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CLINICAL CASE SERIES

Intervertebral Disc Height Changes After Weight Reduction in Morbidly Obese Patients and Its Effect on Quality of Life and Radicular and Low Back Pain

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Study Design. Prospective study in a morbidly obese population after bariatric surgery.

Objective. To document the effect of significant weight reduction on intervertebral disc space height, axial back pain, radicular leg pain, and quality of life.

Summary of Background Data. Low back pain is a common complaint in obese patients, and weight loss is found to improve low back pain and quality of life. The mechanism by which obesity causes low back pain is not fully understood.

On acute axial loading and offloading, intervertebral disc changes its height; there are no data on intervertebral disc height changes after significant weight reduction.

Methods. Thirty morbidly obese adults who underwent bariatric surgery for weight reduction were enrolled in the study. Disc space height was measured before and 1 year after surgery. Visual analogue scale was used to evaluate axial and radicular pain. The 36-Item Short Form Health Survey and Moorehead-Ardelt questionnaires were used to evaluate changes in quality of life.

Results. Body weight decreased at 1 year after surgery from an average of 119.6 ± 20.7 kg to 82.9 ± 14.0 kg corresponding to an average reduction in body mass index of 42.8 ± 4.8 kg/m^2 to 29.7 ± 3.4 kg/m^2 ($P < 0.001$).

The L4–L5 disc space height increased from 6 ± 1.3 mm, presurgery to 8 ± 1.5 mm 1 year postsurgery ($P < 0.001$).

Both axial and radicular back pain decreased markedly after surgery ($P < 0.001$). Patients' Moorehead-Ardelt score significantly improved after surgery ($P < 0.001$). Although the 36-Item Short Form Health Survey score did not show any statistically significant improvement after surgery, the physical component of the questionnaire showed a positive trend for improvement.

No correlation was noted between the amount of weight reduction and the increment in disc space height or back pain improvement.

Conclusion. Bariatric surgery, resulting in significant weight reduction, was associated with a significant decrease in low back and radicular pain as well as a marked increase in the L4–L5 intervertebral disc height.

Reduction in body weight after bariatric surgery in morbidly obese patients is associated with a significant radiographical increase in the L4–L5 disc space height as well as a significant clinical improvement in axial back and radicular leg pain.

Key words: morbid obesity, intervertebral disc height, Radicular leg pain, axial back pain, life quality, disc height restoration, bariatric surgery. **Spine 2012;37:1947–1952**

Obesity is a growing public health concern, which has turned into a pandemic in Western society.[1–5]

Morbid obesity has been found to increase the risk of serious comorbidities including hypertension, diabetes mellitus, hyperlipidemia, respiratory disorders (hypoventilation, sleep apnea), gastrointestinal diseases, and other pathologic conditions.[6,7]

Low back pain (LBP) is a common complaint among morbidly obese patients. The association between being overweight and LBP was found to be stronger in women and in patients with abdominal *versus* generalized obesity.[4] Despite the plethora of research focused on gaining an understanding of the interplay between obesity and LBP, many of the underlying mechanisms remain obscure. Moreover, data on the effect of weight loss on quality of life of obese patients, as well as possible consequent anatomical changes in the spine, are even more scarce.[1–4,6,8,9]

The purpose of this study was to determine the effect of weight loss on quality of life and back pain in severely obese patients undergoing bariatric surgery and to correlate them with changes in disc space height.

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PATIENTS AND METHODS

Thirty-five morbidly obese adults undergoing bariatric surgery were enrolled in the study.

All morbidly obese patients referred to the hospital's obesity clinic, for potential surgical treatment, underwent a multidisciplinary evaluation by a dietitian, a psychologist, an anesthesiologist, and a bariatric surgeon. The indications for surgery as recommended by the National Institutes of Health Consensus Conference were body mass index (BMI) exceeding 40 kg/m^2 or more than 35 kg/m^2 with at least 1 severe obesity-related comorbidity (diabetes type 2, hypertension, sleep apnea, osteoarthropathy, *etc.*) as well as failure of previous conservative attempts to lose weight.[4,10]

The choice of procedure was decided according to the individual characteristics of the patient, such as age, BMI, health-related conditions, previous operations, medications taken, degree of self-discipline, eating habits (sweet eaters, binge eaters), anatomic conditions (large hiatal hernia), and the patient's individual preferences.

The bariatric procedures performed on the study patients included laparoscopic gastric banding, sleeve gastrectomy, laparoscopic Roux-en-Y gastric bypass, and duodenal switch procedure. Postoperative care planed by the bariatric surgeon did not include physiotherapy or any other rehabilitation therapy. Patients' height and weight were measured before and a year after surgery.

Abdominal computed tomographic (CT) scans were obtained at the L4–L5 vertebral body levels before and a year postsurgery. The L4–L5 CT scans where obtained by the bariatric surgeons in order to evaluate the peripancreatic abdominal visceral fat depots dynamics and the relationship of the peripancreatic fat to weight loss and metabolic syndrome. This study uses those CT scans to document the changes in disc space height. The CT scans obtained as part of the study were taken in supine position between 4 and 6 PM. Patients were asked not to rest after 12 PM at the day of scanning. The study was approved by the Research Ethics Committee of the Hadassah-Hebrew University Medical Center and written informed consent was obtained from all patients.

Outcome Measures

Radiographical

Measurements of the L4–L5 intervertebral disc height were obtained using the PACS system internal measuring tool (GE Medical System Information Technology Centricity Enterprise Web). Scans were interpreted by a single independent radiologist experienced in spine imaging.

The L4–L5 disc level was identified and its height was measured using the following technique: An axial cut was used to draw a line from the anterior to posterior and from right to left lateral borders at its longest diameter at L4 inferior and L5 superior endplates. The crossing point of these lines determined the center of the disc on axial imaging cuts. Disc space height was measured on sagittal reconstructed image from the crossing points of the axial cuts lines (Figure 1).

Clinical

Quality of life was assessed before and 1 year after surgery, using the 36-Item Short Form Health Survey (SF-36) and the Moorehead-Ardelt (MA) questionnaires. The SF-36, as detailed elsewhere, is a 36-item questionnaire that measures the physical and mental domains of reported health status to assess quality of life.[11] The MA Quality of Life Questionnaire is a disease-specific instrument developed to measure postoperative outcomes of self-perceived quality of life in obese patients.[12]

Pain assessment was quantified using the visual analogue scale score. Only patients having chronic back and/or leg pain for more than 3 months were assessed. Four patients who did not have chronic pain obtained a preoperative 0 score.

STATISTICAL ANALYSIS

Descriptive statistics are given as a mean and standard deviation for continuous variables and frequency distribution for categorical variables.

Individual changes in BMI, disc height, quality of life, and leg and back pain after surgery were calculated.

The associations between the aforementioned parameters before and after surgery, as well as between the extent of change within the aforementioned parameters and age, were evaluated using the Spearman correlation coefficient for ordinal variables, and the Pearson coefficient for continuous variables.

Paired sample *t* test was used to assess the effect of weight reduction after surgery on MA, SF-36, BMI, and CT results, whereas the Wilcoxon signed-rank sum test was applied to evaluate changes in leg and back pain.

Two sample *t* tests were used for comparison between males and females, regarding BMI and disc height changes after surgery.

Multiple linear regression analyses were performed to locate factors independently associated with disc height change in CT scan after weight reduction surgery. The following explanatory variables were included in the model: age, sex, and BMI change.

Multiple logistic regressions were used to determine which variables are independently associated with differences in leg and back pain. Variables included in the models were age, sex, change in BMI, and change in disc height on CT scan. Several model-building methods were used including forced entry forward selection and backward elimination.

All statistical analyses were performed using SAS for Windows 9.1.3.

RESULTS

Thirty patients completed the study: 15 women and 15 men, mean age: 49 ± 10.4 years (range: 31–77 yr).

Five patients, who did not comply with the postoperative study protocol, were excluded from the study after 3 failed attempts to contact them.

Average body weight decreased significantly at 1 year postsurgery from 119.6 ± 20.7 kg to 82.9 ± 14.0 kg corresponding

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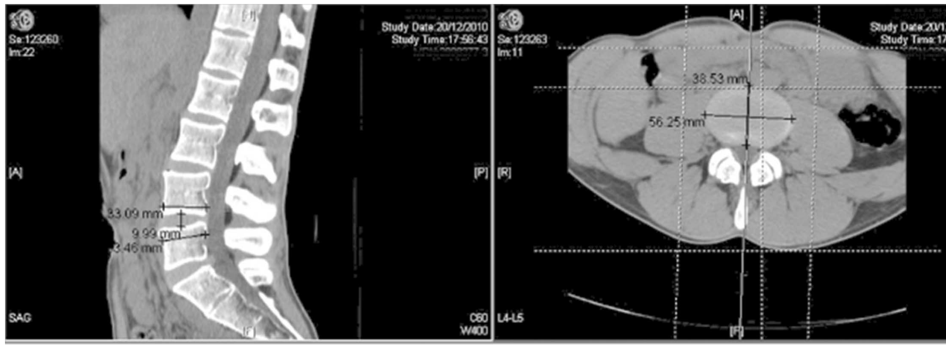

Figure 1. Disc height measurement.

to an average reduction in BMI from 42.8 ± 4.8 kg/m^2 to 29.7 ± 3.4 kg/m^2 ($P < 0.001$) (Figure 2).

A significant increase in L4–L5 disc height was measured from a baseline of 6 ± 1 mm to 8 ± 1 mm, 1 year postsurgery ($P < 0.001$) (Figure 3).

Prior to surgery, 26 patients experienced axial back pain, 16 patients had radicular leg pain, 15 patients described a combination of both axial and radicular pain, and 4 patients had no axial or radicular pain.

No radiological significant root compression or spinal stenosis was noted on the preoperative CT scan.

Axial back pain decreased markedly 1 year after the operation (5.70 ± 3.12 to 1.33 ± 2.13, Wilcoxon signed rank test = 175.5; $P < 0.001$). In addition, a significant improvement in radicular leg pain was reported (3.46 ± 3.78 to 0.46 ± 1.10, Wilcoxon signed-rank test = 60; $P < 0.001$) (Figure 4).

No significant changes were noted in the Mental Component Summary (MCS-36) and Physical Component Summary (PCS-36) of the SF-36 questionnaire when comparing preoperative with postoperative data ($t = 1.70$; $P = 0.104$ and $t = 1.73$; $P = 0.097$, respectively) (Figures 5 and 6). However, the MA questionnaire showed a significant change 1 year after surgery (5.91 ± 1.099 to 7.91 ± 1.38, $t = 8.09$; $P < 0.001$) (Figure 7).

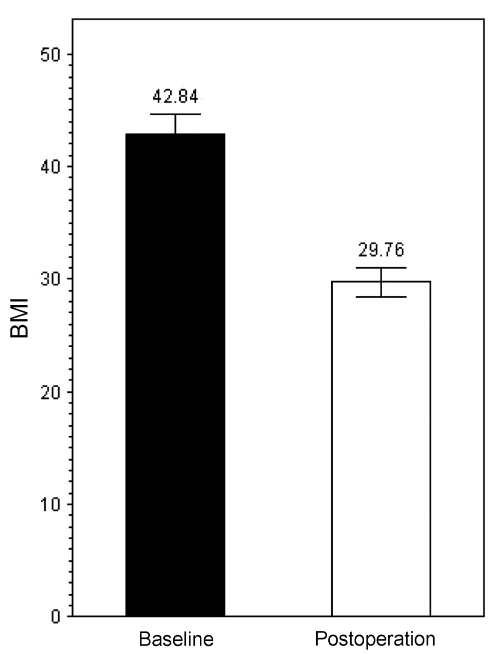

Figure 2. Change in BMI (baseline *vs.* 1 yr postoperation). BMI indicates body mass index. *$P < 0.05$.

No significant correlation was found between the mean change in the MCS-36 and BMI ($r = 0.084$; $P = -0.376$), nor between the change in MA and BMI ($r = 0.233$; $P = 0.258$).

The correlation between the change in PCS-36 and BMI was on the verge of statistical significance ($r = 0.751$; $P = 0.071$).

Although no significant correlation was established between decrease in BMI and improvement in back pain ($r = 0.231$; $P = 0.218$), the former was associated with a significant improvement in leg pain ($r = 0.515$; $P = 0.0036$).

Multiple logistic regression models using backward elimination and forward selection, with leg pain changes as the dependent variable and age, sex, and changes in BMI and CT as the predictors, yielded the same level of the C parameter (area under the ROC curve of the model), C = 0.782. In summary, this model indicates that reduction in BMI is an independent predictor of improvement in leg pain.

Sex had no effect on disc height changes ($t = -1.96$; $P = 0.0596$).

Raw data collected are presented in Appendix A (see Web Table Supplemental Digital Content 1, available at http://links.lww.com/BRS/A677).

DISCUSSION

Both mechanical and systemic inflammatory effects may contribute to back pain in obese patients. Obesity is characterized by reduced range of motion of the spine, causing postural adaptation with an increased anterior pelvic tilt due to increased lumbar lordosis.[2] In addition, obesity can increase the mechanical load on the spine by causing a higher compressive force or increased shear stress on the lumbar spine.[2] Of note, osteoarthritis, estimated to affect 34% of the obese population, is significantly correlated with BMI.[2] Furthermore, obesity may cause LBP by low-grade systemic inflammation resulting from increased production of cytokines and acute-phase reactants and through activation of proinflammatory pathways in adipose tissue[3,13]

Reports on the prevalence of back pain in severely obese patients show varying results. Although 86% of our study population experienced back pain prior to the bariatric procedure, Shiri *et al*[4] reported only a 22% prevalence of axial back pain in overweight and obese patients. The discrepancy may stem from differences in studied population because they

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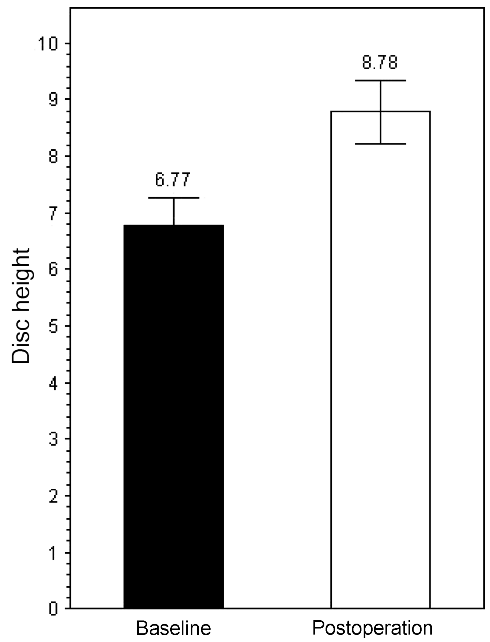

Figure 3. Disc height changes (baseline *vs*. 1 yr postoperation). $*P < 0.05$.

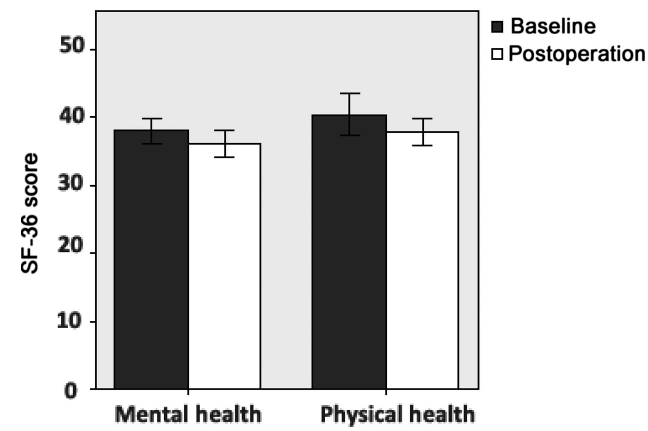

Figure 5. 36-Item Short Form Health Survey Mental and Physical Health (baseline *vs*. 1 yr postoperation).

included patients with BMI more than 24 kg/m^2, whereas our cohort was heftier, with BMI more than 35 kg/m^2 (mean, 42 kg/m^2). Indeed, Urquhart *et al*[14] showed positive association between increased fat mass and intensity of back pain.

Previously, weight loss has been reported to improve back pain and quality of life. Khoueir *et al*[1] prospectively observed 38 patients treated by bariatric surgery and found significant improvement in the mental as well as in the physical component of the SF-36, a 24% reduction in the Oswestry Disability Index as well as a moderate reduction in back pain, 1 year after surgery. These findings were corroborated by Melissas *et al*,[6] who observed 29 patients after bariatric surgery. These results stand in contrast to the lack of improvement in the SF-36 components in this study. In this study, although pain reduction was significant, it is not the only parameter contributing to quality of life after bariatric surgery. The effects of weight reduction surgery, including the acquiring of new eating habits, changing old daily routines, psychosocial factors, reduction in cholesterol, diabetic control, and improvement of blood pressure levels and sleep apnea, may not be reflected in a general quality of life questionnaire such as the SF-36; indeed, the mental part showed no improvement but the physical part showed near significant improvement. The MA functional scale, which is an oriented, disease-specific, validated scale for obese patients, demonstrated a significant improvement after surgery.

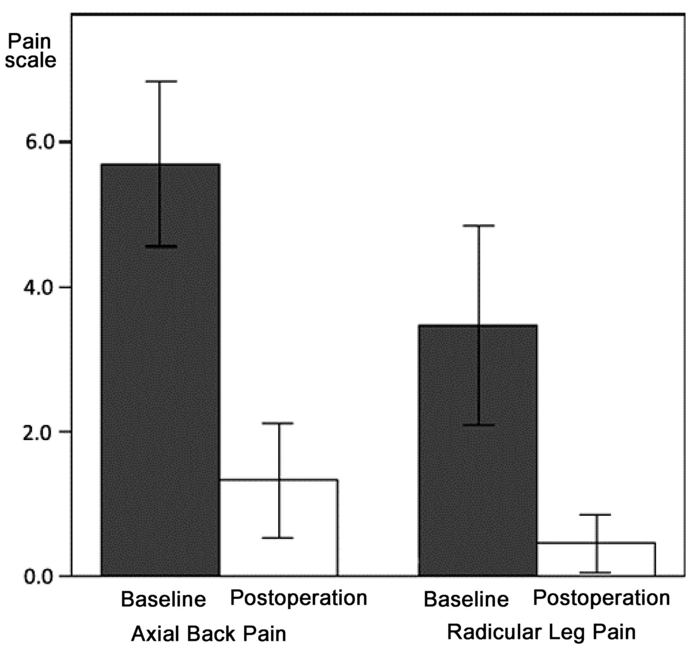

Figure 4. Axial back and radicular leg pain (baseline *vs*. 1 yr postoperation).

Disc space changes, especially increase in disc space height in response to reduced axial loads, were documented in a few previous studies. The disc space was found to significantly change in height, volume, and morphology upon assuming recumbent and upright position.[15,16] Similar results were obtained when acute compressive forces were axially applied.[17] Kimura *et al*[18] measured a 1-mm height reduction at the L4–L5 disc level when loading the spine with 50% body weight. In this study, we found a clear correlation between the amount of weight loss and the degree of improvement in radicular pain, whereas back pain also improved significantly, albeit, not in linear correlation to the magnitude of weight reduction. Similarly, although disc height restoration after weight reduction was significant, a direct correlation to the extent of weight loss was lacking. These observations held true when comparing the absolute values as well as when comparing the percentages of weight reduction with disc height restoration. Hence, back pain and disc space height seem to behave as an "all or none" phenomenon.

Malko *et al*[19] performed a magnetic resonance imaging study exploring diurnal changes in disc space height in young patients, which may serve to explain this newly observed phenomenon. They showed that acute axial compression causes reversible disc height changes due to a water content shift, of approximately 70% to 80%, in and out the nucleus and the annulus.

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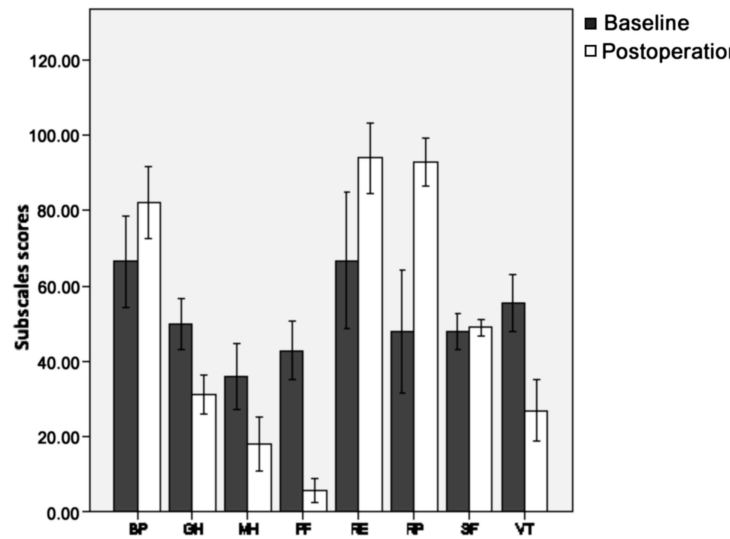

Figure 6. 36-Item Short Form Health Survey subscale scores (baseline *vs.* 1 yr postoperation).

Although we did not find a linear correlation between the amount of weight reduction and disc height increment, we think that the restoration of disc space height is a true occurrence as previous studies had shown and by the fact that our patients served as their own control group.

The nonlinear "all or nonphenomena" may be explained by the observation that in severely obese patients, the disc and facet joints are exposed to long years of considerable axial loads, combined with normal aging and dehydration of the disc. These changes, in turn, may lead to a reduction in the elasticity of the disc and ligaments, causing them to behave in a stepwise rather than in a linear fashion.[20]

LIMITATIONS

Although most of the study population experienced LBP and radicular pain, we did not attempt to rule out ancillary spinal pathologies such as spinal stenosis or nerve root compression at other levels.

Given that we used only imaging studies acquired for the bariatric study, only the L4–L5 level could be investigated, and because back pain, radicular pain, and disc space height were significantly improved despite these limitations, we conclude that weight reduction by itself contributed to these results.

As our study group comprised only 30 patients, further investigations with a larger number of patients and magnetic resonance imaging of the whole lumbar levels are necessary to further validate our results and assumptions.

CT scans were obtained to measure disc space height, and although theoretically upright radiographs may be more suitable to measure disc height, they are more difficult to analyze and harder to accurately measure disc space height. Furthermore, because our patients served as their own control group, we think that changes in disc space height are a true observation.

Although we used SF-36 and MA questionnaires that are well-known quality-of-life assessment tools, it would have been advisable to add a more oriented questionnaire such as the Oswestry LBP scale.

Axial pain and radicular pain are dynamic features, and we assessed our patients using the visual analogue scale score system before and 1 year after the operation. Greater sampling frequency would have given us clearer understanding of their pain improvement over time.

In conclusion, our findings indicate that reduction in body weight after bariatric surgery is associated with a significant radiographical increase in the L4–L5 disc space height as well as a significant clinical improvement in axial back and radicular leg pain. The disc space height restoration and back pain behave in a nonlinear fashion; this phenomenon may be explained by the severe load posed on the lumbar spine of overweight patients, leading to marked degenerative changes and loss of elasticity.

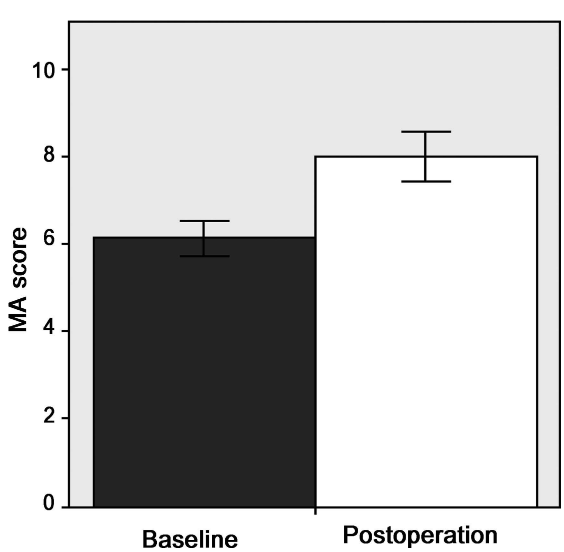

Figure 7. Moorehead-Ardelt Scale score (baseline *vs.* 1 yr postoperation). MA indicates Moorehead-Ardelt.

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➢ Key Points

- ❑ Bariatric surgery, resulting in significant weight reduction, is associated with:
- ❑ Marked increase in the L4–L5 intervertebral disc height.
- ❑ Significant decrease in low back and radicular pain.
- ❑ Significant improvement in MA quality-of-life questionnaire.

Supplemental digital content is available for this article. Direct URL citation appears in the printed text and is provided in the HTML and PDF versions of this article on the journal's Web site (www. spinejournal.org).

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