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MINIMALLY INVASIVE TRANSFORAMINAL LUMBAR INTERBODY FUSION IN GERIATRIC PATIENTS

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ABSTRACT

Objective: Several studies report that spine surgery in elderly patients (>65 years old) is associated with higher reoperation and complication rates. Although transforaminal lumbar interbody fusion (TLIF) in elderly patients can result in lower clinical improvement and higher complication rates, minimally invasive surgery (MIS) TLIF has potential advantages. We compared clinical outcomes and complication rates after MIS TLIF with pedicle screw fixation in younger and older geriatric patients (those aged 65 to 74 years compared to those aged 75 to 85 years).

Materials and Methods: This was a retrospective cohort study of patients with lumbar degenerative spondylolisthesis. Patients were divided into those between 65 and 74 years old (n=45) and those between 75 and 84 (n=23). Patients had two-year follow-up.

Results: Older geriatric patients (between 75 and 84 years old) had 1.3 times as many comorbidities as the younger patients, but the difference was not statistically significant. Surgery was significantly longer in the older cohort, but there were no significant differences in intraoperative complications. There were no differences in complication rates during postoperative hospitalization or within 30 days after discharge. No significant differences in complication rates were noted at 6 or 24 months after discharge. There were no differences in patient reported outcomes. Minimum clinically important differences in patient reported outcomes were the same between cohorts at last reported outcome.

Conclusion: The MIS TLIF with pedicle screw fixation for degenerative spondylolisthesis is as safe and effective in older geriatric patients as in younger ones.

Keywords: Degenerative spondylolisthesis, transforaminal lumbar interbody fusion, minimally invasive surgery, geriatric, patient reported outcomes

INTRODUCTION

Advanced age is associated with the development of degenerative spondylolisthesis[1]. As life expectancy increases, and older adults desire to remain active and enjoy high quality of life, it is likely that the number of surgeries performed will increase. Several studies have reported that spine surgery in elderly patients is associated with a higher likelihood of reoperations and complications[2,3]. When non-operative treatments fail to treat symptomatic degenerative spondylolisthesis, decompression and fusion surgeries are frequently performed in the presence of unstable segments, even in elderly patients[4]. The transforaminal lumbar interbody fusion (TLIF) technique is one fusion option and can be used for various pathologies of the spine including degenerative spondylolisthesis[5].

Although TLIF in elderly patients can result in lower clinical improvement and higher complication rates[6], minimally invasive surgery (MIS) TLIF has many potential advantages: less blood loss, shorter hospital stays, and earlier rehabilitation compared to open surgery[7,8]. MIS surgery is particularly well suited for the lumbar region for decompression and interbody fusion. By reducing the surgical trauma, MIS surgery can reduce perioperative morbidities and improve functional outcomes.

The goal of this study was to determine whether advanced age affects complication rates and clinical outcomes of patients who underwent MIS TLIF for degenerative spondylolisthesis. Our hypothesis was that advanced age would not affect complication rates and clinical outcomes.

MATERIALS AND METHODS

We conducted a retrospective cohort study of subjects treated over a four-year period at a spine specialty center by a single investigator. Quorum Review Institutional Review Board (#30779/1) approved the investigation and we obtained written informed consent for participation from all participants. In this study, eligible subjects were 65 years old or older on the date of surgery. All subjects were diagnosed with lumbar

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degenerative spondylolisthesis and treated by MIS TLIF with pedicle screw fixation. Other pathologies (traumatic, dysplastic, isthmic, and pathologic spondylolisthesis) and other treatments (e.g., open posterolateral fusion) were excluded. Prior lumbar spine fracture and a history of malignancy were also reasons for exclusion. We only studied patients who were cleared by anesthesia and received surgery. Information about others who did not receive surgery because of health concerns was not available to us.

At 65 years, patients are considered old[9] and at 75 years, old-old[10]. Accordingly, we stratified subjects into two cohorts, according their ages at the time of their index surgery: sixty-five to 74 years old and 75 to 84 years old[11]. Patient demographics were collected, including age, body mass index (BMI), sex, smoking status, worker compensation status, and prior lumbar spine surgery history. Eight comorbidities (diabetes mellitus, chronic kidney disease, coronary artery disease, chronic obstructive pulmonary disease, endocrinopathy, neurologic disorder, metabolic bone disease, and rheumatologic disorder) were noted. Patients were followed for 24 months.

Our minimally invasive technique has been previously described[12]. A 2.5 cm, paramedian skin incision is made 4.5 cm from midline on the symptomatic side. A fascial incision is made medial to the skin incision. The 22 mm retractor tube is obliquely directed in the Wiltse plane toward the facet joint. When the tube meets the facet joint at the operative level, radiographic confirmation is obtained. A unilateral facectectomy is performed with high-speed burr or osteotome for direct decompression of the disc space. Resected bone tissue is saved for bone grafting. The discectomy is performed with scalpel and box chisel; rasps are used for endplate preparation. The disc space is sized with trials and the appropriately-sized interbody device (packed with bone graft) is implanted by gentle impaction. For two-level procedures, the retractor tube is "wanded" to access both disc spaces and all pedicle screw locations through a single skin incision. The contralateral side is similarly exposed to place pedicle screws and perform facet joint fusion.

Intraoperative data included the length of surgery, estimated blood loss (EBL), number of levels fused, and use of bone morphogenetic protein (BMP). Complications were collected intraoperatively, during postoperative hospitalization, and 30 days, 6 months, and 24 months postoperatively. Major complication classifications included durotomy, genitourinary injury, wound-related, neurologic, pulmonary, cardiac, vascular (including deep vein thrombosis and pulmonary embolism), and gastrointestinal. Complications requiring surgical management within 24 months were adjacent segment disease, recurrence of symptoms, painful instrumentation and pseudoarthrosis. Painful instrumentation was defined as local pain over the site of the instrumentation which was relieved by trigger point injection. In all patients diagnosed with this complication, the instrumentation was removed, and symptoms resolved.

Functional outcomes [oswestry disability index (ODI) and the visual analog scale (VAS) for back and leg pain] were collected preoperatively and at each postoperative clinic visit (6 weeks and 3, 6, 12, and 24 months). Because some data points were missing for some patients at one or more time point, we calculated the difference between the preoperative value and the last reported value. The minimum clinically important difference (MCID) for ODI was 12.8, for VAS back pain was 1.2, and VAS leg pain was 1.6[13].

Statistical Analysis

The two age cohorts were compared using independent sample t-tests for numeric variables. Chi-square analysis was used for categorical variables. Fisher's exact test was used instead of the chi-square t-test when expected cells sizes were less than 5. A significance level of 0.05 was used throughout. The data analyses for this paper were generated using the Real Statistics Resource Pack software (Release 6.8). Copyright (2013-2020) Charles Zaiontz. www.real-statistics.com.

RESULTS

Patient Characteristics

Eighty-five subjects were identified but seventeen declined to be involved in research (Figure 1). The average age at the time of the index surgery was 71 (range, 65-84) (Table 1). There were 45 subjects in the 65-74 cohort and 23 in the 75-84 cohort. There were 40 females and 28 males. The average BMI was 30±6 (Table 1). Thirty subjects (30/68, 44%) were current and former smokers. Eighteen patients (26%) had prior lumbar spine surgery. Two subjects (3%) were receiving worker's compensation. All patients had 2-year follow-up for complications.

Cohort Specific Comorbidities

The older cohort had, on average, 1.3 times more comorbidities than the younger cohort, but difference was not statistically significant (p=0.20, Table 2). In the 65-74 cohort, 24 subjects (53%) had one or more major comorbidity and in the 75-84 cohort, 16 subjects (70%) had. Coronary artery disease was

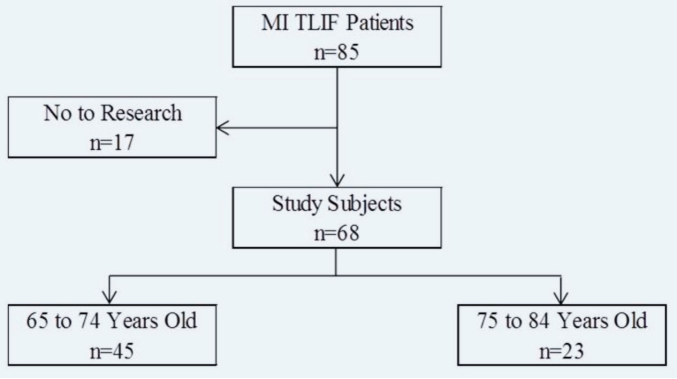

Figure 1. Disposition of study population
TLIF: Transforaminal lumbar interbody fusion

significantly more prevalent in the older group compared to the younger group (p<0.01).

Perioperative Factors

The younger and older cohorts were statistically similar with respect to the length of surgery, the EBL, the number of levels fused, use of biologics, and length of hospital stay (Table 3).

Intraoperative Complications

An incidental durotomy was noted in one patient in the 65-74 cohort (Table 4). Statistically, there was no difference between cohorts with respect to intraoperative complications (p=1.00). The length of surgery was statistically longer for the older group compared to the younger group (p=0.4), but EBL, number of levels fused, and use of BMP were not different.

Hospitalization Complications

It is the general practice at our institution to monitor patients in the in-patient setting for MIS spine fusion surgery. Accordingly, most patients were discharged a few days postoperatively [median length of stay (LOS), 3 days, range 2 to 12 days] (Table 2). Genitourinary complications were the most common during postoperative hospitalization, but the rate was not different between groups (Table 4, p=0.22). Wound-related, neurologic, pulmonary, and cardiac complications occurred less frequently. Overall, the complication rate during postoperative hospitalization the same between groups.

30-day Postoperative Complications

Six subjects (9%) experienced a complication from the day of discharge to 30 days postoperatively. Three subjects were in the younger cohort and 3 were in the older cohort (p=0.40). There were two superficial wound complications among the older subjects (Table 4).

6-Month Postoperative Complications

Two subjects (4%) experienced complications in the period between 30 days after discharge and six months postoperatively (Table 4). Both were in the 64-74 years old cohort (Fisher's exact test, p=0.55).

Table 1. Demographics of study population

		Age category		
Demographic	**All patients (n=68)**	**65-74 (n=45)**	**75-84 (n=23)**	**p-value***
Age at surgery, median (range)	71 (65-84)	69 (65-74)	77 (75-84)	<0.01
BMI, mean (SD)	31±7	31±7	30±7	0.61
Female sex, n	40	27	13	0.78
Smoking status, n				
Current	2	1	1	0.69
Former	28	20	8	
Never	38	24	14	
Prior lumbar surgery, n	18	13	5	0.53
WC/litigation, n	2	1	1	0.62

*Comparing age categories
BMI: Body mass index, SD: Standard deviation

Table 2. Comorbidities of study population

		Age category		
Major comorbidity	**All patients (n=68)**	**65-74 (n=45)**	**75-84 (n=23)**	**p-value***
Diabetes mellitus	14	9	5	1.00
Chronic kidney disease	7	4	3	0.68
Coronary artery disease	13	4	9	<0.01
Chronic obstructive pulmonary disease	5	3	2	1.00
Endocrinopathy	11	6	5	0.49
Neurologic disorder	5	2	3	0.33
Metabolic bone disease	7	4	3	0.68
Rheumatologic disorder	3	3	0	0.55
Patients having 1 or more major comorbidity	40	24	16	0.20

*Comparing age categories

Table 3. Perioperative factors

Factor	All patients (n=68)	Age category 65 74 (n=45)	75-84 (n=23)	p-value*
Length of surgery, minimum Median (range)	131 (75-248)	123 (73-203)	144 (85-248)	0.04
Estimated blood loss, mL Median (range)	113 (10-600)	100 (10-600)	150 (50-500)	0.21
Number of levels fused Median (range)	1 (1-2)	1 (1-2)	1 (1-2)	0.20
BMP used, n	34	21	13	0.44
Length of stay, days Median (range)	3 (2-12)	4 (2-12)	3 (2-10)	0.44

*Comparing age categories
BMP: Bone morphogenetic protein

Table 4. Summary of complications

Complication	All patients (n=68)	Age category 65-74 (n=45)	75-84 (n=23)	p-value*
Intraoperative period				
Durotomy	1	1	0	1.00
Hospitalization period				
Genitourinary	7	3	4	0.22
Wound-related	2	1	1	1.00
Neurologic	2	2	0	0.54
Pulmonary	4	3	1	1.00
Cardiac	2	0	2	0.11
30-day postoperative follow-up				
Genitourinary	1	1	0	1.00
Wound-related	2	0	2	0.11
Neurologic	1	1	0	1.00
Pulmonary	1	1	0	1.00
Vascular/DVT/PE	1	0	1	0.34
Gastrointestinal	1	1	0	1.00
6-month postoperative follow-up				
Neurologic	1	1	0	1.00
Pulmonary	1	1	0	1.00
Vascular/DVT/PE	1	1	0	1.00
Two-year postoperative follow-up				
Adjacent segment disease	3	2	1	1.00
Recurrence of symptoms	3	1	2	0.26
Painful instrumentation	4	3	1	1.00
Pseudoarthrosis	1	1	0	1.00
Patients having 1 or more complication				
Intraoperative period	1	1	0	1.00
Hospitalization period	12	6	6	0.32
30-day postoperative follow-up	8	5	3	1.00
6-month postoperative follow-up	2	2	0	0.55
Two-year postoperative follow-up	11	7	4	1.00

*Comparing age categories
DVT: Deep vein thrombosis, PE: Pulmonary embolism

24 month Postoperative Complications

Painful instrumentation was the most common complication between six and 24 months postoperatively (Table 4). Overall, 10 of the 68 subjects (15%) experienced a complication in this period.

Functional Outcomes

ODI, VAS back pain, and VAS leg pain were comparable between older and younger subjects (Table 5). Considering the proportions of subjects achieving MCID, there were no statistically significant differences between cohorts ODI, VAS back pain, or VAS leg pain (Table 6).

DISCUSSION

Low back and leg pain from degenerative spondylolisthesis complaints are common in the elderly population, impacting the activities of daily living and decreasing quality of life. Additionally, chronic pain can cause depression, sleep disorders and loss of independence[14]. As the population ages, spine surgeons can expect to have more surgical discussions with this population in the future. Knowledge of the expected outcomes and complication rates in this population is critical for surgical decision making. The literature has demonstrated both good outcomes, as well as increased complication rates. Studies have shown that MIS techniques are safe for the elderly population[15]. However, elderly patients who had longer operative times and more extensive surgeries have been found to have more complications[16]. A meta-analysis showed that MIS TLIF has shorter operative times and LOS compared to open surgery, while providing similar clinical outcomes[17]. Rouben et al.[18] showed excellent five-year clinical outcomes in older patients who underwent MIS TLIF, comparable to the younger population. Our study corroborates these findings by showing that younger and older geriatric patients improved in ODI, VAS back and VAS leg after surgery and at last follow-up[18]. MIS surgery, when compared to open surgery, has similar complication rates and clinical success, but is technically challenging with a steep learning curve[19,20]. This is a consideration in elderly patients, who may be more affected by the increased blood loss and operative time associated with MIS procedures performed by surgeons learning MIS techniques. In the present study, a senior surgeon who with 20 years of MIS experience performed all the surgeries. The overall intraoperative complication rate for older patients was like that of the younger population. Buck and Yoon[21] reported a 5% rate of incidental durotomies for short segment lumbar

Table 5. Patients reported outcomes

		Age category		
Outcome (n)	All patients	65-74	75-84	p-value†
Oswestry disability index				
Preoperative (62)	46±15	46±15	45±14	0.73
12 m postoperative (51)	22±19	22±19	23±20	0.81
24 m postoperative (26)	27±17	25±18	29±16	0.53
VAS-back				
Preoperative (39)	7±3	6±3	8±2	0.07
12 m postoperative (37)	2±3	2±3	2±3	0.99
24 m postoperative (26)	2±3	2±2	3±4	0.27
VAS-leg				
Preoperative (40)	7±3	6±3	7±2	0.29
12 m postoperative (26)	2±3	1±2	2±4	0.75
24 m postoperative (22)	2±2	1±2	2±3	0.11

*Number of subjects at the time point of interest
†Comparing age categories
VAS: Visual analog scale

Table 6. Patients achieving MCID* at last patient reported outcome†

		Age category		
Outcome	All patients	65-74	75-84	p-value‡
Oswestry disability index	39 (63%)	26 (62%)	13 (65%)	0.81
VAS-back	33 (85%)	20 (77%)	13 (100%)	0.08
VAS-leg	27 (71%)	17 (71%)	10 (71%)	0.97

†MCID Thresholds: 12.8 for ODI; 1.2 for VAS-back; 1.6 for VAS-leg
‡Comparting age categories
*MCID: Minimum Clinically Important Difference, VAS: Visual analog scale

fusions, with age being a risk factor. Klingler et al.[22] reported a rate of 6% incidental duratomies for MIS-TLIF, with age greater than 65 being a positive predictor factor. In the present study, durotomy was seen in 1.5% of patients. Other studies found advanced age to be a risk factor for incidental durotomy in lumbar surgery, but we did not find age to be a risk factor for durotomy in MIS-TLIF[21,23,24].

Complications after surgery may or may not have direct connection to the procedure. Wang reported a 37% overall complication rate after MIS TLIF, 14% related to the surgery and 23% not. Similarly, in our study 18% of patients experienced one or more complication during hospitalization (12/68), but only 7% of patients (5/68) experienced one or more complication directly related to the surgery. Wang found genitourinary problems were the most common complication not directly related to the surgery[25]. Likewise, the most common complication we observed was genitourinary (10% of all patients). Pneumonia, delirium, confusion, arrhythmia, pulmonary edema, and hypoxia were other problems encountered during hospitalization in the elderly group.

In a meta-analysis comparing the incidence of adjacent segment disease after open versus MIS TLIF and posterior lumbar interbody fusion, authors reported MIS can reduce the incidence of adjacent segment degeneration[26]. Ong et al.[3] reported a 17% reoperation rate and a 25% readmission rate after posterolateral fusion in older patients at 2 years. Sears et al.[27] reported 13% of patients who had a lumbar interbody procedure needed further surgery at an adjacent level at a mean of 43 months. Age greater than 60 years was a risk factor for adjacent level surgery in Sears et al.[27] study. Lee et al.[28] also reported that age greater than 60 years was an independent risk factor for adjacent segment disease. In our study, there was an overall 4% incidence of adjacent segment disease. The incidence did not increase with aging, as the rates were the same between cohorts. Preserving supportive midline tissues via MIS in this particular group may decrease adjacent segment disease. A future study comparing open vs MIS TLIF in elderly patients could guide optimal treatment for this demographic.

Patient reported outcomes were similar between cohorts. At the end of the study period, there were no differences between older patients (>75 years old) and younger patients (>65 years old). Moreover, even though geriatric patients often have significant comorbidities, our sub-analyses of patients with one or major comorbidity did not elucidate any differences between cohorts with respect to complications or functional outcomes. The older patients need not expect more complications or inferior clinical outcomes compared to younger patients.

Study Limitations

This study was limited to the diagnosis of degenerative spondylolisthesis. This limitation strengthens our study with respect to others as some investigators report that clinical outcome depends upon pathology. By limiting ourselves to one pathology, we avoided a possible confounder. Another limitation of this study is that it is retrospective. Retrospective designs may have unrecognized bias and/or confounders. We had 2-year follow up for complications, but we had some loss-to-follow-up with regard to patient-reported outcomes. Fortunately, the proportions of patients in the cohorts was similar at the beginning and end of the study. Thus, this bias may possibly be mitigated. Another limitation is that we did not include a radiographic evaluation of the MIS TLIF technique. This was outside the scope of the present study.

CONCLUSION

This study asked the question whether advanced age affects complication rates and clinical outcomes of MIS TLIF for degenerative spondylolisthesis. We found that MIS TLIF for degenerative spondylolisthesis is as safe and effective for older geriatric patients (75-84 years old) as it is for younger geriatric patients (65-74 years old). Older patients need not expect more complications or inferior clinical outcomes compared to younger patients. These results can help guide surgeons and patients when considering an MIS TLIF with pedicle screw fixation for degenerative spondylolisthesis.

Ethics

Ethics Committee Approval: Quorum Review Institutional Review Board (approval number: #30779/1, date: 30.07.2015) approved the investigation.

Informed Consent: Written informed consent was obtained for participation from all participants.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: A.F.B., E.S., J.M.D., C.J.G., J.D.S., Concept: A.F.B., E.S., J.M.D., C.J.G., J.D.S., Design: A.F.B., E.S., J.M.D., C.J.G., J.D.S., Data Collection or Processing: A.F.B., E.S., J.M.D., C.J.G., J.D.S., Data analysis or Interpretation: A.F.B., E.S., J.M.D., C.J.G., J.D.S., Literature Search: A.F.B., E.S., J.M.D., C.J.G., J.D.S., Writing: A.F.B., E.S., J.M.D., C.J.G., J.D.S.

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