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Minimally Invasive Transforaminal Lumbar Interbody Fusion versus Posterior Lumbar I

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Summary

Objective: Surgical management of degenerative lumbar disorders continues to evolve. Recent publications have demonstrated an advantage for fusion procedures in certain pathologies, such as degenerative spondylolisthesis. The optimal surgical approach still needs to be defined. We sought to compare two approaches, minimally invasive TLIF and open PLIF, for the management of symptomatic spondylolisthesis.

Methods: Two ambispective cohorts were compared with primary outcomes being surgical blood loss and time in hospital and secondary outcomes being VAS back and leg and ODI, at 1 year po stop.

Results: There were 90 patients enrolled (PLIF 31, mTLIF 59). Both groups improved significantly at the 1 year follow-up. Despite significant differences in pre-operative pain scores the TLIF group demonstrated lower blood loss (228±138cc versus 764±488cc, p<0.001) and shorter hospital stay (87±41hrs versus 156±45hrs, p<0.0001). Furthermore, on multivariate analysis the surgical group was a significant predictor in the change in outcomes scores at 1 year, favoring mTLIF (p<0.0001).

Conclusion: Our data suggest that mTLIF is a comparable surgical approach to traditional open PLIF and may have advantages in surgical blood loss, speed of recovery and functional outcomes.

Introduction

Surgical treatment of spondylolisthesis, degenerative disc disease and recurrent disc herniation is becoming increasingly refined. Since the landmark study, by Fritzell et al. [1] showed surgery as a favorable option compared to conservative management of lower back pain, the number of fusion surgeries has increased [1]. These landmark results were further, and more convincingly, confirmed in the recent Spine Patient Outcome Research Trial (SPORT) [2,3].

Historically, lumbar fusion surgeries relied on posterior lateral approaches and laying bone laterally against the facets, pars interarticularis and the transverse process of the vertebrae. This approach had several theoretical biomechanical limitations as it did not closely approximate normal functional mechanics [4,5]. These limitations are improved with the option of 360 degree fusion; currently, there are several widely used techniques that offer 360 degree fusion: posterior lumbar interbody lumbar fusion (PLIF), transforaminal lumbar interbody fusion (TLIF), anterior lumbar interbody fusion (ALIF) and an extreme lateral lumbar interbody fusion (XLIF) [6-8]. The PLIF and TLIF procedure offer an additional advantage in that they only require one approach. The TLIF technique has gained popularity despite the limited evidence supporting the approach. Several theoretical, biomechanical advantages are largely responsible for the gain in popularity, as well as a few unrandomized studies [9,10]. Biomechanically, TLIF offers access to spinal canal and disc via a path that runs through the far lateral portion of the vertebral foramen. This route results in minimal retraction on nerve roots and the dural sac. Hence, there is a decrease in neurological deficit post surgery [11-13]. Also, TLIF is a single-staged procedure that offers circumferential fusion.

Furthermore, TLIF was shown experimentally to have faster recovery, decreased post-operative pain, decreased time in hospital, decreased amount of post-operative analgesics and decreased blood loss intra-operatively compared to PLIF [10,12-15]. These benefits are balanced against a decreased area of exposure and decreased application. Based on very little evidence from poorly or uncontrolled trials, TLIF gained favor over PLIF.

Advancement of the TLIF technique allows for a minimally invasive approach. This approach is designed to have the same advantages TLIF offers, but to further reduce blood loss and iatrogenic muscle damage. Initial results show that mTLIF is safe and efficacious [16-19]. The limited experimental evidence prompted our group to carry out a prospective cohort study comparing the control group PLIF to the experimental group minimally invasive TLIF.

Our group hypothesized that the mTLIF group would have a faster recovery, less blood loss intraoperatively, and less time in hospital. Our group did not hypothesize any difference in long-term pain outcomes because the procedure should result in the same biomechanical outcome.

Methods

Two prospective databases were retrospectively examined and consecutive patients from each were assigned to PLIF and mTLIF surgical groups. The first group was from a single Canadian medical center (PLIF) and the second was from a single US institution (mTLIF). Pain and functioning survey scores were used to compare outcomes between the PLIF and mTLIF groups. The PLIF group was evaluated using the Visual Analogue Score (VAS) and Oswestry disability index (ODI) surveys [20-22]. In addition to these surveys, the mTLIF group was also administered the SF-36® [23]. Patients were asked to complete the surveys at the pre-surgical visit, six weeks post-surgery, and one year post-surgery. The mTLIF group additionally completed the survey at six months post surgery and at the last available follow up.

All surveys have been validated elsewhere in a wide range of patients including spine patients [20-24]. Briefly the VAS score consists of a 10cm line on a paper that is anchored on either end by a descriptor (no pain on the left, highest pain on the right). The patient marks on the continuum where their pain is for them. The mark is then measured and this measurement becomes the VAS score [20,24,25]. The Oswestry disability index is a survey that was designed to access daily level of functioning. Generally, the survey assesses the extent to which the subject can perform the necessary activities for daily life. This method has been validated for spine patients [21,22]. The SF-36 is a commercial survey of 36 question designed to broadly access mental and physical health but more specifically to access six sub-categories: Physical Functioning (PF), Role-Physical (RF), Bodily Pain (BP), General Health (GH), Vitality (VT), Social Functioning (SF), Role-Emotional (RE), Mental Health (MH) [23,26,27].

Procedures

Posterior lumbar interbody fusion (PLIF)

Posterior lumbar interbody fusion is a widely-used procedure. The details of the procedure have been previously described in the literature [28,29].

Minimally invasive transforaminal lumbar interbody fusion (mTLIF)

The minimally invasive transforaminal lumbar interbody fusion has also been previously described.18 Briefly, the technique utilized in this cohort required the patient to be positioned prone on a Wilson frame. Fluoroscopy was used to localize the surgical level. An incision was planned 2.5 to 3.5cm lateral of midline ipsilateral to the predominant leg symptoms. Following the surgical incision, a K-wire is passed through the muscle and docked on the medial facet. Position is confirmed with fluoroscopy. Serial dilators are then passed to dilate the musculature and expand the lumbodorsal fascia. A tubular working channel is then passed over the dilators and fixed to the operative table. Through the retractor, under microscopic magnification, a hemi-laminotomy and facetectomy are performed followed by an aggressive disectomy to achieve root decompression. Interbody grafting included morselized autograft and bone morphogenic protein (rhBMP-2–Infuse, Medtronic). The working channel is then removed and percutaneous pedicle screws placed bilaterally.

Statistics

Statistical analysis was performed with SPSS for windows version 15.1 Data are presented as mean and standard deviation. The PLIF group was assigned as the “control” group and the mTLIF group assigned the “experimental” group. Selected graphs were generated using Microsoft excel for Mac version 11.5. Distribution of the data was examined by generating histograms with visual inspection and then by performing the Kolmogorov-Smirnov test. Data that was not normally distributed was compared using non-parametric testing and multiple comparisons were made using the Mann-Whitney test (MW). Data that was normally distributed was compared using ANOVA with Tukey’s post hoc testing. Differences in dichotomous outcomes were tested by Chi-square. Analysis of variables predicting patient outcomes was performed using linear regression models. Because of significant differences between age and sex in the surgical interventions, these variables were included in the models. SF-36 data was examined using the graphing feature in Microsoft excel.

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Results

Table 1 shows that there were significant differences between groups for age and sex. The table also shows that TLIF was associated with less operative blood loss and shorter stays in hospital. The baseline VAS for the leg and back as well as the Oswestry Disability Index (ODI) were different preoperatively between the PLIF and mTLIF groups (Table 2). However, both interventions resulted in significantly (P<0.0001) improved pain scores.

Table 1: Demographic data and surgical outcomes.

	PLIF	TLIF	P-value
N	31	59	
Age	42±11	54±13	<0.0001
Sex (%female)	69	45	0.035
Blood loss (cc)	764±488	228±138	<0.0001
OR time (min)	121±34	241±44	<0.0001
Hospital stay (hrs)	156±45	87±41	<0.0001

Table 2: Pre-surgical and post-surgical median (and interquartile range) for VAS of the back (B) or Leg(L) and ODI are compared between the control and experimental groups. Greater VAS is shown pre-operatively in the control group. Lower pain scores are shown in the experimental group post-surgery. *p<0.0001 PLIF vs mTLIF; ** p<0.0001 Pre vs Post; † p<0.01 pre vs. post at 1 year.

	Pre VASL	Pre VASB	Pre ODI	Post VASL	Post VASB	Post ODI
PLIF	9.0 (9,10)*	9.0* (8,10)	78* (72,80)	3.0** (2,3)	3.0** (3,4)	24** (23,28)
mTLIF	5.0 (1.8,7)	5.6 (3,7.5)	42 (36,52)	0.0**† (0.0, 2.3)	1.3**† (1.0,2.1)	18**† (16,21)

Table 3: Linear Regression of predictors for pre-operative and change (delta) in pain outcomes.

Dependent variable	Predictors	Coefficient (B)	95% CI	P-value
Pre-surgical VASL	Group	-46.4	(-58.1,-34.7)	<0.0001
Pre-surgical VASB	Group	-27.408	(-38.7,-16.1)	<0.0001
	Sex	-14.4	(-25.6,-3.1)	0.013
Pre-surgical ODI	Group	-30.4	(-35.6,-25.2)	<0.0001
	Age	-0.172	(-.357,0.013)	0.068
Delta VASL	pre-surgical VASL	0.428	(0.166,0.679)	0.002
	Group	-23.336	(-39.3,-7.4)	0.005
Delta VASB	pre-surgical VASB	0.677	(0.475,0.880)	<0.0001
Delta ODI	Group	-25.6	(-33.4,-17.7)	<0.0001

Since there were statistical differences in sex, age and baseline scores, multivariate linear regression was performed to predict variables associated with pre- and pre-post (delta) surgery pain scores. Table 3 shows that pre-surgical scores were largely associated with assigned surgical intervention (group); however, pre-surgical VASB was also associated with sex (more females in PLIF) and pre-surgical ODI was associated with age (older age with mTLIF). When the change (delta) in pain score was examined by linear regression, pre-surgical score was the only significant predictor (P<0.0001) of change at one year for the VAS back. For delta VAS leg, both pre-surgical score and assigned surgical intervention (group) were significant predictors. However, assigned surgical intervention (group) was the only independent predictor of delta ODI score post surgery. In all these analyses age and sex were forced into the model but were not significant. Also, multivariate linear regression of the post-surgical scores was performed. In all cases the surgical group was a significant predictor of final score (p<0.0001). The results for the post-surgical group regression favored the mTLIF group.

The SF-36 was collected for the mTLIF group only. Scores were converted and plotted. Physical Functioning (PF), Role-Physical (RF), Bodily Pain (BP), General Health (GH), Vitality (VT), Social Functioning (SF), Role-Emotional (RE), Mental Health (MH) all show improvement in the mTLIF group. MH and GH increase slightly over the first 6 weeks and decline to the pre-surgical score in the case of GH. All other measures appear to improve steadily over the first year and then level out after 52 weeks (Figure 1).

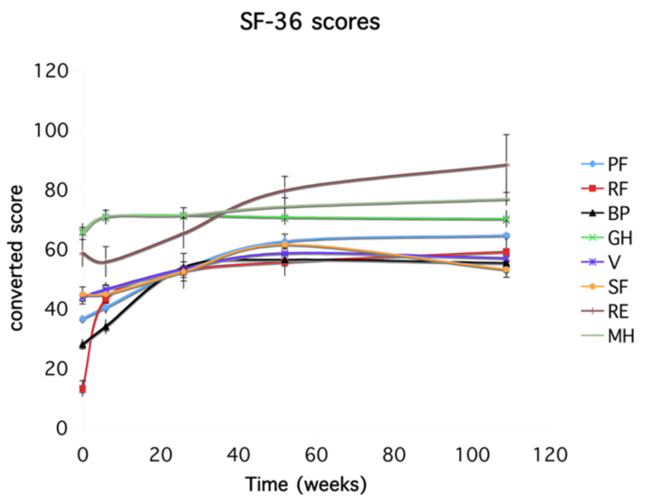

Figure 1: In the TLIF group all measures shown show a trend for improvement over the first year then the trend is for stabilization.

Discussion

The mTLIF procedure resulted in several excellent clinical advantages. Although we did not compare the minimally invasive method to the traditional TLIF, our blood loss and hospital stays appear to be lower. Blood loss was 228ml in this report compared

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to 489-1612ml for the traditional TLIF [6,11,15,19,29]. We report much shorter hospital stay (87hrs) compared to the traditional TLIF (118-168hrs) [11,29]. Moreover, in this study median VAS scores of back pain for the mTLIF group are lower at the last follow up (1.35) compared to the traditional TLIF scores in the literature (3.2-3.7) [10,14,30]. The SF-36 data is further evidence that the mTLIF procedure has good long-term outcomes. In a study by Dhall et al. [19] comparing open and mTLIF a similar reduction in blood loss and hospital stay was seen in the mTLIF group [31]. Furthermore, a recent meta-analysis by Goldstein et al confirmed these trends [19].

The mTLIF procedure results in significantly less blood loss, shorter hospital stays and lower pain-scores at one-year post surgery compared to the PLIF group. With respect to patient pain scores, the best outcome is arguably the post surgical score. However, some would contend that a change in score is more important. We analyzed both separately. Clearly, mTLIF resulted in the lowest pain scores. PLIF had the biggest improvements. We attempted to identify what proportion was the result of the intervention, the demographics and the baseline pain scores. The results were mixed. Delta VAS back appeared to be largely explained by pre-score. ODI was explained by the intervention alone: whereas, both intervention and pre-surgical score predicted delta VAS leg. These findings, slightly favoring mTLIF, are in accord with Goldstein et al. [19].

The baseline preoperative scores between the 2 groups were significantly different. Differences in sex contributed statistically to differences in baseline preoperative pain in the VAS of the back group by linear regression analysis and age approached significance for the ODI score. The assigned surgical intervention (group) was a predictor in all cases. Since the surgical intervention cannot explain baseline pain scores we speculate the patients differed in other ways. The PLIF group was comprised of Canadian only patients. The TLIF group was comprised of patients from the United States. The US patients were, in general, operated on sooner than the Canadian group. In Canada longer wait times may result in the progression of pain. Perhaps increased degeneration over time may partially explain the increased pain in the Canadian group. Poor patient selection may result in a falsely significant decrease in pain. Therefore, the greater drop in pain score may be an artifact of the higher pre-surgical pain level of the PLIF group.

Our group did not hypothesize finding any long-term difference in overall pain reduction. The end result of the procedures should be mechanically the same. The lower one-year VAS in the mTLIF group compared to the PLIF group should be interpreted with caution. Our group did not collect enough demographic data to convincingly determine the effect of demographics on pain scores both pre- and post-operatively. Regardless, both the control and experimental showed both clinically and statistically significant improvement in pain and functioning scores.

Despite the limitations of this non-randomized study, the observations support mTLIF as a procedure to be considered for patients requiring lumbar fusion in the setting of degenerative disease. Our results demonstrate less blood loss, shorter hospital stays and excellent improvement in pain measured by validated instruments.

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