Mean BMI of Overweight and Obese Patients Does Not Decrease After Successful Ankle Reconstruction

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Background: End-stage arthritis may be associated with increased body mass index (BMI). Overweight patients with ankle arthritis often request surgery in the hope that this will allow them to initiate a weight loss program.

Methods: One hundred and forty-five overweight (BMI = 25.1 to 29.9 kg/m²) or obese (BMI > 30 kg/m²) patients who had successful ankle replacement or ankle fusion, as defined by the absence of revision ankle surgery and a postoperative improvement in the Ankle Osteoarthritis Scale (AOS) score, were identified in a retrospective cohort ankle database. Their BMIs at six months and one, two, and five years postoperatively were compared with their preoperative BMI as the primary outcome measure. Linear regression analysis was used to correlate the outcome scores against BMI with time.

Results: No significant change in the mean BMI, compared with the preoperative BMI, was found at six months or one, two, or five years postoperatively, despite significant improvement in the AOS and Short Form-36 (SF-36) Physical Component Summary scores at all time points. The factor that most strongly correlated with postoperative BMI was preoperative BMI.

Conclusions: Pain and disability are significantly reduced in overweight and obese patients after successful ankle replacement or fusion. Despite this, the mean BMI remains unchanged after the surgery, indicating that weight loss does not commonly occur following successful ankle reconstruction in this patient population. Obesity is likely attributable to factors other than limited mobility caused by ankle arthritis.

Level of Evidence: Prognostic Level IV. See Instructions for Authors for a complete description of levels of evidence.

In the past twenty years, there has been an increase in the prevalence of overweight and obese individuals in the United States1 and Canada2,3. A corresponding increase in diabetes mellitus has been documented4. Healthy weight standards are exceeded by 54.4% of American adults and 48% of Canadian adults5,6. Osteoarthritis of the knee is a well-documented musculoskeletal sequela of obesity7, suggesting that symptomatic osteoarthritis elsewhere in the lower extremity, including the ankle joint, may also be correlated to obesity.

The physical disability and reduction in quality of life caused by end-stage ankle arthritis are severe8. Patients with end-stage ankle arthritis have severe pain, diminished health-related quality of life, and limited physical function that are at least as severe as findings in patients with end-stage hip arthritis9. Patients with ankle arthritis frequently identify their increased weight as an indicator of the decline in their quality of life.

Weight loss is often advised for these patients, with the expectation that symptoms will be reduced, function will improve, and the need for surgical intervention will be delayed or avoided. However, overweight and obese patients commonly assert that such weight loss is impossible in the face of disabling ankle pain. They often cite restricted mobility and pain as the primary factors limiting their ability to stay fit and lose weight.

Patients commonly assume that weight loss will naturally follow successful ankle replacement or ankle fusion. Indeed, it is common for patients to believe that weight loss will be

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The objective of this study was to determine if overweight and obese patients with successful ankle reconstructive surgery had weight loss at the time of early and midterm follow-up.

**Materials and Methods**

**Patient Inclusion Criteria**

Patient data for this study were collected from a retrospective cohort that included all patients who had undergone ankle fusion or ankle replacement at our institution between 2003 and 2010. Patients were included in this study if all of the following criteria were met:

- primary ankle replacement or fusion and a duration of follow-up of at least one year
- successful ankle surgery, with the Ankle Osteoarthritis Scale (AOS) score improved (lower) at all follow-up points compared with the preoperative score
- overweight or obesity prior to surgery according to BMI standards (overweight = 25.1 to 29.9 kg/m², obese = 30.0 to 34.9 kg/m², and morbidly obese = ≥35.0).

Patients were excluded from the study if they had at least one of the following:

- a BMI of <25 kg/m²
- diabetes mellitus and neuropathy or Charcot arthropathy
- a need for revision of the ankle fusion or replacement
- no improvement in the AOS score after surgery
- less than one year of follow-up
- a major medical comorbidity that could limit function (major cardiopulmonary disease, a stroke-induced neurologic deficit, neuromuscular impairment, cognitive or severe psychiatric disease, or debilitating hip or knee arthritis)
- unable to communicate in English or unable to follow the study protocol.

**Data Collection**

Overweight and obese patients were selected on the basis of their BMI. Height and weight were measured in the preoperative assessment clinic by a registered nurse. At follow-up visits at six months, one year, two years, and five years, postoperative weight was recorded on the basis of the patient’s self-reported weight or the clinical nurse’s measurement if the patient was not certain about his or her weight.

BMI was calculated with the formula: weight (kg)/[height (m)]². Patients were selected if they were classified as overweight or obese as defined by a BMI of ≥25.12,14.

The functional patient outcome was assessed with both a disease-specific and a general outcome instrument. The disease-specific instrument was the Ankle Osteoarthritis Scale (AOS), a simple, reliable, and validated outcome measure for the clinical assessment of ankle osteoarthritis. Improvement in the overall AOS score was required for a patient to be considered to have had a successful outcome and to be included in the study.

The general outcome was assessed with the Short Form-36 (SF-36) functional health and well-being score, comprised of a Physical Component Summary (PCS) score and a Mental Component Summary (MCS) score. It is the most frequently used health-status measure in the United States and is a valid measure of the health status of a wide range of patients. Change in the SF-36 score was measured along with change in BMI, both to determine if the outcome after ankle surgery was successful in a broader sense than on the basis of AOS scores alone and to determine if BMI outcomes might have been confounded by persisting reductions in the PCS or MCS score.

**Statistical Methods and Analysis**

A paired Student t test was performed to analyze differences between the preoperative and postoperative AOS scores, SF-36 MCS and PCS scores, and BMIs. A linear regression analysis was utilized to compare the preoperative BMI with the follow-up BMIs at two and five years. Also, a linear regression analysis was utilized to assess whether the extent of improvement in the AOS score was associated with the change in the BMI of each patient. A p value of <0.05 was considered to be significant.

**Source of Funding**

There was no external source of funding for this study.

**Results**

**Demographics**

Review of our database identified 371 patients who had undergone primary ankle replacement or ankle fusion. Of these 371 patients, 276 (74%) had a preoperative BMI of >25 kg/m²; 178 of the 276 had more than one year of follow-up, with 152 of the 178 reporting improvement in their AOS score. Seven patients were excluded because of the presence of several medical comorbidities that limited their activity. This left 145 patients who met our inclusion and exclusion criteria. There were eighty-seven men (60%) and fifty-eight women (40%). The average age at the time of ankle surgery was 61.5 years (range, thirty-eight to eighty-nine years). The average BMI was 29.2 kg/m² (range, 25 to 39.9 kg/m²).

**Statistical Analyses**

The objective of this study was to determine if overweight and obese patients with successful ankle reconstructive surgery had weight loss at the time of early and midterm follow-up.
Preoperatively, ninety-nine (68%) of the 145 patients were classified as overweight (BMI of 25.1 to 29.9 kg/m²), thirty-five (24%) were obese (BMI of 30.0 to 34.9 kg/m²), and eleven (8%) were morbidly obese (BMI of ≥35.0).

Ninety patients (62%) were treated with ankle replacement, and fifty-five (38%) were treated with ankle fusion. The indication for surgery in all cases was end-stage ankle arthritis. The average duration of follow-up (and standard deviation) was 37.1 ± 19.8 months (range, twelve to ninety months).

### Outcome Scores

**AOS:** As shown in Table I, the mean AOS score improved considerably after ankle reconstruction. The average improvement (and standard deviation) was 36.1 ± 19.2 points (95% confidence interval [CI], 32.5 to 40.0; p < 0.05) at two years and 34.1 ± 17.8 points (95% CI, 29.1 to 39.0; p < 0.05) at five years. Both the ankle fusion and the ankle replacement group showed significant improvement in AOS scores, and the difference between these groups was not significant at five years.

**SF-36:** The mean SF-36 PCS score improved significantly at both two years (10.4 ± 10.6 points; 95% CI, 8.3 to 12.4; p < 0.05) and five years (9.2 ± 11.8 points; 95% CI, 6.0 to 12.3; p < 0.05) postoperatively. The improvement was significant in both the ankle fusion (9.6 ± 11.9 points; 95% CI, 3.4 to 15.7; p < 0.05) and the ankle replacement (9.0 ± 11.8 points; 95% CI, 5.2 to 12.7; p < 0.05) group, although no significant difference was noted between these groups at five years (Table II).

A significant improvement in the mean SF-36 MCS score was observed at two years (2.6 ± 11.6 points; 95% CI, 0.37 to 4.8; p < 0.05) and five years (4.7 ± 12.1 points; 95% CI, 1.5 to 7.9; p < 0.05) postoperatively (Table III).

### Table III

<table>
<thead>
<tr>
<th></th>
<th>No.</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Dev.</th>
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<td>37.20</td>
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BMI Change

There was no significant difference between the mean preoperative BMI and the BMI at one year (−0.1 ± 1.9 kg/m²; 95% CI, −0.45 to 0.24; p = 0.5), at two years (+0.14 ± 2.5 kg/m²; 95% CI, −0.3 to 0.6; p = 0.6), or at five years (−0.07 ± 2.9 kg/m²; 95% CI, −0.8 to 0.7; p = 0.8) postoperatively in the whole study population (Table IV). Similarly, with the number of patients studied, no significant changes were seen when these same comparisons were carried out for the overweight, obese, and morbidly obese subcategories separately.

At one year, the mean BMI was increased by 0.12 ± 1.7 kg/m² (95% CI, −0.5 to 0.26; p = 0.53) in overweight patients, decreased by 0.07 ± 2.4 kg/m² (95% CI, −0.9 to 1.0; p = 0.87) in obese patients, and increased by 0.53 ± 1.56 kg/m² (95% CI, −1.7 to 0.67; p = 0.34) in morbidly obese patients.

At two years, the mean BMI was increased by 0.02 ± 2.3 kg/m² (95% CI, −0.5 to 0.55; p = 0.92) in overweight patients, decreased by 0.5 ± 2.9 (95% CI, −0.5 to 1.4; p = 0.34) in obese patients, and decreased by 0.71 ± 2.0 kg/m² (95% CI, −0.8 to 2.2; p = 0.32) in morbidly obese patients.

At five years, the mean BMI was increased by 0.05 ± 2.6 kg/m² (95% CI, −0.75 to 0.86; p = 0.89) in overweight patients, increased by 0.12 ± 3.5 kg/m² (95% CI, −1.5 to 1.7; p = 0.88) in obese patients, and decreased by 1.12 ± 1.7 kg/m² (95% CI, −1.0 to 3.3; p = 0.23) in morbidly obese patients.

There was a significant and strong linear correlation between the preoperative BMI and the BMI at two years (r² = 0.66, p < 0.05) (Fig. 1) and five years (r² = 0.6, p < 0.05) for each patient (Fig. 2).

Despite the overall improvement in the AOS score, we found no correlation with a change in the BMI at two or five years (see Appendix). Rather, consistent improvement was seen postoperatively in all outcome scores, while the mean BMI of overweight and obese patients does not decrease after successful ankle reconstruction.

**TABLE IV Average BMI Preoperatively and Over the Five-Year Follow-up Period**

<table>
<thead>
<tr>
<th>No.</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Dev.</th>
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<tr>
<td>Preop.</td>
<td>145</td>
<td>25.00</td>
<td>39.85</td>
<td>29.23</td>
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<tr>
<td>6 mo</td>
<td>117</td>
<td>20.80</td>
<td>40.74</td>
<td>28.84</td>
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<tr>
<td>1 yr</td>
<td>121</td>
<td>22.59</td>
<td>41.62</td>
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<td>2 yr</td>
<td>113</td>
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<tr>
<td>5 yr</td>
<td>63</td>
<td>23.01</td>
<td>39.90</td>
<td>29.35</td>
</tr>
</tbody>
</table>

Fig. 2

Linear regression analysis of BMI before and five years after successful ankle surgery (y = 1.72 + 0.944 X) (r² = 0.6, p < 0.05).
postoperative BMI remained constant and equivalent to the mean preoperative BMI (Fig. 3).

For comparison, the average AOS score, SF-36 PCS score, SF-36 MCS score, and BMI at similar time points were calculated for patients with a normal BMI who had improved AOS scores after ankle surgery in our foot and ankle database. Figure 4 demonstrates this trend over a five-year period.

Overall, at the two-year follow-up evaluation, twenty-four patients (21%) had gained one unit of BMI or more, twenty-seven patients (24%) had lost one unit of BMI or more, and sixty-two patients (55%) remained within one unit of their preoperative BMI.

At the five-year follow-up evaluation, twenty-one patients (33%) had gained one unit of BMI or more, twenty-one patients (33%) had lost one unit of BMI or more, and twenty-one patients (33%) had remained within one unit of their preoperative BMI.

Discussion

This study demonstrates that, on average, overweight and obese patients do not lose weight despite a significant reduction in ankle pain and disability following successful ankle replacement or ankle fusion. Unfortunately, this finding is contrary to the hopes often expressed by patients who are awaiting ankle surgery. However, it is not entirely surprising, as similar retention of obesity has been seen following successful hip and knee replacement and successful spine surgery.
Our results support the concept that obesity is a multifactorial condition with increasing prevalence. Factors that are correlated with obesity include the presence of a musculoskeletal disorder, age, sex, income level, employment status, and geographic location. Additionally, obesity is often a longstanding problem for many patients and is associated with established personal behaviors. As a result, it is not surprising that a decrease in ankle pain, only one of these factors, does not commonly lead to a marked reduction in BMI.

It is also worth noting that, while the mean AOS score improved dramatically (by more than 30 points) after surgery, the values at two and five years postoperatively remained well above the population average, suggesting that, despite improvement, ankle disability persisted. The persistence of some level of disability may be a factor that inhibits postoperative weight loss.

The cause of the persistent physical disability postoperatively is not identifiable in this study. However, the overweight or obese status of all patients in this study may itself be a cause of physical dysfunction. If so, the cause and effect of obesity in our patients may be intertwined, further suggesting that improved postoperative ankle function alone is unlikely to lead to weight loss.

A potential limitation of this study is the reliance on self-reported postoperative height and weight for the assessment of more than half of the patients. While this has the potential to bias the results, a previous study on 1622 adults aged eighteen to sixty-four years demonstrated that men self-reported their weight without significant bias, while women underreported their weight by an average of 1.1 kg. This implies that our reliance on self-reported weight is reasonable, and that any bias in our data might actually lead to underreporting of the magnitude of the BMI.

Since postoperative weight loss cannot be expected, weight loss prior to surgery should be strongly encouraged. This may result in relief of ankle symptoms, as occurs with weight loss in patients with end-stage knee arthritis. We are not aware of any studies on weight loss and symptom relief in patients with foot and ankle conditions. Weight loss also lowers the patient’s risk for cardiac disease, cancer, and diabetes.

In conclusion, this study suggests that overweight or obese patients and their physicians should not anticipate that significant weight loss will follow successful ankle replacement or ankle fusion. The reasons for this are likely multifactorial. Appropriate preoperative counseling is recommended to avoid unrealistic expectations from the ankle surgery.

Appendix

Figures showing the improvement in the AOS scores and the changes in the BMI two and five years after successful ankle surgery are available with the online version of this article as a data supplement at jbjs.org.

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References


