The Effect of Obesity on the Improvement in Health State Outcomes following Minimally Invasive Transforaminal Interbody Fusion

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Global Spine J 2016;6:744–748.

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Abstract

Study Design Observational study.

Objective Studies have shown a correlation between obesity and lumbar spine pathology, but also that obese patients have higher rates of complication following lumbar spine surgery. It is unknown if obese patients have clinical gains following lumbar spine surgery comparable to the gain of normal-weight patients. This study investigated the correlation of obesity and the delta change in outcomes in a single surgeon's cohort of normal-weight and obese patients undergoing minimally invasive (MIS) transforaminal lumbar interbody fusion (TLIF).

Methods A retrospective review was performed of a single surgeon's patients at an academic medical center who underwent MIS TLIF between July 2011 and December 2013. Statistical analyses included independent sample *t* test for continuous variables, Fisher exact test for categorical data, and repeated measures two-way analysis of variance to assess the interaction between obesity status and the change in Short-Form Health Survey 12 (SF-12) results.

Results Thirty-eight patients from a single institution were reviewed, and 19 had a body mass index greater than 30. The nonobese and obese postoperative SF-12 mental composite scores (MCS; 52.70 ± 2.50 versus 52.16 ± 1.91; $p = 0.87$) and physical composite scores (PCS; 45.56 ± 2.72 versus 41.03 ± 2.65; $p = 0.24$) did not show any significant differences. There was no significant interaction between obesity and change in SF-12 MCS (F [1, 36] $= 0.96$, $p = 0.33$) or SF-12 PCS (F [1, 36] $= 0.74$, $p = 0.40$) between the pre- and postoperative scores. There was a significant effect of obesity on SF-12 PCS scores (F [1, 36] $= 7.15$, $p = 0.01$).

Conclusions Patients undergoing MIS TLIF sustain meaningful and significant gains in SF-12 MCS and PCS that is not impacted by their obesity status.

Keywords
- obesity
- back pain
- lumbar spine
- degenerative disk disease
- transforaminal lumbar interbody fusion (TLIF)
- minimally invasive
- patient-reported outcomes

Introduction

The obese patient presents a challenge for the spine surgeon. More than one-third of Americans have a body mass index (BMI) greater than 30, and current and future surgeons will be forced to address the issue.[1] Studies have shown that obese patients who undergo spine surgery have higher rates of perioperative and postoperative complications, such as urinary and pulmonary complications, extended length of stay, and more wound complications.[2–4] However, the obese

received
September 7, 2015
accepted after revision
January 15, 2016
published online
March 2, 2016

DOI http://dx.doi.org/10.1055/s-0036-1579747.
ISSN 2192-5682.

population has nevertheless reported improvements in pain and functional outcomes on par with nonobese patients.[5–8] The incidence of lumbar back pain, degenerative disk disease, and radiculopathy strongly correlate to obesity, and the prevalence of obesity is increasing, even at younger ages.[9,10] Thus, the crux of the issue is to determine the true benefit of surgical intervention in the obese patient.

Transforaminal lumbar interbody fusion (TLIF) was developed to decompress the spine and achieve fusion. Historically, open TLIF has been an effective surgical technique with excellent clinical outcomes and fusion rates.[5–8] More recently, a variation, minimally invasive (MIS) TLIF, has been shown to have comparable outcomes scores and fusion rates as open TLIF.[11–13] MIS TLIF, with its percutaneous incisions and significantly reduced muscle dissection, is an appealing alternative for the obese patient to potentially lessen the preoperative and postoperative complication risk.

Obese patients have been shown to do equally as well following MIS TLIF as after open TLIF. Data has shown that open and MIS TLIF have comparable improvements in patient-reported and functional scores, such as the visual analog scale (VAS), Oswestry Disability Index (ODI), Short-Form Health Survey 36 (SF-36), and similar time to return to work.[14–17] Complication rates in some studies were reduced in the MIS group compared with the open group.[18] However, it is not yet clear whether the obese patient experiences clinical benefits comparable to the nonobese patient.

There is limited data addressing the comparison of patient-reported outcomes following only MIS TLIF in obese patients compared with nonobese patients.[19] The purpose of this study is to investigate the correlation of obesity and the change in outcomes in a single surgeon's cohort of normal-weight and obese patients undergoing MIS TLIF.

Materials and Methods

A retrospective review was performed for patients of a single surgeon at an academic medical center who underwent MIS TLIF between July 2011 and December 2013. The electronic medical record and paper office charts were reviewed to retrieve data consistent with the study's inclusion criteria. This study was approved by the Institutional Review Board.

All patients included in the study underwent an appropriate trial of nonoperative treatment including activity modification, physical therapy, anti-inflammatory medications, opioid analgesics, or transforaminal epidural steroid injections for at least 3 months. The operative indications included degenerative spondylosis or spondylolisthesis resulting in central or foraminal stenosis, radiculopathy, or neurogenic claudication, as well as failure of nonoperative management.

A standard MIS TLIF was performed in all cases. The patients were placed prone on a Jackson table with a chest roll was used to increase lumbar lordosis. Using fluoroscopic localization, the pedicles above and below the level of pathology were identified. A 2- to 3-cm incision was made lateral the pedicle on the side of the pathology. Jamshidi needles were then placed in the pedicles at the appropriate level. Guide wires were then advanced under fluoroscopic imaging. Following sequential dilation, a 21-mm tubular retractor was placed and docked on the pars interarticularis at the disk space. A laminectomy was performed on the ipsilateral side with removal of the medial edge of the pars, lamina, and the medial facet joint. To decompress the contralateral side, the tubular retractor was medicalized to allow undercutting of the spinous process. The facet joint was removed until the medial wall of the pedicle could be palpated. The ligamentum flavum was removed, the epidural veins overlying the disk space were coagulated, and the traversing nerve root was retracted medially. The disk space was then entered and prepared with the use of rongeurs, curettes, and disk space shavers. Trial interbody cages were inserted until appropriate tension was achieved. A combination of recombinant human bone morphogenetic protein-2 and local bone was placed anterior within the disk space followed by impaction of the final PEEK interbody cage. Percutaneous medical screws were then placed over the placed guide wires following appropriate tapping. Once all pedicle screws were placed, a rod was placed percutaneously and secured with end caps.

Epidemiologic variables were recorded, including age, sex, BMI, medical comorbidities, and smoking status. Prospectively recorded outcomes data included the 12-item Short-Form Health Survey-12 (SF-12). The mental composite score (MCS) and physical composite score (PCS) were calculated for both pre- and postoperative data.

GraphPad Prism v6.5 (La Jolla, California, United States) was utilized for statistical analysis with independent sample *t* test for continuous variables and Fisher exact test for categorical data. A repeated measures two-way analysis of variance (ANOVA) was used to assess the interaction between patient obesity status and the change in SF-12 outcomes scores from the preoperative to the postoperative state. A p value < 0.05 was considered statistically significant.

Results

Patient Characteristics and Demographics

The records of 38 patients from a single institution were reviewed. Patient characteristics can be found in ►**Table 1**. Obesity in the study was defined as a BMI > 30. Nineteen patients had a BMI < 30. Conversely, 19 patients had a BMI > 30. Of those with a BMI > 30, 11 patients were categorized as morbidly obese with a BMI > 35. The average age in the nonobese group was 60.00 ± 3.26 compared with 60.26 ± 1.64 in the obese group ($p = 0.94$). BMI averaged 24.42 ± 0.82 in the nonobese group and 36.66 ± 1.31 in the obese group ($p < 0.0001$). There was no difference in the two groups with respect to hypertension, diabetes, smoking history, or number of vertebral levels involved. The operative time was significantly longer in the obese group (202.80 versus 156.47 minutes, $p = 0.009$).The average clinical follow-up was 25.29 ± 1.28 months in the nonobese group and 23.83 ± 1.45 months in the obese group ($p = 0.48$). There were no perioperative complications encountered in either group.

Obesity and Clinical Outcomes

The patients were divided into dichotomous groups (nonobese and obese), and average pre- and postoperative SF-12

Table 1 Patient characteristics and demographics

Characteristics	Nonobese	Obese	*p* Value
n	19	19	
Age (y)	60.00 ± 3.26	60.26 ± 1.64	0.94
Men;women	10;9	7;12	0.33
Body mass index	24.42 ± 0.82	36.66 ± 1.31	<0.0001
Hypertension	10 (52.6%)	13 (68.4%)	0.32
Diabetes	3 (15.8%)	5 (26.3%)	0.42
Smoking history	3 (15.8%)	5 (26.3%)	0.42
No. of vertebral levels involved	1.21 ± 0.12	1.21 ± 0.10	>0.99
1	16	15	
2	2	4	
3	1	0	
OR time (min)	156.47	202.8	0.009
Preoperative SF-12 PCS	29.53 ± 2.10	25.72 ± 1.60	0.16
Preoperative SF-12 MCS	45.08 ± 2.43	36.93 ± 3.16	0.04
Postoperative SF-12 PCS	45.56 ± 2.72	41.03 ± 2.65	0.24
Postoperative SF-12 MCS	52.70 ± 2.50	52.16 ± 1.91	0.87

Abbreviations: MCS, mental composite score; OR, operating room; PCS, physical composite score; SF-12, Short-Form Health Survey 12.

MCS and PCS scores were calculated. The average preoperative SF-12 MCS score was 45.08 ± 2.43 in the nonobese group and 36.93 ± 3.16 ($p = 0.04$) in the obese group. Similarly, the average preoperative SF-12 PCS score was 29.53 ± 2.10 in the nonobese group and 25.72 ± 1.60 in the obese group ($p = 0.16$). Comparing the nonobese and obese postoperative SF-12 MCS (52.70 ± 2.50 versus 52.16 ± 1.91; $p = 0.87$) and PCS (45.56 ± 2.72 versus 41.03 ± 2.65; $p = 0.24$) scores did not show any significant differences between the two groups.

There was no significant interaction between obesity and change in SF-12 MCS between the pre- and postoperative values (F [1, 36] = 0.96, $p = 0.33$). There was no significant effect of obesity on overall SF-12 MCS scores. Patients who were obese were no more likely to have lower postoperative SF-12 MCS scores than nonobese patients. There was, however, a significant increase from the pre- to postoperative SF-12 MCS state for both the nonobese and obese groups (F [1, 36] = 20.01, $p < 0.0001$; ►**Fig. 1**).

There was no significant interaction between obesity and change in SF-12 PCS between the pre- and postoperative values (F [1, 36] = 0.74, $p = 0.40$). There was, however, a significant effect of obesity on SF-12 PCS scores (F [1, 36] = 7.15, $p = 0.01$). Patients who were obese were more likely than nonobese patients to have lower pre- and postoperative SF-12 PCS scores. There was additionally a statistically significant increase in SF-12 PCS scores in both groups irrespective of their obesity status (F [1, 36] = 27.92, $p < 0.0001$; ►**Fig. 2**).

Discussion

Obesity remains a clinically relevant concern as the prevalence of obese and morbidly obese patients continues to rise. Current estimates identify roughly one-third of the U.S. population as obese.[20] These patients represent a significant challenge for the treating physician as a growing body of evidence supports a higher risk for perioperative

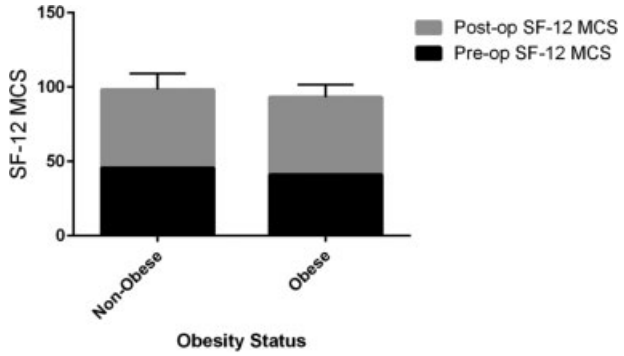

Fig. 1 Two-way analysis of variance of Short-Form Health Survey 12 (SF-12) mental composite score (MCS) and obesity.

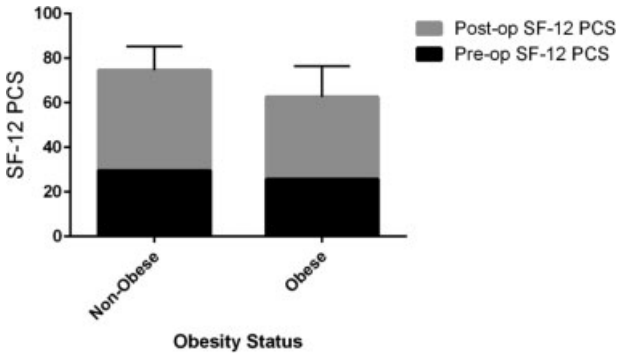

Fig. 2 Two-way analysis of variance of Short-Form Health Survey 12 (SF-12) physical composite score (PCS) and obesity.

complications including wound infections, airway-related events, deep vein thromboses, and even pulmonary embolus.[4,5,21–26] Foley et al were the first to describe the MIS TLIF using tubular retractors via a muscle-splitting approach to decrease the amount of soft tissue injury.[27] The subsequent data has shown MIS TLIF to be safe and efficacious with clinical and radiographic results comparable to the open TLIF approach.

The current study is one of the first to directly compare the change in outcomes between the preoperative and postoperative states of nonobese and obese patients undergoing MIS TLIF. To date, several studies have demonstrated the efficacy of MIS TLIF when compared with the open TLIF procedure in obese patients. Furthermore, evidence supports clinically significant gains in VAS, ODI, and SF-36 among obese patients undergoing MIS TLIF. However, there is limited published literature looking at the change in outcomes from the pre- to postoperative state between a nonobese and obese population that both underwent an MIS TLIF.

Rosen et al were the first to look at the role of obesity and patient-reported outcomes after MIS TLIF.[16] The authors looked at 110 patients, of whom 32% were defined as obese with a BMI > 30. Linear regression analysis did not identify a correlation between weight or BMI and pre- and postsurgery changes in any of the outcome measures. Wang et al compared ODI and VAS scores in obese patients undergoing open or MIS TLIF.[17] The authors found that the MIS TLIF group had significantly less operating time, less blood loss, and less postoperative back pain. The radiation time was significantly longer in the MIS TLIF group. The clinical outcomes were not significantly different between the two groups. Similarly, Terman et al compared the outcomes of open and MIS TLIF in obese patients, concluding that obese patients experienced clinically and statistically significant improvement in both pain and function after undergoing either open or MIS TLIF.[14]

Lau et al recently published the only study in the literature that directly compared the relative preoperative to postoperative improvement in nonobese and obese patients following MIS TLIF.[18] Estimated blood loss, operative time, complication rate, and length of hospital stay were compared. The outcomes variables of interest were ODI and VAS. Both groups had significant improvements in VAS (obese, $p = 0.003$; normal, $p = 0.016$) and ODI (obese, $p = 0.020$; normal, $p = 0.034$) scores. There were no statistically significant differences between the nonobese and obese groups in postoperative VAS ($p = 0.728$) and ODI ($p = 0.886$) scores. Patients with significant obesity experienced clinical improvement similar to that of normal-weight patients, suggesting that obesity does not impact MIS TLIF outcomes. This study is limited in the conclusions that can be drawn due to a low number of patients included in both groups (seven nonobese, nine obese).

In the current study, the baseline SF-12 MCS and PCS were lower in the obese patient population, though the difference was only significant for the MCS. As the SF-12 is a general health survey, the lower preoperative score in the obese group is not surprising. In a study by Wee et al, obese patients when compared with normal-weight controls scored 8.8 points lower on the PCS-12 and 5.7 points lower on the PCS-36 after adjustment for age, sex, and race.[28] In the postoperative period, there were no significant differences between the nonobese and obese groups with respect to either SF-12 MCS or PCS. The net change from baseline for MCS was ~7 points in the nonobese group and 15 points in the obese group. This change between pre- and postoperative scores was not significantly different between the two groups when analyzed with the two-way ANOVA model ($p = 0.33$). In the model, however, both groups demonstrated a statistically significant gain in MCS after surgery. Similarly, there was no significant difference between the average pre- and postoperative SF-12 PCS scores between the two groups. Although the obese group started at a lower baseline PCS state, each group improved by ~15 points postoperatively. This change between pre- and postoperative scores was not significantly different between the two groups when analyzed with the two-way ANOVA ($p = 0.40$). However, each group demonstrated a statistically significant improvement from their baseline state ($p < 0.001$).

The major limitations of this study are the retrospective nature and relatively small number of patients in each cohort. This study did not have a matched cohort; instead, it was a retrospective review of a single surgeon's consecutive series of patients. The outcomes data used in this study was prospectively collected by the treating surgeon as part of the normal scope of practice, which likely eliminates any bias in terms of data collection, as the data was systematically collected according to the surgeon's established postoperative protocol. Given the small number of patients in each arm of the study, it is possible that the study is underpowered to detect a true statistically significant difference in outcomes between the two groups. However, when compared with similar studies published in the literature, this study represents the largest cohort comparison of outcomes in nonobese and obese patients undergoing MIS TLIF.

Another potential limitation of this study is the use of only a single outcome metric for comparison between the two groups. It is possible that another validated outcome measure such as the Euroqol-5 Dimension, ODI, or VAS would have yielded a different result.

Conclusions

This study is one of the first and largest to look at the correlation of obesity and the change in outcomes between the preoperative and postoperative state in patients undergoing MIS TLIF. Patients undergoing MIS TLIF achieved meaningful and significant gains in SF-12 MCS and PCS that was not impacted by their obesity status.

Disclosures
Steven J. McAnany: none
Diana C. Patterson: none
Samuel Overley: none
Daniel Alicea: none
Javier Guzman: none

Sheeraz A. Qureshi: Committee board member (AAOS, Cervical Spine Research Society, Musculoskeletal Transplant Foundation, NASS); Editorial board member (*Clinical Orthopaedics and Related Research*, *Contemporary Spine Surgery*, *Global Spine Journal*, *Spine*, *The Spine Journal*); Speakers' bureau (Globus Medical, Medtronic Sofamar Danek, Stryker); Consultant (Medtronic, Orthofix, Inc., Stryker, Zimmer); Royalties (Zimmer).

References

1 Ogden CL, Carroll MD, Kit BK, Flegal KM. Prevalence of childhood and adult obesity in the United States, 2011–2012. JAMA 2014; 311(8):806–814
2 Buerba RA, Fu MC, Gruskay JA, Long WD III, Grauer JN. Obese class III patients at significantly greater risk of multiple complications after lumbar surgery: an analysis of 10,387 patients in the ACS NSQIP database. Spine J 2014;14(9):2008–2018
3 Kalanithi PA, Arrigo R, Boakye M. Morbid obesity increases cost and complication rates in spinal arthrodesis. Spine (Phila Pa 1976) 2012;37(11):982–988
4 Patel N, Bagan B, Vadera S, et al. Obesity and spine surgery: relation to perioperative complications. J Neurosurg Spine 2007;6(4):291–297
5 Djurasovic M, Bratcher KR, Glassman SD, Dimar JR, Carreon LY. The effect of obesity on clinical outcomes after lumbar fusion. Spine (Phila Pa 1976) 2008;33(16):1789–1792
6 Gaudelli C, Thomas K. Obesity and early reoperation rate after elective lumbar spine surgery: a population-based study. Evid Based Spine Care J 2012;3(2):11–16
7 De la Garza-Ramos R, Bydon M, Abt NB, et al. The impact of obesity on short- and long-term outcomes after lumbar fusion. Spine (Phila Pa 1976) 2015;40(1):56–61
8 Gepstein R, Shabat S, Arinzon ZH, Berner Y, Catz A, Folman Y. Does obesity affect the results of lumbar decompressive spinal surgery in the elderly? Clin Orthop Relat Res 2004;(426):138–144
9 Shiri R, Karppinen J, Leino-Arjas P, Solovieva S, Viikari-Juntura E. The association between obesity and low back pain: a meta-analysis. Am J Epidemiol 2010;171(2):135–154
10 Liuke M, Solovieva S, Lamminen A, et al. Disc degeneration of the lumbar spine in relation to overweight. Int J Obes 2005;29(8): 903–908
11 Rodríguez-Vela J, Lobo-Escolar A, Joven E, Muñoz-Marín J, Herrera A, Velilla J. Clinical outcomes of minimally invasive versus open approach for one-level transforaminal lumbar interbody fusion at the 3- to 4-year follow-up. Eur Spine J 2013;22(12):2857–2863
12 Peng CW, Yue WM, Poh SY, Yeo W, Tan SB. Clinical and radiological outcomes of minimally invasive versus open transforaminal lumbar interbody fusion. Spine (Phila Pa 1976) 2009;34(13):1385–1389
13 Dhall SS, Wang MY, Mummaneni PV. Clinical and radiographic comparison of mini-open transforaminal lumbar interbody fusion with open transforaminal lumbar interbody fusion in 42 patients with long-term follow-up. J Neurosurg Spine 2008;9(6):560–565
14 Terman SW, Yee TJ, Lau D, Khan AA, La Marca F, Park P. Minimally invasive versus open transforaminal lumbar interbody fusion: comparison of clinical outcomes among obese patients. J Neurosurg Spine 2014;20(6):644–652
15 Adogwa O, Carr K, Thompson P, et al. A prospective, multi-institutional comparative effectiveness study of lumbar spine surgery in morbidly obese patients: does minimally invasive transforaminal lumbar interbody fusion result in superior outcomes? World Neurosurg 2015;83(5):860–866
16 Rosen DS, Ferguson SD, Ogden AT, Huo D, Fessler RG. Obesity and self-reported outcome after minimally invasive lumbar spinal fusion surgery. Neurosurgery 2008;63(5):956–960, discussion 960
17 Wang J, Zhou Y, Feng Zhang Z, Qing Li C, Jie Zheng W, Liu J. Comparison of the clinical outcome in overweight or obese patients after minimally invasive versus open transforaminal lumbar interbody fusion. J Spinal Disord Tech 2014;27(4): 202–206
18 Lau D, Khan A, Terman SW, Yee T, La Marca F, Park P. Comparison of perioperative outcomes following open versus minimally invasive transforaminal lumbar interbody fusion in obese patients. Neurosurg Focus 2013;35(2):E10
19 Lau D, Ziewacz J, Park P. Minimally invasive transforaminal lumbar interbody fusion for spondylolisthesis in patients with significant obesity. J Clin Neurosci 2013;20(1):80–83
20 Flegal KM, Carroll MD, Kit BK, Ogden CL. Prevalence of obesity and trends in the distribution of body mass index among US adults, 1999–2010. JAMA 2012;307(5):491–497
21 Aghi MK, Eskandar EN, Carter BS, Curry WT Jr, Barker FG II. Increased prevalence of obesity and obesity-related postoperative complications in male patients with meningiomas. Neurosurgery 2007;61(4):754–760, discussion 760–761
22 Espejo B, Torres A, Valentín M, et al. Obesity favors surgical and infectious complications after renal transplantation. Transplant Proc 2003;35(5):1762–1763
23 Lau D, Terman SW, Patel R, La Marca F, Park P. Incidence of and risk factors for superior facet violation in minimally invasive versus open pedicle screw placement during transforaminal lumbar interbody fusion: a comparative analysis. J Neurosurg Spine 2013;18(4):356–361
24 Lynch RJ, Ranney DN, Shijie C, Lee DS, Samala N, Englesbe MJ. Obesity, surgical site infection, and outcome following renal transplantation. Ann Surg 2009;250(6):1014–1020
25 Noun R, Riachy E, Ghorra C, et al. The impact of obesity on surgical outcome after pancreaticoduodenectomy. JOP 2008;9(4):468–476
26 Rogde AJ, Gudbrandsdottir G, Hjelle KM, Sand KE, Bostad L, Beisland C. Obesity is associated with an improved cancer-specific survival, but an increased rate of postoperative complications after surgery for renal cell carcinoma. Scand J Urol Nephrol 2012;46(5):348–357
27 Foley KT, Holly LT, Schwender JD. Minimally invasive lumbar fusion. Spine (Phila Pa 1976) 2003;28(15, Suppl):S26–S35
28 Wee CC, Davis RB, Hamel MB. Comparing the SF-12 and SF-36 health status questionnaires in patients with and without obesity. Health Qual Life Outcomes 2008;6:11