The impact of obesity measured by outer abdominal fat on instability of the adjacent segments after rigid pedicle screw fixation

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Abstract

Previous studies have shown coherence between obesity and higher rates of complications following spinal surgery. However, there is a lack of information about the influence of obesity and the mass of outer abdominal fat (OAF) on adjacent segment instability after spinal fusion surgery. Radiographs of 194 patients with spinal fusion surgery were assessed retrospectively. Radiographs were performed after surgery during two years' follow-up and signs of adjacent segment instability were documented. Patients were classified regarding their BMI and extent of OAF was assessed using CT at the umbilical level. In 20 patients (10.3%) instability of adjacent segments occurred during follow-up. In this cohort mean OAF was significantly thicker (28.07 mm) compared to the patients without instability (22.39) (P=0.038). A total of 45% of patients with instability showed OAF of more than 30 mm at time of intervention compared to 10% in those without signs of instability. There exists significant correlation between the extent of OAF and development of adjacent segment instability postoperatively. Thus, weight reduction before spinal surgery could potentially decrease risk of adjacent segment instability.

Introduction

Obesity poses a major public health issue causing higher rates of diseases for the individual generally, such as hypertension or diabetes, but also represents a risk factor regarding the development of chronic low back pain and vertebral degeneration. Moreover, it results in enormous expenses regarding health care funding. Mainly, overweight was defined as Body-Mass-Index (BMI) of 25 kg/m^2 and more, obesity is classified as BMI of 30 kg/m^2 and more.[1] In the United States, the Centres for Disease Control and NHANES statistics revealed that about 66% of all people presented overweight in 2003-2004 (BMI >25 kg/m^2) and 32.9% were obese.[2,3] Statistical analysis of the Europeans presented similar results pointing out a prevalence of obesity in around 30% of the population.[4]

Chronic back pain is a common disease in the elderly. Due to limited activity and work loss, back pain generates high costs in today's health systems. Lifetime prevalence of low chronic back pain ranges from 11 to 84% in general population.[5] Dorsal spondylodesis is one of the most common surgical treatment options to achieve spinal stability and pain relief required by numerous varies of degenerative diseases of the spine. Spinal fusion surgery is an advanced surgical technique presenting high rates of success, thus, coming along with a high risk for perioperative and postoperative complications differing in appearance and severity: Main complications are pseudarthrosis or persistence of chronic back pain and surgical site infections.[6,7] Additionally, adjacent segment degeneration (ASD) is pointed out to be a high-risk complication after rigid pedicle screw fixation as it causes instability of the spine.[8] Thus, the increased mobility of vertebral segments above and or below of the index fixation level may result in facet joint degeneration, causing relapse chronic low back pain in postoperative patients, possibly leading to re-intervention.[8]

Some risk factors as previous spinal surgery, diabetes, nicotine abuse, corticosteroid therapy and duration of surgery are widely accepted to be relevant regarding the development of perioperative complications.[9,10] Obesity, generating multiple comorbidities, causes more mechanical stress and may lead to early degeneration of the spine. Therefore, even bariatric surgery in advance of spinal fusion surgery for weight reduction was considered beneficial.[10]

In the literature, the impact of obesity influencing perioperative complications and final outcome in comparison to normal weighted patients remains controversial due to a paucity of studies.[10,11] Only limited information is accessible regarding the impact of obesity on instability at adjacent segments after spinal fusion.

Therefore, the present study aimed at assessing the impact of obesity measured by the layer of outer abdominal fat (OAF) on instability at the adjacent segments after rigid pedicle screw fixation in spinal surgery.

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Materials and Methods

194 patients, who underwent rigid pedicle screw fixation of the spine, were included in this retrospective case-control study. All of them got radiography directly after surgical intervention as during a period of two years at follow-up and got computed tomography (CT) scan at the time of surgical intervention. Patients were dedicated to four groups regarding their examined body-mas-index (BMI) at the time of surgical intervention.

Postoperative X-rays, functional imaging as MR-imaging were analysed regarding screw loosening and adjacent level instability.

Radiographically instability was diagnosed, if spondylolisthesis >4 mm (anterior or posterior translation) was presented at functional imaging, segmental kyphosis >10°, hypermobility in rotation >15°, complete herniated disc, degradation in Weiner-Classification of two or more grades, complete collapse of intervertebral space, lateral Translation >3 mm and disc wedging >5° occurred at follow-up imaging at the adjacent level above or below the instrumentation.[12,13] Two experienced orthopaedic surgeons assessed radiological measurements independently. As a parameter to measure obesity, the outer abdominal fat (OAF) describing the maximal extent of subcutaneous fat tissue of the abdominal wall was measured in millimetres using CT scans at the umbilical region (Figure 1). As previously published OAF correlates with the total amount of body fat.[14] Measurements were performed by a single observer using basic functions in IMPAX EE (Agfa HealthCare GmbH, Bonn, Germany) running on a Microsoft Windows based computer system.

Statistical analysis was performed using SPSS Software (SPSS 21.0, Inc. Chicago, IL, USA). Data assessment included non-parametric tests such as the Mann Whithey U Test and the One-sample Kolgomorov Smirnov Test. Additionally, statistics were visualised in the normal and the de-trended Quantile-Quantile-Plot (Q-Q Plot). In regards of ratios, the Chi-Square Test, Pearson Chi Square and the Likehood Ratio were used.

Results

194 patients aging from 10 up to 88 years were included in this retrospective analysis. The mean age of all patients accounted for 59.7-42.8% of patients were female (n=83) and 57,2% were male (n=111).

According to the literature patients were divided into groups regarding their BMI level:[15] Eight patients had normal weight (18.5-25 kg/m^2), 60 were pre-adipose (25-30 kg/m^2), 22 were classified as obesity I (30-35 kg/m^2), four patients as obesity II (35-40 kg/m^2) and two patients as obesity III (>40 kg/m^2).

The mean OAF of all patients accounted for 22.98±10.13 mm. Within 20 patients (10.3%) adjacent segment instability was observed. Mean OAF of patients developing adjacent segment instability during a follow-up of two years amounted to 28.07 mm. Thickness of the fat layer in these patients ranged from 5.9-59.1 mm (Figure 2). Patients with adjacent segment instability were issued regarding their weight: four were normal weighted, nine were pre-adipose, three were distributed to class I, one patient to class II and no BMI matched class III.

Among all patients without adjacent segment instability mean value of OAF came to 22.39±10.1 mm. Extent of the fat layers ranged from a minimum of 5.2 to a maximum of 59.9 mm (Figure 2). Four patients without adjacent segment instability were normal weighted, 51 were pre-adipose. BMI values of 19 patients matched class I, whereas three parted class II and two class III.

A significant difference (P=0.038) in OAF thickness between the two cohorts was observed (22.39 mm *vs*. 28.07 mm).

A total of 45% of patients with adjacent level instability had an OAF of more than 30 mm compared to 10% of patients without signs of instability (Figure 3). 10% of patients presenting adjacent level instability even showed an OAF of more than 40 mm, compared to only 4% of patients without signs of instability.

Comparing OAF levels of the patients to the evaluated BMI at the time of surgical intervention according to the WHO Classification of Obesity, there is no correlation between the mass of OAF (mm) and BMI classes (I, II, III), as no significant correlation between BMI classes and adjacent segment instability after spinal fusion surgery (Figure 4).[15]

Discussion

Based on our present findings we conclude, that there exists a highly significant correlation between increased OAF mass and appearance of adjacent segment instability. 30 mm of OAF is supposed to be the key mark concerning an increased development of adjacent level instability: Only 19,55% of the patients without instability had OAF measuring 30 mm or more compared to 45% of patients showing instability of adjacent segments.

Moreover, higher values of OAF than 40 mm and above were found to influence the development of adjacent level instability following spinal fusion significantly (P=0.038). 10% of the patients developing adjacent level instability at follow-up presented an OAF extent of 40mm and above whereas only 4% of patients with OAF of 40 mm showed no sign of instability.

Showing that OAF levels (mm) did not correlate to Body Mass Index classes of obesity underlines the impact of OAF as a valuable predictive factor regarding adjacent segment instability in spinal surgery. In general, previous findings have shown the BMI to influence outcomes and satisfaction of patients undergoing spinal surgery.[16] However, we cannot show any general correlation between a higher BMI and an increased occurrence of adjacent segment instability after spinal surgery.

Spinal fusion surgery is a widely-

Figure 1. Measurement of OAF in millimetre on axial planes of computed tomography scans at the level of umbilicus and thickest subcutaneous fat tissue.

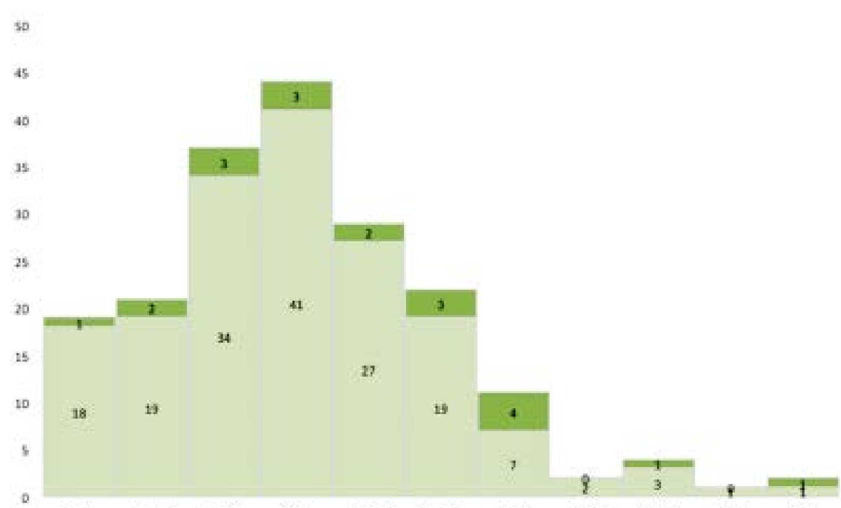

Figure 2. Depiction of the number of patients (vertical axis) and their extent of OAF (mm; horizontal axis) and occurrence of adjacent segment instability (dark green).

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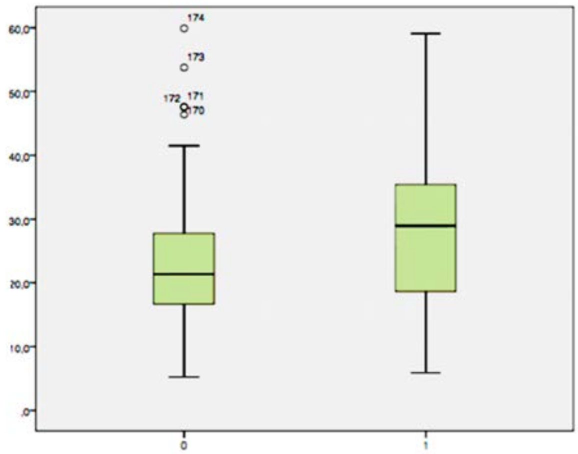

Figure 3. Patients of different OAF (mm; vertical axis) and outcome at two years' follow-up (0= no signs of instability; 1= adjacent level instability; horizontal axis).

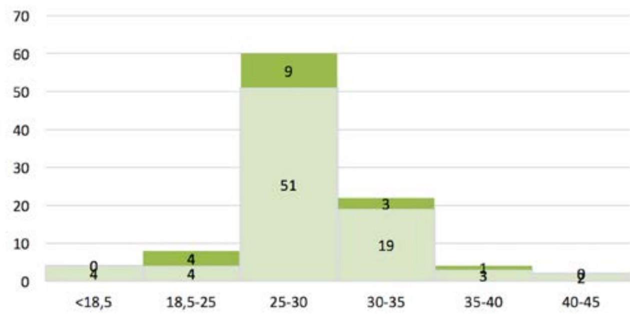

Figure 4. Depiction of the number of patients (vertical axis) and their BMI (kg/m2 horizontal axis) and occurrence of adjacent segment instability (dark green) and occurrence of adjacent segment instability (dark green).

accepted treatment option for pathologies of the spine resulting in chronic low back pain. This method can assess a multiple of pathologies such as degenerative disc diseases, spinal disc herniation, spondylolisthesis and scoliosis or kyphosis.

Within all, spinal fusion surgery shows good outcome regarding quality of life, pain relief and cost-effectiveness.[17-19] However, surgery still can lead to serious perioperative complications in general, especially in obese.[6,7]

For total hip arthroplasty (THA) Hanna *et al.* revealed a significantly higher risk of failure for revision surgery of morbid obese patients.[20] Some authors suggest, that obesity contributes to perioperative complications in spinal fusion surgery such as wound healing disorders, surgical site infections or extended lengths of stay.[10,21,22]

Previous studies showed worse outcome of obese patients in spinal fusion surgery compared to normal weighted patients. De la Garza-Ramos *et al*. pointed out, that obese patients were 2.1 times more likely to show perioperative complications and 3.1 times more likely to show surgical site infection.[23] Knutsson *et al.* analysed long-term outcome after surgery for lumbar spinals stenosis of obese patients, demonstrating that obese patients generally benefit of spinal fusion surgery, however the outcome of obese patients was worse compared to less-obese patients similarly to present findings.[16]

Melissas *et al.* pointed out that surgical weight reduction performed before spine surgery in obese leads to a significant improvement of the outcome.[24] It can be considered, that any weight reduction, but especially OAF reduction in advance of a spinal fusion surgery might be a helpful assessment to avoid perioperative complications in spinal surgery and, thus, achieve better outcomes. Jentzsch *et al*. published a similar study measuring OAF by computed tomography scans showing a greater extent of OAF leading to higher risk of facet joint arthritis of the spine and corroborating our presented findings, that higher OAF levels may cause higher biomechanical stress at the spine.[25]

Several limitations of this study must be mentioned. A higher number of patients would generally provide a more powerful validity regarding the impact of obesity on spinal fusion surgery and is necessary to support present findings in future studies. Moreover, prospective assessments including regularly evaluated OAF and BMI as analysing the outcome regarding the influence of further pre-existing conditions and physical activity as part of multi-variance analyses would be desirable to minimize selection bias.

Conclusions

In conclusion, OAF is significantly increased in patients with instability of adjacent segments and leads to persistence in chronic low back pain in obese patients. Therefore, it must be considered, that any reduction of OAF in advance of a spinal fusion surgery may be a key regulator to avoid adjacent segment instability and, potentially, decrease the risk of adjacent segment instability with associated back pain and re-intervention.

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