Preliminary Results on Feasibility of Outpatient Instrumented Transforaminal Lumbar Interbody Fusion

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Study Design: A retrospective chart review study was performed.

Objective: The primary objective of this study was to analyze our preliminary results to examine whether it is safe and effective to perform instrumented lumbar interbody fusions on an outpatient basis by comparing 2 groups of patients who were discharged the same day versus those who stayed overnight. The secondary objective was to identify the need for prolonged observation for complications that may occur in the immediate postoperative period.

Summary of Background Data: There is currently no information in the literature on the safety and complication rates of instrumented transforaminal lumbar interbody fusions performed in an ambulatory surgery setting.

Methods: Surgeries were performed at an ambulatory surgery center (n = 27) or hospital outpatient departments (n = 25). The mean age of patients was 49.8 years (range, 19–72 y). The safety of outpatient lumbar fusions was assessed by analyzing complications that occurred from the moment of discharge up to the seventh postoperative day (0–7 POD), as well as all complications that occurred up to 6 months postoperatively (> 7 POD). The efficacy of surgical intervention was also evaluated by assessing change in pain, patient satisfaction scores, and fusion rates.

Results: There were no cases of pneumonia, urinary tract infection, or thromboembolic complications. Four patients (14%) who had surgeries performed at an ambulatory surgery center had complications within 7 days postoperatively compared with 1 (4%) patient who had surgery performed at a hospital outpatient department. This difference was not statistically significant ($P = 0.36$, Fisher exact test). Lower back and leg pain was significantly ($P < 0.0001$) decreased postoperatively. The average postoperative back pain was 18.8 (range, 0–90) compared with 74.5 (range, 0–100) preoperatively as measured on a 0–100 visual analog scale. The average postoperative leg pain was 9.1 (range, 0–60) compared with 54.2 (range, 0–100) preoperatively.

Conclusions: Although further confirmation is needed, this study discusses the possibility of performing instrumented lumbar interbody fusions with the transforaminal lumbar interbody fusion technique as an outpatient procedure. These results support a future prospective randomized study with a well-defined patient selection criteria.

Key Words: interbody lumbar fusion, outpatient surgery, safety, transforaminal

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From 1994 to 1996 an estimated 4%–13% of all lumbar surgery cases were performed on an outpatient basis. In the next 3-year period (1997–2000), there was a 9%–17% increase in outpatient lumbar procedures. Lumbar discectomies comprised up to 90% of these cases and the proportion of fusions was below 1%.[1] A significant increase was seen in lumbar fusion rates in 2007 with 10.6% performed in ambulatory settings.[2] Traditionally, lumbar fusion surgeries have been performed as inpatient procedures; however, recently this standard of care is gradually changing due to the development of less-invasive surgical techniques that allow for reduced operative time, blood loss, and intraoperative complications.[3–5] There is currently no information in the literature on the safety and complication rates of instrumented lumbar interbody fusion performed in an ambulatory surgery setting.

Health care providers are beginning to look at hospitalization issues from a perspective of today's changing clinical environment, especially in the setting of today's antibiotic-resistant and hospital-acquired infections. Centers for Disease Control and Prevention estimates that almost 100,000 deaths annually are caused by hospital-acquired infections in the United States.[6] Acquired antimicrobial resistance remains the major factor contributing to the mortality rates. Antimicrobial resistance was significantly higher in a study that compared the occurrence rates between inpatient and outpatient groups.[7] According to a model for hand transmission of a pathogen in a hospital ward, a single noncompliant health care worker who attends to numerous patients could cause a 73%–238%

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increase in infections per month.[8] Recently, the methicillin-resistant *Staphylococcus aureus* prevalence and risk of spread have been identified.[9] A total of 12.7% (191 of 1501) patients who were hospitalized for > 48 hours carried methicillin-resistant *S. aureus* and transmitted it to the other household members after discharge from the hospital.

Thromboembolism remains another important complication after surgical interventions. A recent study prospectively examined hospital admission and postoperative risk of venous thromboembolism in a cohort of almost 1 million middle-aged women.[10] There was a 7-fold increased risk of venous thromboembolism complications after inpatient surgeries compared with outpatient surgeries in the first 6 weeks. The higher risk was associated with certain types of surgeries (joint replacement or cancer surgeries), but hospital admission remained an important factor.

A systematic review of the literature[11] analyzed a diverse group of outpatient surgeries and included studies published from 1966 to 2000. The analysis revealed that 45% of the patients postoperatively complained of pain, 42% of drowsiness, 21% of fatigue, 18% of dizziness, 17% of nausea, 17% of nonspecific headaches, 9% of postdural puncture headaches, and 8% of vomiting. There were no problems reported in this study that were critical or life threatening. Moreover, there were no infections (urinary tract, pneumonia), acute respiratory distress syndrome, venous thromboembolism including pulmonary or deep vein thrombosis reported in this study.

Prolonged hospital stays may better address such problems as inadequate pain control, urinary retention, constipation, nausea, and vomiting but are directly associated with rising health care costs and increased risk of infection, pneumonia, and thromboembolic complications. An active and prompt rehabilitation leads to faster recovery and early resumption of normal activities. Therefore, the primary objective of this study was to analyze our preliminary results to examine whether it is safe and effective to perform instrumented lumbar interbody fusions on an outpatient basis by comparing 2 groups of patients who were discharged the same day versus those who stayed overnight. The secondary objective was to identify the need for prolonged observation for complications that may occur in the immediate postoperative period.

MATERIALS AND METHODS

Patients

A total of 52 one-level transforaminal lumbar interbody fusions (TLIF) with instrumentation were performed as follows: 27 patients had surgery on an outpatient basis at an ambulatory surgery center (ASC) and were discharged the same day of surgery and 25 patients were admitted overnight to hospital outpatient departments (HOD) for a < 24-hour observation period. The determination to perform outpatient surgeries was based on several factors, including the age of patients, comorbidities, adequacy of postoperative home care, need for analgesic medications, travel distance, or personal preferences. Hospitalization time in this study was defined as the time from when a patient leaves the operating room until discharge, including the stage I and stage II recovery time. The majority of surgeries at HODs were performed before the middle of 2008 and almost all outpatient surgeries performed at ASC following that.

TABLE 1. Selected Demographic and Surgical Patient Parameters

	ASC (n = 27)	HOD (n = 25)	*P*-value
Demographic parameters			
Age	48.9 (26–61)	50.7 (19–72)	0.6
M/F	12/15	16/9	0.18*
Previous surgeries	7 (26%)	12 (48%)	0.15*
Surgical parameters			
EBL	73 (25–300)	179 (25–1000)	0.007
Operative time	146 (95–274)	196 (108–291)	0.002
Open approach	2 (7.4%)	18 (72%)	N/A
Percutaneous approach	3 (11.1%)	6 (24%)	N/A
Miniopen approach	22 (81.5%)	1 (4%)	N/A

t test and Fisher exact (*) tests were used to calculate *P* values.
ASC indicates ambulatory surgery center; EBL, estimated blood loss; HOD, hospital outpatient departments; N/A, not applicable.

Patients with at least of 12 months follow-up time were included in the study; the mean follow-up time was 25 months (range, 17–48 mo). There were 24 women and 28 men in this cohort of patients. The mean age was 49.8 years (range, 19–72 y). The patients underwent surgery for painful degenerative disk disease associated with radiculopathy (n = 13), herniated disk (n = 13), stenosis (n = 15), instability (n = 10), and intradural tumor (n = 1). A total of 19 patients (37%) had previous surgeries including fusion (n = 2), microdiscectomy (n = 10), laminectomy (n = 5), compression fracture (n = 1), and sacral root stimulator (n = 1). Selected patient demographic criteria are presented in Table 1 for the ASC and HOD groups. There were no statistically significant differences between the groups.

Safety and Clinical Outcome Assessment

This was a retrospective chart review study with a prospective complication-related data collection. Safety of outpatient lumbar fusions was assessed by analyzing complications that occurred from the moment of discharge and up to the seventh postoperative day (0–7 POD). Complications were defined as any adverse events that required symptomatic treatment or intervention and occurred intraoperatively and/or during a follow-up period and were directly or indirectly related to surgery. Complications included hospital admissions, visits to the emergency department as well as complications reported by patients or identified by a surgeon at follow-up appointments. Special attention was paid to the complications that may have been directly related to hospitalization: urinary tract infections, pneumonia, and thromboembolic complications. All complications that occurred up to 6 months

	Very satisfied	Somewhat satisfied	Don't know	Somewhat dissatisfied	Dissatisfied
How satisfied are you with the outcomes of your surgery?	☐	☐	☐	☐	☐
	Much better	Better	Same	Worse	Much worse
How is your pain or condition that you had surgery for now compared to before surgery?	☐	☐	☐	☐	☐
	Definitely yes	Probably yes	Don't know	Probably no	Definitely no
Would you have surgery again for the same condition?	☐	☐	☐	☐	☐
Satisfaction Score	100%	75%	50%	25%	0%

FIGURE 1. Patient Satisfaction Questionnaire.

postoperatively (> 7 POD) were examined in a separate group.

The efficacy of surgical interventions was evaluated by comparing preoperative and postoperative visual analog scale (VAS from 0 to 100) pain scores for lower back and lower extremities. Patient satisfaction was assessed using a self-reported patient satisfaction survey (Fig. 1). A total score was calculated for each patient by averaging the scores from all 3 responses and the means were compared between the patient groups who underwent surgery at ASC or HOD. Answers were scored on a scale from 0% to 100%. The patients who had surgery performed at ASC were also asked whether they would have surgery as an outpatient procedure again.

Complete radiographic fusion was defined as an allograft bone incorporation into the surrounding bone and < 2-degree angular movement on flexion/extension lateral radiographs.

Surgeries

Excessive blood loss and duration of the surgical procedure could lead to additional intraoperative and perioperative complications, thus all surgeries were analyzed according to 3 different approaches for both the ASC and HOD groups. Surgeries were performed using: percutaneous (n = 9), miniopen (n = 23), and open (n = 20) approaches. The percutaneous TLIF approach was performed using the tubular retraction system (METRx Tubular Retractor, Medtronic Sofamor Danek), and all of these patients had bilateral pedicle screws. Pedicle screws were placed percutaneously using the CD Horizon Sextant Spinal System (Medtronic Sofamor Danek), PathFinder pedicle screw system (Zimmer Spine, Minneapolis, MN), and Telluride MIS Spinal Fixation System (Lanx, Broomfield, CO). The surgical techniques for the percutaneous and open TLIF procedures have been previously described.[3] All open procedures were also performed using bilateral pedicle screw fixation.

The miniopen approach (n = 23) was performed using the Aspen Spinous Process System (Lanx). The Aspen device is an interspinous process clamp designed to be directly attached to the spinous processes of the levels being fused and functions as a substitute or an adjunct to pedicle screw fixation. It allows for a less-invasive

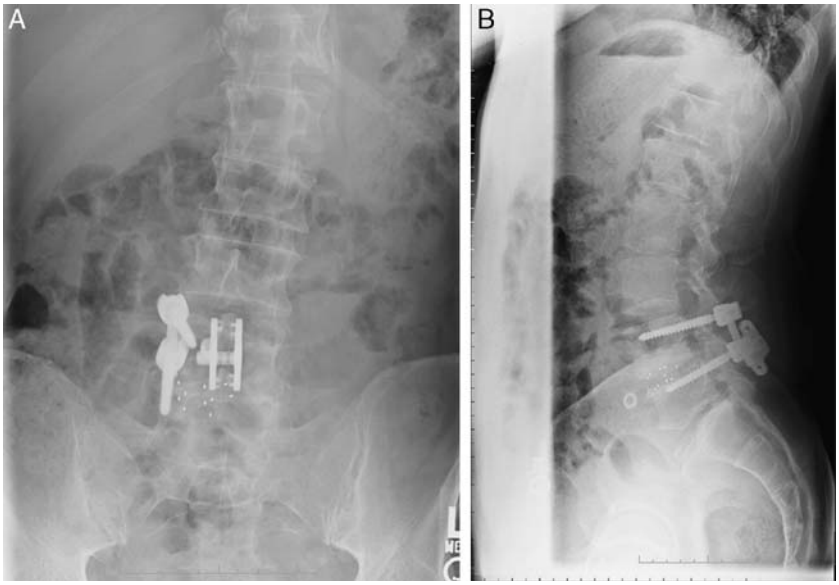

FIGURE 2. Postoperative anteroposterior (A) and lateral (B) radiographs demonstrating the Aspen device and unilateral pedicle screws.

approach when used along with unilateral pedicle screw fixation. Unilateral pedicle screws were used in 20 (including 2 patients who had unilateral screws placed percutaneously) of 23 cases. The remaining 3 patients in this group had no pedicle screws. For the miniopen approach using the Aspen device and unilateral pedicle screws, a small midline incision was created over the spinous processes at the index level. The incision was carried down to the fascial layer, which was then incised using a monopolar electrocautery and carried in the subperiosteal plane along the spinous process down the lamina bilaterally. The facet joints were indentified and carefully exposed after fluoroscopic verification of the correct level. Because the pedicle screws are placed on the side of the transfacet decompression and TLIF, the medial border of the pedicles was directly visualized. This allows for a much more medial starting point for placement of the pedicle screws and avoids extensive lateral dissection along with muscular deinnervation and associated pain that is required with standard approaches used in posterior fixation techniques. The entire contralateral facet is preserved for posterolateral bone graft without requiring exposure of the transverse processes. Using computer volumetric stereotactic navigation, pedicle screws were placed unilaterally with a more medial starting point and less of a lateral-to-medial trajectory. A rod was placed under distraction, and far lateral transfacet decompression was then performed on the same side. A complete discectomy under high microscopic visualization was then performed. The endplates were prepared and 2 structural allografts, locally harvested autograft and bone morphogenetic protein were placed for transforaminal lumbar interbody fusion. The Aspen posterior spinal fixation device was then inserted posteriorly for added fixation to the unilateral screws while preserving the posterior elements (Figs. 2A, B).

Economical Analysis

The average reimbursement rates for 1-level fusion surgeries performed at the ambulatory surgery facility were calculated. Such data were not available for HODs.

RESULTS

The percutaneous approach was associated with the longest operative times; 245 minutes (range, 175–291 min), followed by open with 175 minutes (range, 108–236 min), and the miniopen with 131 minutes (range, 95–182 min) approach, which was found to be statistically significant with a P-value ≤ 0.0008. A significantly higher ($P \leq 0.04$) mean estimated blood loss was reported in patients who underwent surgeries using the open approach compared with the miniopen or percutaneous approach: 204 mL (range, 50–1000 mL), 66 mL (range, 25–100 mL), and 82 mL (range, 25–150 mL), respectively. Operative time was significantly shorter ($P = 0.002$) and surgeries were performed with less estimated blood loss in the ASC setting (Table 1). The reason for such difference was thought to be because more patients at an ASC center had the surgery performed using the miniopen approach (81.5%) and more patients at HODs had surgery performed using an open approach (72%). This distribution did not depend on the difficulty of the surgery, but rather on the timing of the surgery, as the majority of surgeries were lately performed at the ASC using miniopen approach. The difference in surgical approaches is apparent, but our patient sample was too small to make any meaningful statistical analysis.

Average patient recovery and hospitalization times were longer ($P < 0.0001$) at HODs; 21.5 hours (range, 14.5–23.0 h) compared with 4.4 hours (range, 2.7–6.7 h) at the ASC. There were no patients in this study who had surgery at the ASC and had to be transferred to inpatient hospital settings.

All postoperative complications according to surgery location are described in Table 2. There were no cases of pneumonia, urinary tract infection, or thromboembolic complications. Four patients (14%) who had surgeries performed at an ASC had complications within 7 days postoperatively compared with 1 (4%) patient who had surgery performed at HODs. This difference was not statistically significant ($P = 0.36$, Fisher exact test). There were 3 hospital readmissions (Table 2). One patient was admitted to the hospital the next day after surgery for pain control and remained hospitalized for 2 additional days. Another patient was admitted on the third day after the surgery due to surgical wound infection. A patient who underwent surgery at an HOD had delirium tremens and was readmitted to the hospital on the third day after discharge.

There were 2 visits to emergency departments: one on POD #2 for constipation and another due to cerebrospinal fluid leak on POD #3 (Table 2). Other complications included cerebrospinal fluid leaks, allograft and pedicle screw malpositions, and pericarditis. Analysis that included all complications (both POD 0–7 and POD > 7; Table 3) showed that none of the approaches had any more complications than expected compared with the other 2 approaches ($P = 0.7$, Fisher exact test).

TABLE 2. Postoperative Complications According to Surgery Location

	ASC (n = 27)	HOD (n = 25)	Total
Hospital readmissions (0–7 d POD)	1 pain control #1 1 wound infection #3	1 delirium tremens #3	3
Visits to ED (0–7 d POD)	1 constipation #2 1 CSF leak #3	—	2
Other complications (> 7 d POD)			
CSF leak	2 (#35, H and #8)	1 (#10)	3
Allograft malposition	1 (#45, H)	1 (#90, H)	2
Pedicle screw malposition	1 (#8, H)	—	1
Pericarditis	1 (#14, H)	—	1
Total	9 (33%)	3 (12%)	12 (23%)

ASC indicates ambulatory surgery center; CSF, cerebrospinal fluid; ED, emergency department; H, hospitalization was required; HOD, hospital outpatient departments; POD, postoperative day; #, no. days after discharge.

TABLE 3. Postoperative Surgical Technique-related Complications

	Open (n = 20)	Percutaneous (n = 9)	Miniopen (n = 23)	Total
Hospital readmissions (0–7 d POD)	1 delirium tremens #3/H	—	1 pain control #1/H 1 wound infection #3/H	3
Visits to ED (0–7 d POD)	1 constipation #2	—	1 CSF leak #3	2
Other complications (> 7 d POD)				
CSF leak	—	1 (#10)	2 (#35/H and #8)	3
Allograft malposition	1 (#90/H)	—	1 (#45/H)	2
Pedicle screw malposition	—	1 (# 8/H)	—	1
Pericarditis	—	—	1 (#14/H)	1
Total (%)	3 (15)	2 (22)	7 (30)	12 (23)

# indicates no. days after discharge; CSF, cerebrospinal fluid; ED, emergency department; H, hospitalization was required; POD, postoperative day.

On an average, lower back and leg pain was significantly ($P < 0.0001$) decreased postoperatively. The average postoperative back pain was 18.8 (range, 0–90) compared with 74.5 (range, 0–100) preoperatively as measured on a 0–100 VAS scale. The average postoperative leg pain was 9.1 (range, 0–60) compared with 54.2 (range, 0–100) preoperatively. The mean satisfaction scores were 81.1% (range, 25–100) and 77.5% (0–100) for the patient group who had surgery on an outpatient basis at ASC and were admitted overnight to an HOD, respectively. There was no statistically significant difference detected between the groups; P value = 0.6. In addition, 21 of 27 patients who had their surgery performed at ASC as an outpatient procedure responded to the question whether they would undergo surgery as an outpatient procedure again: 16 (76%) patients said "yes" and 5 (24%) patients said "no." These 5 patients who responded negatively to the question also had higher mean postoperative back (6.0 vs. 1.8; $P = 0.0004$), leg (3.3 vs. 1.4; $P = 0.1$) VAS, and lower satisfaction (76.8% vs. 89.9%; $P = 0.1$) scores compared with the patients who responded positively.

Fusion was assessed at the last follow-up appointment and 2 (3.8%) patients were found to have radiographic pseudoarthrosis.

Economical Analysis

The average ASC facility reimbursement rate was $18,420 (range, 3200–26,000) for 1-level fusion surgery. It increased to an average of $29,983 (range, 8300–70,000) when the cost for implants and rhBMP-2 was added.

DISCUSSION

The patients in this study were selected to undergo 1-level lumbar fusion surgery as an outpatient procedure or with an overnight admission based on patient preferences and the absence of comorbidities that would require such surgery to be performed as an inpatient procedure. The average hospitalization time was 2.8 days in our previous study that evaluated inpatient 1-level lumbar fusions.[12] Surgeries were performed using percutaneous or open approaches at that time.

The analysis of complications, hospital readmissions, visits to the emergency department that occurred in the first 7 days after discharge did not demonstrate any statistically significant differences between HOD and ASC patients. However, it was concerning that 1 patient who had surgery performed at an ASC, was discharged 4 hours after the surgery and had to be readmitted to the hospital for an additional 2 days for pain control. On the basis of these findings, we have had a lower threshold for keeping patients for overnight observation when their surgery is performed at an ASC.

The optimal time for patients to be discharged after surgery varies slightly depending on the patient's personal preferences and clinical circumstances. One study examined "patient home readiness"[13] for a total of 500 randomly selected patients who underwent various ambulatory surgeries. The majority of patients were ready to be discharged 2 or 3 hours after surgery (82% and 96%, respectively). The discharge delays were due to personal nonmedical reasons in 50% of the patients.

In a study that incorporated a diverse group of surgeries performed in outpatient settings, the rate of hospital readmissions was 0.6%.[14] On the basis of these findings, the authors developed a risk index that identifies patients who have a higher risk for readmission to the hospital after ambulatory surgeries. The index includes such variables as the patient's age (65 y and above), operating time (> 120 min), heart conditions, cerebral and peripheral vascular disease, malignancy, seropositive findings for human immunodeficiency virus, and general anesthesia. The rate of hospital readmissions was almost 6% in our study and although our patients were slightly younger (only 5 patients were older that 65), all of them had general anesthesia and approximately two thirds of the surgeries lasted > 120 minutes.

An increased rate of postoperative complications has been reported in older patients (above 65 y) who underwent lumbar fusion surgeries.[15] Wound infections (10%), urinary tract infections (34%), and pneumonia (5%) were the most frequent hospitalization or surgery-related complications encountered in this patient population. Although we only had 5 patients who were older than 65 and would not be able to make any definite conclusions, we have not observed any postoperative complications, hospitalizations, or Emergency Department visits in this small group of patients. A study by Rosen et al[16] in which authors analyzed clinical outcomes in patients who were older than 75 years (mean, 80.8; range, 75–97 y) reported no major complications. Fifty-seven patients underwent minimally invasive

(MI) lumbar spine decompression surgeries with the mean hospitalization time of 29 hours and minimum of 5 hours for some patients. The authors concluded that the use of MI techniques results in a lower postoperative complication rate and pain, allowing to shorten the hospitalization time even in this challenging patient population.

Improved outcomes in an outpatient setting was suggested by a study that compared 360,780 with 175,288 surgical procedures performed on Medicare patients at outpatient hospital departments and ASCs, respectively.[17] The 7-day complication rate was significantly lower at the ASC compared with HOD procedures. There were 104 versus 259 emergency department visits per 100,000 procedures, respectively. There was an even greater difference for inpatient admissions. Ninety-one hospital admissions occurred per 100,000 procedures performed for an ASC versus 433 per 100,000 at HODs, respectively.

In our experience, the number of instrumented lumbar fusions that we perform in either an ASC or HOD setting has been increasing over the past several years. This increase has been associated with several factors: growing medical staff and surgeons' confidence, the opening of new ASC in the area and the availability of the supplemental, "less invasive" posterior fixation systems. The interspinous process fixation device has been particularly instrumental in this transition, as the approach and anatomy is very familiar to the surgeon but the incision and soft tissue trauma associated with the approach is much lower than for open surgery. This study demonstrates that the operative time and blood loss is significantly decreased for this miniopen approach compared with both open and percutaneous pedicle screw fixation techniques. Our study evaluated the effectiveness of the procedure by assessing change in pain and patient satisfaction scores. There was 75% and 83% decrease in postoperative lower back and leg pain scores, respectively. There was no difference in patient satisfaction scores for the surgeries performed at ASC or HODs and a significant majority of patients responded that they would have surgery again at ASC. The results also show that the use of this less-invasive technique that does not require bilateral pedicle screw fixation potentially allows for reduced soft tissue morbidity and does not compromise spinal fusion. This further suggests that such surgeries can be effectively performed on an outpatient basis.

Inpatient Versus Outpatient Cost Comparison

Lower cost is another potential benefit associated with performing lumbar fusion as an outpatient procedure. Forty 1-level procedures performed from 1996 to 1998 were analyzed in a study evaluating the costs of the TLIF procedure.[18] The costs were normalized to 1998 standards and included all hospital charges excluding the radiologist, anesthesiologist, surgeon, and assistant fees. The average hospital stay was 3.3 days (range, 2–4 d) with 2 patients admitted to the intensive care unit. The average hospitalization and surgery-related cost was $33,784 (range, $27,984–$42,082). Significantly higher costs were reported in a more recent paper by Patel et al.[19] The average cost in this study was $45,184, which included the use of rhBMP-2 ($5400). In this study, the authors randomly selected 10 one-level TLIF procedures and accounted for operating room time, inpatient room costs, and nursing staff wages. Indirect costs included hospital overhead, maintenance, and administrator salaries. The average hospital stay was 3 days for these patients. When the average cost for implants was deducted ($10,524), there were $17,898 direct hospital expenses in addition to $11,362 indirect hospital costs. The mean cost of inpatient and outpatient lumbar fusion surgeries was $67,079 and $23,175, respectively, in the most recent study that analyzed the characteristics of ambulatory and inpatient surgeries performed in community hospitals in 28 states.[2]

When hospital costs of the aforementioned inpatient studies are compared with average reimbursement rates of the ambulatory facility used in this study, outpatient 1-level instrumented lumbar fusion surgeries can be performed at a fraction of the cost. This variation could be explained by the difference in Medicare reimbursement rates between the hospitals or HODs and ASCs. A more efficient management and lack of hospital-associated indirect costs also play a major role. As a result, ASCs are able to deliver less expensive, consumer driven, and potentially better care to the patients.

Limitations

The study lacks a true control group and all the clinical outcome data were not collected prospectively. However, the main intention of this study was to question the current standard of care to perform all lumbar fusion surgeries as inpatient surgeries and demonstrate a possibility that instrumented lumbar fusion surgeries could be efficiently and safely performed on an outpatient basis in selected patients. We did not encounter any unexpected complications in this cohort of patients or complications that could have been prevented if patients remained hospitalized longer, except for 1 patient who was admitted to the hospital for pain control. Reports suggest that patients remain hospitalized as many as 5.3 (± 2.6) or 10.8 (± 2.5) days after 1-level minimally invasive or open posterior lumbar interbody fusion surgeries, respectively[20] and complications were comparable with the ones reported in our study.

The information regarding clinical outcomes was obtained retrospectively by reviewing charts, so only a limited conclusion of clinical outcomes could be confirmed. However, the same surgical techniques were utilized for our inpatients as for the patients undergoing surgery in ambulatory settings, and we do not expect that any other criteria would affect clinical outcomes besides shortened postoperative hospital care and complications associated with this.

As it was mentioned in the methods section, some of the patient selection criteria were objective (eg, age, comorbidities), but we have also based our decisions to perform outpatient surgeries on subjective criteria, for example, patient personal preferences. Therefore, a further prospective study is needed with predefined patient

selection and enrollment criteria. Our patient sample size was too small to make any recommendations regarding patients for whom this type of surgery should not be performed on an outpatient basis. The decisions and recommendations were made on the case-by-case basis to the certain categories of patients not to undergo TLIF as an ambulatory procedure. Therefore, the inclusion and exclusion criteria need to be defined further.

We believe that our study, although not prospective or randomized, raises important questions in this changing health care and economical environment. It demonstrates that 1-level instrumented TLIF surgery performed in the ambulatory setting is not associated with increased complication rates but instead may have a potential to reduce such complications as hospital-acquired infections or thromboembolic complications.

CONCLUSIONS

Although further confirmation is needed, this study discusses the possibility of performing instrumented lumbar interbody fusions with the TLIF technique as an outpatient procedure. The results support a future prospective randomized study with a well-defined patient selection criteria.

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