIS TLIF (10 patients)	Open TLIF (12 patients)	p Value
Mean operative time (min)	389.67	365.30	0.33
Mean blood loss (mL)	466.67	565.63	0.26
Transfusion (intraoperative)			
Mean amount (mL)	67.50	152.78	0.11
% Patients receiving it	25%	78%	0.044*

* $p < 0.05$; statistically significant.

3.4. Postoperative outcomes and complications

Significantly fewer patients in the MIS TLIF group required postoperative drainage (using a Jackson Pratt or Blake 19 drain) than those in the open TLIF group (20.0% vs. 83.3%; $p = 0.0048$), and the drain was required for fewer days in the MIS TLIF group (Table 3; $p = 0.02$). Postoperatively there was no difference between the two patient groups in the percentage of patients who required postoperative transfusions or in the mean amount of blood transfused (Table 3).

The mean time to ambulation (number of days before the patient attempted to walk with or without an aid) was shorter for patients who underwent MIS TLIF surgery compared to the open TLIF group (1.8 days vs. 3.63 days; $p = 0.049$) (Table 3). However, the two groups of patients stayed in hospital for a similar amount of time ($p = 0.10$) (see Table 3).

The complication rate (any intraoperative or postoperative event that required surgical or medical intervention, including infections) for patients in the MIS TLIF group tended to be higher (40%) than for those in the open TLIF group 8.3% ($p = 0.10$) (Table 3). The details of the complications are listed in Table 3. There were no deaths in either group.

3.5. Complication by diagnosis breakdown

Fewer patients in the open TLIF surgery group (0%) with spondylosis developed complications compared to 80% (4 out of 5) in the MIS TLIF group ($p = 0.015$). A similar number of patients in both groups with spondylolisthesis suffered complications (Table 4).

3.6. Pain outcome scores

Postoperative pain was compared to preoperative as being "worse" (more pain), "same" (same amount of pain), or "better" (less pain). Patients in both the MIS and open surgical groups reported similar pain outcomes in each category (Table 5).

4. Discussion

Several studies have shown that MIS TLIF is a feasible procedure and is able to achieve results that are comparable to the open TLIF approach.[4,7,16] While it would seem that MIS TLIF would decrease the risk of morbidity and complications because of minimal soft tissue, nerve, and muscle injury during surgery, there is still insufficient evidence to show that MIS fusions are superior in terms of patient outcome.

The level of surgical difficulty can have a role in morbidity and outcome. Generally, fusion of more levels can lead to increased risk