Effect of Surgical Weight Loss on Plantar Fasciitis and Health-Care Use

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Background: Plantar fasciitis (PF) is one of the most common causes of heel pain. Obesity is recognized as a major factor in PF development, possibly due to increased mechanical loading of the foot due to excess weight. The benefit of bariatric surgery is documented for other comorbidities but not for PF.

Methods: A retrospective medical record review was performed for patients with PF identified from a prospectively maintained database of the Cleveland Clinic Bariatric and Metabolic Institute. Age, sex, surgery, excess weight loss, body mass index (BMI), and health-care use related to PF treatment were abstracted. Comparative analyses were stratified by surgery type.

Results: Two hundred twenty-eight of 10,305 patients (2.2%) had a documented diagnosis of PF, of whom 163 underwent bariatric surgery and were included in the analysis. Eighty-five percent of patients were women, mean ± SD age was 52.2 ± 9.9 years, and mean ± SD preintervention BMI was 45 ± 7.7. Postoperatively, mean ± SD BMI and excess weight loss were 34.8 ± 7.8 and 51.0% ± 20.4%, respectively. One hundred forty-six patients (90%) achieved resolution of PF and related symptoms. The mean ± SD number of treatment modalities used for PF per patient preoperatively was 1.9 ± 1.0 ($P = .25$). After surgery, the mean ± SD number of treatment modalities used per patient was reduced to 0.3 ± 0.1 ($P = .01$).

Conclusions: We present new evidence suggesting that reductions in BMI after bariatric surgery may be associated with decreasing the number of visits for PF and may contribute to symptomatic improvement. (J Am Podiatr Med Assoc 108(6): 442-448, 2018)

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The plantar fascia, or plantar aponeurosis, is a longitudinal band of connective tissue originating on the medial process of the calcaneal tuberosity. As it courses anteriorly toward the toes, it diverges into the five digital bands, inserting on the bones of the proximal phalanx and forming dense adhesions to the overlying dermis.[1,2] The primary functions of the plantar aponeurosis are to define the longitudinal arch of the foot and protect the deeper structures of the foot.

Plantar fasciitis (PF) is most correctly considered an enthesopathy of the origin of the plantar

aponeurosis.[1-5] Soreness or tenderness of the sole of the foot near the heel corresponding to the bony attachment of the plantar aponeurosis is the most commonly occurring symptom.[3-5] Pain is often worst in the morning as mechanical load is newly applied to the foot that had been unloaded during sleep. Pain worsens in the evening again, following repeated loading during movement and standing throughout the day.[3-5]

The diagnosis of PF is made clinically based on symptoms alone. Laboratory studies and imaging are not necessary to diagnose PF, although magnetic resonance imaging can confirm the diagnosis. In practice, magnetic resonance imaging and plain radiography are mainly used to differentiate PF from other pathologic abnormalities of the heel. The incidence of PF peaks in the fifth and sixth decades of life and has been most strongly associated with repetitive motion exercise (especially running), prolonged standing, and excessive body mass.[6-9] It is estimated that PF affects approximately 10% of the general population, accounting for approximately 1 million outpatient visits each year, and represents a significant health-care cost burden.[8,10,11] Consensus guidelines for diagnosis and treatment have been established by the American College of Foot and Ankle Surgeons.[4,12] Initial treatment consists of anti-inflammatory medication, mechanical off-loading, and temporary exercise cessation, and it may progress to custom orthotic devices or surgery.[12]

As obesity rates in the United States have increased, several weight-related comorbid diseases, including PF, have seen a parallel increase in incidence.[14,16] Some of the chronic conditions associated with obesity, including diabetes, hypertension, hyperlipidemia, and coronary artery disease, contribute to end organ dysfunction and premature death, as well as influence decreases in the quality and length of life.[15] Plantar fasciitis, on the other hand, is part of a set of comorbid conditions that may also include venous stasis disease, gout, and degenerative joint disease, which collectively have a primary effect on decreasing quality of life.[5] Weight loss has been shown to reverse or forestall the progression of many of these conditions.[13] Unfortunately, conditions such as osteoarthritis and PF that have pain as a primary symptom limit an individual's ability to comfortably perform physical exercise, which may confound attempts to lose weight.[5,14]

Despite evidence that obesity is an independent risk factor for the development of PF, there is little evidence showing improvement or resolution of PF with weight loss.[8] Weight loss is currently not part of the recommended treatment algorithm by the American College of Foot and Ankle Surgeons.[12] In the morbidly obese population, bariatric surgery is established as the most effective method for durable weight loss.[13,15] Although numerous interventions exist, the most common operations in the Unites States during the past decade have been Roux-en-Y gastric bypass (RYGB), sleeve gastrectomy (SG), and adjustable gastric band (AGB). The efficacy of these operations is derived from restricting the volume of food intake, altering normal metabolism and neurohormonal signaling pathways, or both.[13] To varying degrees these operations reverse or slow the progression of certain weight-related comorbidities, including diabetes.[13,16,17] The primary aim of this study was to determine whether weight loss secondary to bariatric surgery leads to clinical resolution of PF, similar to its improvements in other weight-related comorbid diseases. Secondary outcomes included PF resolution secondary to type of surgical intervention, degree of weight loss, and an assessment of health-care use related to PF treatment.

Methods

Study Population

After the study was approved by the institutional review board, patients seen at the Metabolic and Bariatric Institute of the Cleveland Clinic (Cleveland, Ohio) for surgical and medically managed weight loss between January 1, 2004, and December 31, 2012, were retrospectively reviewed. All of the patient records were queried for a diagnosis of PF by a primary care physician or a podiatric physician in our hospital system. Patients undergoing laparoscopic RYGB, SG, and AGB were then selected. Patients younger than 18 years were excluded. Demographic information, including age, sex, weight, and body mass index (BMI; calculated as weight in kilograms divided by height in meters squared) at the initial encounter, was recorded. Regarding PF, the follow-up duration (time the patient was followed postoperatively), disease duration, and treatment modalities were documented. The primary outcome was improvement or resolution of PF. Symptom resolution and improvement of PF were determined by reduction in the number or elimination of 1) visits for PF and 2) treatment modalities used for PF. In instances where patients did not undergo a specific treatment intervention for PF before bariatric surgery, a

reduction in the number or elimination of PF visits was defined as improvement.

Brief Overview of Surgical Techniques

All of the operations are routinely performed laparoscopically, and specific procedural details can be found elsewhere.[18-20] Patients with a BMI greater than 40, or a BMI greater than 35 in conjunction with significant weight-related comorbidities, are appropriate candidates for bariatric surgery. An RYGB completely divides the stomach, leaving a 30- to 50-cm^3 gastric pouch attached to the esophagus. To this a 150-cm length of small intestine is connected, called the Roux limb. A second new connection links the Roux limb to the bypassed distal stomach and proximal small intestine (Fig. 1A).[18] Sleeve gastrectomy involves removing 60% to 75% of the stomach, leaving a tubularized gastric remnant, based on an intraoperatively placed sizing device (Fig. 1B).[19] Adjustable gastric band involves placing a ring with an inflatable cuff around the proximal stomach, limiting its ability to expand with an ingested food bolus. The degree of restriction is adjustable by way of filling the cuff with saline (Fig. 1C).[20]

Calculations

The percentage of excess weight loss (%EWL) was calculated by the weight at the time of the operation and the last weight available at follow-up.[21] Two time intervals were evaluated. Interval 1 included the time before bariatric surgery, and was defined as the time from initial diagnosis of PF until the patient underwent bariatric surgery. Interval 2 was defined as the time from surgical intervention for weight loss to last outpatient follow-up available at our hospital.

Statistical Analysis

Continuous variables are described using mean ± SD values, and categorical variables are described by count (percentage). Comparisons of continuous variables were made using the Wilcoxon rank sum test or the Welch two-sample t test. Categorical variables between surgical patients were compared using the Pearson χ^2 test. The three surgical procedure types were compared using the Kruskal-Wallis rank sum test. Pairwise comparisons using the Wilcoxon rank sum test were analyzed for significant results. The Holm method was used to adjust for multiple testing. Associations between BMI change and change in the number of visits for PF were described and tested using the Kendall rank correlation tau. The Kendall rank correlation tau is a rank-based correlation analogous to the Pearson correlation but applied to ordinal rather than continuous data, such as the number of patient visits. A 95% confidence interval for the true value of tau was computed using the bootstrap (B = 10,000). Using a resampling procedure such as the bootstrap allows one to compute confidence intervals for the

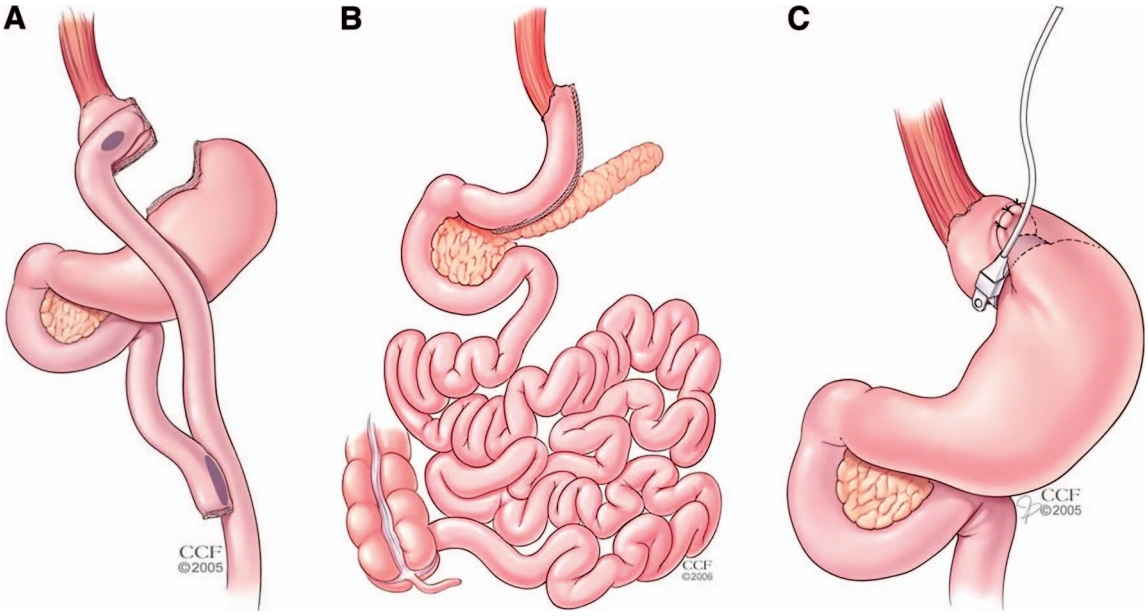


Figure 1. A, Roux-en-Y gastric bypass; B, Sleeve gastrectomy; C, Adjustable gastric band.

tau parameter when no easy analytical solution is available. All of the testing is two-sided and considered significant at the 5% level. All of the analyses were performed using R software (version 3.1.0; Vienna, Austria).

Results

There were 10,305 unique patients with visits to the Cleveland Clinic Bariatric and Metabolic Institute between January 1, 2004, and December 31, 2012, of whom 4,021 (39.0%) underwent bariatric surgery during the study period. There were 228 patients (2.2%) with a documented diagnosis of PF. Sixty-five patients with a clinical diagnosis of PF but who did not undergo bariatric surgery were excluded. Thus, the study cohort included 163 patients with a diagnosis of PF who underwent bariatric surgery, all of whom had a BMI greater than 40, or greater than 35 with significant weight-related comorbid disease. The study cohort was 85.2% female (n = 139), with a mean ± SD age of 52.2 ± 9.9 years (range, 23.0–77.0 years). The mean ± SD BMI was 45 ± 7.7 (range, 32.1–86.8) before the intervention (Table 1). Most bariatric operations performed were laparoscopic RYGB (73.0%; n = 119), followed by laparoscopic SG in 16.6% (n = 27) and laparoscopic AGB in 10.4% (n = 17). Among the patients in the cohort, the mean ± SD duration of interval 1 (PF management before bariatric surgery) was 36 ± 26.6 months.

Table 1. Characteristics of the 163 Study Patients

Characteristic	Value
Age (mean ± SD [years])	52.2 ± 9.9
Sex, F/M (No. [%])	139 (85)/24 (15)
BMI (mean ± SD)	45 ± 7.7
Duration of PF (mean ± SD [mo])	37.8 ± 28.2
PF visits (mean ± SD [No.])	4.6 ± 5.3
PF treatment modalities (mean ± SD [No.])	2.0 ± 1.0
Surgical subgroups (No. [%])	
LRYGB	119 (73)
LSG	27 (17)
LAGB	17 (10)
PF symptom improvement (No. [%])	
Yes	146 (90)
No	17 (10)

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); LAGB, laparoscopic adjustable gastric band; LRYGB, laparoscopic Roux-en-Y gastric bypass; LSG, laparoscopic sleeve gastrectomy; PF, plantar fasciitis.

Primary Outcome

A total of 89.6% of the patients (n=146) achieved complete resolution of PF in the cohort. Before surgery, the prevalence of PF was 4.1%, and compared with the postoperative prevalence of PF of 1.4%, the difference was significant ($P < .001$). In terms of the number of outpatient visits for PF before surgery (interval 1), patients had a mean ± SD of 4.2 ± 5 visits. In the postoperative period, the mean ± SD number of PF-related visits per patient was reduced to 0.6 ± 2.2 in interval 2, representing an 86% reduction ($P < .01$). Preoperative treatment modalities included custom-made orthotic devices in 43.5% (n = 71), prefabricated orthotic devices in 100.0% (n = 163), physical therapy in 28.8% (n = 47), nonsteroidal anti-inflammatory medications in 71.8% (n = 117), and corticosteroid injections in 13.5% (n = 22). The mean ± SD number of treatment modalities used per patient before surgery for PF was 1.9 ± 1.0. After surgery there was a significant reduction in the mean ± SD number of treatment modalities used per patient to 0.3 ± 0.1 ($P = .01$). Although the number of presurgical to postsurgical treatment appointments showed a statistically significant difference, there were no significant ($P = .54$) changes among the three different surgical groups.

Secondary Outcome

At mean ± SD follow-up of 34.8 ± 23.3 months after surgery, patients had a BMI of 34.8 ± 7.8 (range, 21.3–71.2) and overall mean ± SD %EWL of 51.0% ± 20.4% (range, 35.5%–63.0%). Concerning BMI change, there were significantly greater changes in the RYGB group versus the AGB group ($P = .001$), the SG group versus the AGB group ($P = .018$), and finally the RYGB group versus the SG group ($P = .025$) (Figure 2). There were significant differences in %EWL by surgical procedure performed, with the greatest %EWL with RYGB (54.7%) compared with 47.1% after SG and 25.6% after AGB ($P < .001$). The results show that there is a correlation between BMI reduction and PF visit frequency (95% bootstrap confidence interval, –0.19 to 0; $P = .046$).

Discussion

To our knowledge, this is the first study evaluating and assessing morbidly obese patients with PF who have undergone bariatric surgery. Obese patients (BMI >30) have been reported to have an incidence of PF sixfold higher than nonobese patients, with a

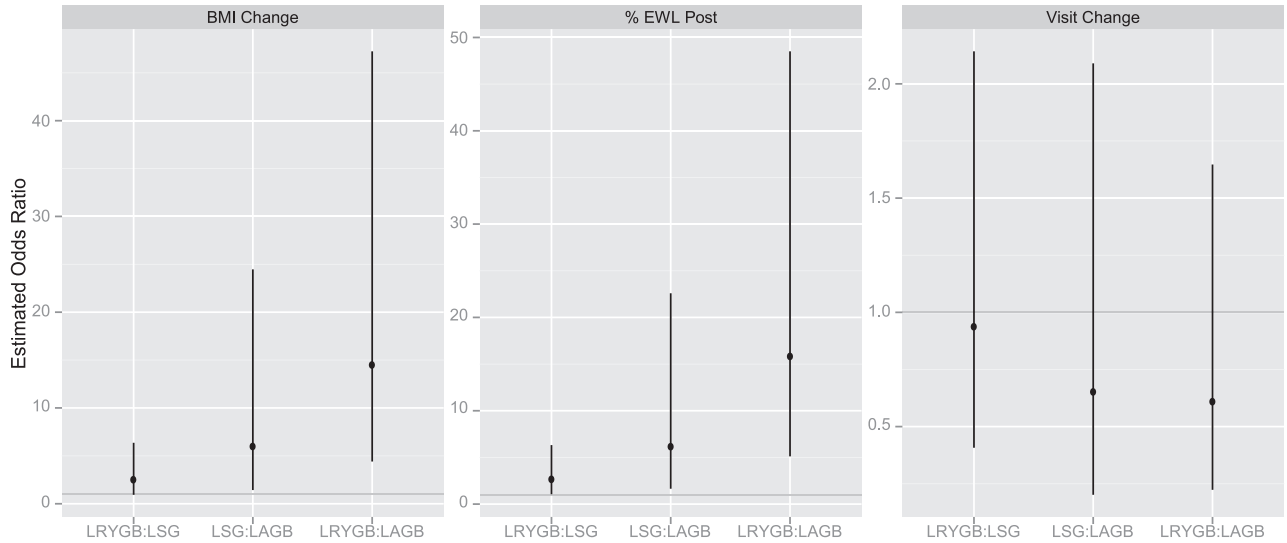


Figure 2. Comparison of body mass index (BMI), percentage of excess weight loss (%EWL), and plantar fasciitis visit change among the three surgical groups. LAGB, laparoscopic adjustable gastric band; LRYGB, laparoscopic Roux-en-Y gastric bypass; LSG, laparoscopic sleeve gastrectomy.

BMI less than 30.[5,7,10] The additional stress on the soft tissue of the feet may worsen symptom severity of PF as BMI increases.[22,23] Biomechanical studies suggest that obese patients exert a greater vertical force on the heel when walking and that the mean pressure on the longitudinal arch is greater in obese patients.[7,24,25] It is posited that there is disproportionate decreased strength of the plantar aponeurosis, as well as other ligaments, which may decrease the bowstring or windlass effect of the plantar fascia on the toe-off phase of the walking stride, altering pressure distribution across the midfoot.[2,14] It follows that reducing this mechanical load on the heel and the longitudinal arch would lead to decreased PF development and symptoms.

The most widely accepted treatment paradigm for PF is a three-tiered approach based on the consensus guidelines of the American College of Foot and Ankle Surgeons for heel pain, first published in 2001 and updated in 2010.[4,12] Plantar fasciitis is the most common cause of chronic heel pain, and the bulk of the guidelines are focused thereon. The first tier includes physical therapy, stretching, padding/strapping, noncustom arch supports, and oral anti-inflammatory medications. If these therapies do not resolve symptoms in 6 weeks, custom orthotic devices, immobilization, night splints, or corticosteroid injections can be considered. Surgical intervention or extracorporeal shockwave therapy is reserved for those with persistent symptoms for 6 to 12 months or longer.[12]

The understanding of PF is in the midst of an evolution, with increasing agreement that PF represents tendinopathy or enthesopathy rather than an inflammatory condition.[26] Historically, the etiology of PF was thought to be repeated microtrauma; however, symptomatic improvement with both systemic anti-inflammatory medications and local corticosteroid injections suggests an inflammatory component.[14] Noting the proinflammatory state associated with obesity, a nonmechanical explanation of PF improvement may be introduced. The generalized reduction in systemic inflammation after weight loss, as evidenced by a decrease in serum biomarkers, would also reduce the inflammatory component of PF.[27,28]

As has been shown in previous studies, the %EWL and BMI reduction varies based on surgical intervention performed. In this study, each of the bariatric operations resulted in weight loss, but the magnitude of that effect was greatest with RYGB and lowest with AGB. There seemed to be a parallel pattern in the degree to which PF resolved, with patients undergoing AGB continuing to require outpatient visits related to PF care compared with patients after RYGB ($P = .009$).

This reported resolution of PF of 89.6% of the cohort after bariatric surgery is quite high but is not without precedent. In 2006, Hooper et al[29] reported the results of a longitudinal study of musculoskeletal pain before and after RYGB. All of the 48 patients included in that series had painful lower-extremity symptoms compared with only 23% after RYGB, and foot-specific musculoskeletal com-

plaints decreased by 83%. They concluded that addressing obesity through prevention and treatment may improve musculoskeletal function.[29] By extrapolation, the present study suggests a similar conclusion. However, it is possible that the results of the present study and the study by Hooper et al[29] overstated results, as neither included validated questionnaires to evaluate symptoms and relied instead on global assessments of symptom improvement. Several validated measures of foot function and pain have been published,[30] although none are routinely used in outpatient clinical visits related to bariatric surgery.

There are several limitations to the present study. This is a retrospective study, which poses its own inherent limitations. The patients included in this series were limited to those with encounters in our institution to care for PF. It is likely that many more patients had symptoms of, or were undergoing treatment for, PF at medical facilities outside our hospital system. Similarly, because the Cleveland Clinic Bariatric and Metabolic Institute is a referral center for bariatric care, many patients elect to have follow-up care after the immediate postoperative period elsewhere and as such limited the follow-up data. This study also lacks a comparative control arm of patients with PF who participated in medically supervised weight loss rather than surgical intervention. However, from historical data, medically supervised weight loss is less likely to result in substantial weight loss over time.[31,32] It also seems from this study that %EWL, and not the specific intervention to achieve that end, is the more important metric in terms of resolution of PF symptoms and decreased health-care use related to PF. Despite these limitations, this study sheds new light on a previously unstudied weight-related comorbid condition and its marked improvement after bariatric surgery.

Conclusions

In this large series of patients with PF who underwent bariatric surgery, nearly 90% of patients saw an improvement in their symptoms related to PF. Resolution of PF correlated with %EWL, which seemed to be most dependent on the type of surgical intervention performed. Resolution of PF also resulted in decreased use of outpatient services for PF. Surgical intervention for weight loss may be a consideration for some obese patients with PF, especially those with other weight-related comorbidities.

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