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Impact of morbid obesity (BMI > 40 kg/m^2) on complication rate and outcome following minimally invasive transforaminal lumbar interbody fusion (MIS TLIF)

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ABSTRACT

Objectives: The negative effects of obesity on the health and quality of life of those afflicted has become an important public concern. Previous studies have shown an association between obesity and higher rates of complications and unfavorable outcomes following spine surgery. This study is to identify peri- and post-operative complication rates as well as short-term and long-term outcomes in morbidly obese patients who underwent minimally invasive transforaminal lumbar interbody fusion (MIS TLIF) in comparison to age-matched normal-weight patients.

Patients and methods: We retrospectively reviewed medical records for all adult patients with a body mass index (BMI) ≥40 kg/m^2 who underwent 1- to 2-level MIS TLIF for degenerative disease between February 2009 and February 2014 at a single institution and compared them to age-matched normal-weight patients (BMI 20–25 kg/m^2). Duration of operation, length of hospital stay, use of analgesics, minor and major complications (infections and re-operations) as well as postoperative pain reduction within 30 days of surgery were recorded. Furthermore, we collected long-term follow-up data (> 1 year) regarding complications and pain reduction.

Results: We identified 14 patients with a BMI ≥ 40 kg/m^2 (mean, 43.2 kg/m^2) who underwent MIS TLIF. Both groups showed comparable complication rates and clinical results in the short term (< 30 days). Compared to 14 normal-weight patients (mean, 23.5 kg/m^2), morbidly obese patients had significantly longer duration of single level operations (235 vs. 168 min; P = 0.0264) as well as a longer average length of stay (7.7 vs. 5.4; P = 0.0308) and a numerically higher need for analgesics (WHO level; P = 0.0828). In the long-term follow-up of the available 13 patients, the morbidly obese group had a higher complication rate (2/7 morbidly obese vs. 0/6 normal weight), a greater need for analgesics and a higher score in the VAS for lower back pain (6.0 vs. 2.4).

Conclusion: MIS TLIF is technically feasible in morbidly obese patients with no evidence of higher complication rates among this demographic compared to normal-weight individuals when followed-up in the short-term (< 30 days); however, available long-term follow-up data suggest a higher complication rate, greater need for analgesics and a much lower reduction of lower back pain in the morbidly obese group.

1. Introduction

Obesity has become one of the most significant public health concerns of our century. According to the World Health Organization (WHO), more than 1.9 billion adults were overweight in 2016 (body mass index (BMI) ≥25 kg/m^2). Of this staggering figure, 650 million individuals were by definition obese (BMI was ≥30 kg/m^2), and a smaller but increasing number of these people is defined as morbidly obese (BMI is ≥40 kg/m^2) [16].

Successive diseases and lifestyle restrictions are an inherent consequence of obesity which can reduce quality of life and lead to further health concerns for those afflicted. Common conditions among obese individuals include cardiovascular conditions, such as heart diseases and stroke as well as diabetes and musculoskeletal disorders [16]. Since obesity is also one of the major causes for spinal degenerative diseases and back pain, the number of patients who request spinal surgery is rising. Many studies have shown that obese patients carry an exceedingly high risk for peri- and postoperative complications due to their comorbidities, making this group of patients particularly difficult to treat. [1–3].

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Nowadays, minimally invasive transforaminal lumbar interbody fusion (MIS TLIF) is a commonly performed operation used to treat degenerative lumbar diseases. So far, studies have focused on either comparing open vs. minimally invasive techniques, or only on overweight and obese patients without special attention to the extreme form of morbid obesity with a BMI ≥ 40 kg/m^2.

The aforementioned studies found that in MIS TLIF operations, obese patients (BMI ≥ 30 kg/m^2) did not carry higher peri- or postoperative risks with an equally good clinical result [4–6].

The aim of this study was to compare a consecutive series of morbidly obese patients with an age-matched normal-weight control group to investigate whether this special subgroup of patients carries more peri- or postoperative risks after MIS TLIF.

2. Patients and methods

2.1. Patients

We retrospectively identified 14 patients with a BMI ≥ 40 kg/m^2 who underwent 1- to 2-level MIS TLIF for degenerative disease between February 2009 and February 2014 at our institution. We randomly matched these patients to 14 normal-weight patients of the same age with the same sex and a similar number of operated levels (1- to 2-levels). Then, electronic medical records and paper charts of all patients were reviewed to collect data concerning operation time, average length of hospital stay, need for analgesics as well as infection and complication rate within 30 days of surgery. Additionally, long-term follow-up data on late complications (re-operations), need for analgesics and lower back pain was collected. The study was approved by the local ethics committee (No. 124/15) and registered in the German Clinical Trials Register (DRKS00007996).

2.2. Surgical indications and technique

All patients were operated on as a result of symptomatic degenerative disc disease or instability (e.g. degenerative spondylosis or spondylolisthesis) after having failed conservative treatment for at least 3 months. Only 1- or 2-level MIS TLIFs were included.

Operations were carried out as previously described using intraoperative fluoroscopy-based 3D navigation or by fluoroscopy alone [7]. Patients were placed in prone position (Fig. 1) and a Jamshidi needle was introduced via bilateral skin incisions of 2–3 cm into the target vertebras through the pedicles. Kirschner wires were then inserted through the Jamshidi needle and a transmuscular approach to the facet joint was performed using a non-expandable tubular retractor system (METRx, Medtronic, Minneapolis, MN, USA). Under the microscope and through the tubular retractor, a complete unilateral facetectomy, uni- or bilateral decompression of the spinal canal via unilateral hemilaminotomy, discectomy, preparation of the endplates, and a transforaminal implantation of the intervertebral cage and autologous bone (harvested during facetectomy) was carried out. Screw insertion via Kirschner wires and rod insertion was performed using CD Horizon

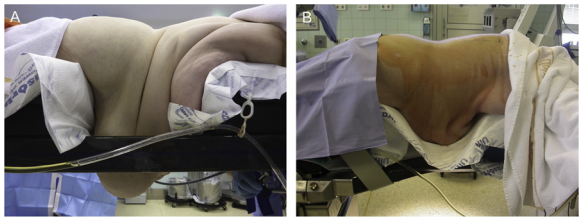

Fig. 1. A and B: Morbidly obese patients in prone position on the operating table before draping. Special care has to be taken to prevent pressure marks and reduce the risk of positioning damage. Note the pressure-free positioning of the enormous abdomen.

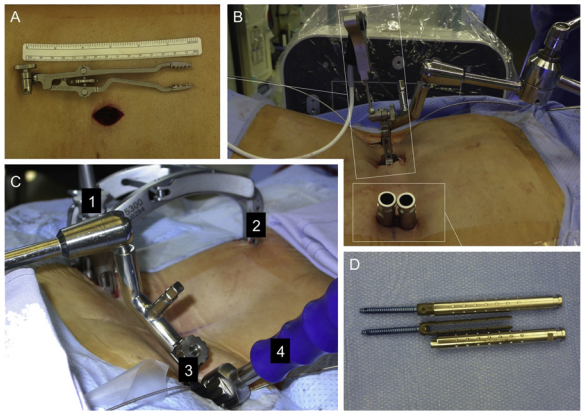

Fig. 2. Different minimally invasive instruments almost reached their limit. Navigation tracker with a length of 15 cm (A) that is deeply attached to the spinous process (B). Screws and screw extenders (D, Evospine, Maxxspine) almost disappeared completely after insertion. The same applies for another system (C, Sextant II, Medtronic) showing screw extenders (1), rod inserter (2), non-expandable tube (length 9 cm, diameter 20 mm) (3) and cage inserter (4) introduced to their maximum.

Sextant II Solera, CD Horizon Longitude (Medtronic, Minneapolis, MN, USA) (Fig. 2C) or Evospine (Maxxspine, Eltville, Germany) (Fig. 2B, D).

2.3. Statistical analyses

Results were expressed as mean with standard deviations. Analysis of continuous quantitative variables between groups was accomplished using the two-tailed student's t-test. Statistical comparisons for categorical values between groups were performed using the two-tailed Fisher exact test. $P < 0.05$ was considered to be statistically significant.

3. Results

3.1. Patients' characteristics

Both the morbidly obese group and the normal-weight group consisted of 14 patients. In each group, 5 patients were male and 9 patients were female. 60.4 years was the average age among those in the morbidly obese group (range, 33.3–76.7 years) and the normal-weight group (range, 31.7–76.8 years). In the morbidly obese group, 12 patients underwent 1-level MIS TLIF and 2 patients underwent 2-level MIS TLIF. In the normal-weight group 13 patients underwent 1-level MIS TLIF and 1 patient underwent 2-level MIS TLIF ($P = 0.5585$) (Table 1).

3.2. Peri- and postoperative complications (short term)

Surgery could be performed in all patients without any technical issues, e.g. changing to an open approach; however, in some cases surgical instruments almost reached their limits (Fig. 2, Fig. 3). Morbidly obese patients had a significantly longer duration of operation time for one level (235 vs. 168 min; $P = 0.0264$) and a longer average length of stay (7.7 vs. 5.4; $P = 0.0308$). There was a numerical, but not significant, difference in the intake of analgesics with more morbidly obese patients needing WHO level III analgesics than normal-weight patients ($P = 0.0828$). There was no postoperative infection in either group and one re-operation in each group due to epidural hemorrhage. None of the patients in either group needed a blood transfusion (Table 1). There was one intraoperative durotomy in each group; however, these did not develop into postoperative cerebrospinal fluid fistulas. None of the patients in either group developed new neurological deficits. There were no readmissions within 30 days of surgery.

Table 1
Patients' characteristics as well as peri- and postoperative complications within 30 days of surgery. BMI = body mass index, MIS TLIF = minimally invasive transforaminal lumbar interbody fusion, WHO = World Health Organization.

	Normal weight (BMI 20–25 kg/m^2)	Morbid obesity (BMI ≥ 40 kg/m^2)	P value
n	14	14	
age (yrs)	60.4 ± 13.2	60.4 ± 13.0	
men : women	5 : 9	5 : 9	
BMI (kg/m^2)	23.5 ± 1.0	43.2 ± 3.0	0.0001
No. of levels			0.5585
1	13	12	
2	1	2	
operation time (min.) (1-level MIS TLIF only)	168 ± 37	235 ± 84	0.0264
intraoperative durotomy	n = 1	n = 1	
postoperative cerebrospinal fluid fistula	n = 0	n = 0	
hospital stay (postoperative days)	5.4 ± 1.6	7.7 ± 3.4	0.0308
analgesics at discharge (WHO level)	level I: n = 4 level II: n = 3 level III: n = 7	level I: n = 2 level II: n = 0 level III: n = 12	0.0828
postoperative neurological deficit	n = 0	n = 0	
epidural hemorrhage	n = 1	n = 1	
blood transfusion	n = 0	n = 0	
infections	n = 0	n = 0	

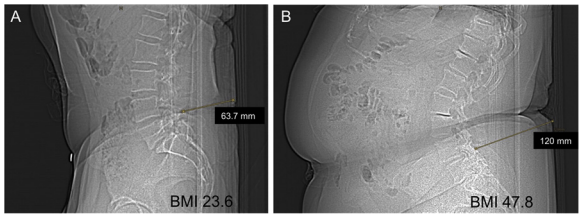

Fig. 3. Localizer of preoperative computed tomograms with measurement of the distance from the skin to the facet joints at L4/5. In a normal-weight patient with a BMI of 23.6 kg/m^2 the distance was 64 mm (A). In a morbidly obese patient with a BMI of 47.8 kg/m^2 the distance was 120 mm (B).

3.3. Long-term results

Seven patients in the morbidly obese group and six patients in the normal-weight group were available for long-term follow-up results. Demographic data is shown in Table 2. The mean follow-up time in both groups was 7 years (range 4–9 years). In the morbidly obese group, there were two re-operations associated with the MIS TLIF operation, compared to none in the control group. Additionally, in the morbidly obese group, five patients still required pain medication WHO level II or III, whereas, in the normal weight group no pain medication was necessary in all but one patient. The mean back pain score in the morbidly obese group was much higher (VAS 6.0) compared to the normal weight group (VAS 2.4).

Table 2
Patients' characteristics as well as long-term complications. BMI = body mass index, WHO = World Health Organization, VAS = visual analogue scale.

	Normal weight (BMI 20–25 kg/m^2)	Morbid obesity (BMI ≥ 40 kg/m^2)
n	6	7
men : women	0 : 6	2 : 5
mean age at follow-up	70 ± 12	70 ± 10
mean follow-up time (yrs)	7 ± 1	7 ± 2
analgesics at follow-up time (WHO level)	none: n = 6 level I: n = 1	none: n = 1 level I: n = 1 level II: n = 3 level III: n = 2
mean VAS back pain	2.4 ± 2.8	6.0 ± 4.0
revision surgeries	0	2

4. Discussion

Obesity has become one of the leading public health issues of our century. This term is defined by the World Health Organization (WHO) as a BMI ≥ 30 kg/m^2, compared to the more extreme form of this condition termed morbid obesity with a BMI ≥ 40 kg/m^2. Due to its association with numerous diseases such as high blood pressure, cardiovascular diseases and type 2 diabetes, [8] this condition is associated with a higher morbidity and mortality rate and has shown to reduce life expectancy by 10 years [9].

Morbidly obese patients can be regarded as specifically difficult to treat in spinal surgery. Due to the associated comorbidities these individuals were generally proven to carry higher peri- and postoperative risks [1–3], which implies that the indication for an operative treatment has to be set with special care.

Most studies so far have focused on the comparison of MIS TLIF versus open TLIF in obese patients (BMI ≥ 30 kg/m^2), some of them including a very small number of morbidly obese patients. From these studies we learned that both methods have their advantages and disadvantages but that the clinical outcome in both groups is equal and most patients benefit from either operation without higher peri- or postoperative complication rates [4,5,10–12].

Adogwa and colleagues [5], for example, investigated 148 obese patients (BMI ≥ 30 kg/m^2) with 108 patients in the open TLIF group and 40 patients in the MIS TLIF group. They found that both methods had similar results concerning clinical outcome and did not find a significant difference for peri- or postoperative complications.

Wang et al. [4] found some advantages associated with MIS TLIF, which had a significantly shorter operating time and less blood loss. On the other hand the radiation time was significantly longer. The overall clinical outcomes were not significantly different from patients operated via an open approach in this study.

Very few studies have focused on the impact of obesity as compared to normal-weight patients on MIS TLIF operations.

Rosen and colleagues [13], for example, compared 110 patients, 32% of which were obese (BMI ≥ 30 kg/m^2) to a normal-weight control group and stated that "obesity should not be considered a contraindication to minimally invasive lumbar spinal fusion surgery", since they could not find a significant difference concerning outcome measures, operation time, length of hospital stay or complications. The mean follow-up time of this study was 13.8 months.

These results were consistent with the findings of two other smaller series' published by McAnany et al. [14] who compared 19 obese patients (BMI ≥ 30 kg/m^2; of the 30 patients 11 patients were categorized as "morbidly obese" with a BMI ≥ 35 kg/m^2) to 19 normal-weight patients and Lau et al. [15] who compared 9 obese (BMI ≥ 35 kg/m^2) to 7 non-obese patients. Both authors did not find significant differences concerning the clinical outcome or complication rate between the two groups. The long-term follow-up data of these studies was collected at 24–25 months and 15–18 months respectively.

To the best of our knowledge, a group of morbidly obese patients has not yet been focused on specifically. This is the first report on morbidly obese patients with a BMI ≥ 40 kg/m^2 compared to an age-matched normal-weight control group for MIS TLIF. The aim of this study was to investigate if MIS TLIF operations can also be carried out in morbidly obese patients without relevant surgical risks and if these patients benefit from the surgery as much as normal-weight patients.

We found that MIS TLIF is a feasible technique that can be performed in this specific subgroup of patients without any major technical difficulties. However, in some patients the lengths of the instruments

almost reached their limits (Fig. 2).

There were significant differences concerning the operation time and the length of hospital stay – all in favor of the normal-weight group. Despite this, within 30 days of surgery, the clinical outcomes did not appear to differ. In all but one patient of each group, local back pain was reduced sufficiently, but the morbidly obese group required a higher WHO level of analgesics. There was one epidural hemorrhage in each group, which required revision surgery, but no infections or any other relevant peri- or postoperative complications within 30 days of surgery.

However, most importantly, at the latest long-term follow-up time (on average 7 years), the morbidly obese group showed more unfavorable results. Two patients in this group had required revision surgery due to screw loosening or screw breakage within the first year and second year after the initial surgery, respectively. There were no revision surgeries in the control group. Morbidly obese patients still required a higher WHO level of pain medication and suffered from considerably higher lower back pain when comparing the VAS scores of the two groups (VAS 2.4 in the normal weight group versus VAS 6.0 in the morbidly obese group). Although this small number of patients does not allow for a statistical analysis or a robust conclusion, the data of this study suggests that morbidly obese patients do not benefit as much from stabilization surgery as normal-weight patients, especially in the long term.

Our findings are contrary to those of the above-mentioned studies that compared less obese patients to normal-weight control groups. This might be attributed to the very special subgroup of morbidly obese patients with a BMI $\geq 40\,kg/m^2$ in our study and the longer follow-up time. The limited data available, however, underline the importance of further investigations of morbidly obese patients in the future and differentiate their results from those of less obese patients with a BMI $< 40\,kg/m^2$.

Limitations of this study lie in its retrospective design and the small number of patients. Due to the retrospective design we are not able to provide assessment scores such as ODI or quality of life questionnaires from the past. The small quantity of available long-term follow-up data is especially limiting, as it only allows us to state our results as an assumption rather than a conclusion. We did not perform a comparison to other surgical techniques such as open TLIF and are therefore not able to make a statement on these techniques. Despite these limitations, this is the first investigation on patients with morbid obesity (BMI $\geq 40\,kg/m^2$) who underwent MIS TLIF and we believe that our data provides important new information on this subgroup of obese patients.

5. Conclusions

MIS TLIF is technically feasible in morbidly obese patients (BMI $\geq 40\,kg/m^2$) with acceptable short-term results. However, our long-term data suggest that morbidly obese patients might have a higher risk for late complications and might not benefit as much from this surgery as normal-weight patients in the long term. Additional studies are needed to further investigate the characteristics, risks, preoperative preparation, and outcome in this special subgroup of patients.

Conflict of interest and source of funding

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