Do Older Patients Benefit from Laparoscopic Gastric Banding as their Younger Peers–a Historical Cohort Study?

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**Abstract:**

**Introduction:** The overall benefit of bariatric surgery in morbidly obese patients over 65 years old is controversial, mainly due to concerns of increased surgical risk. Laparoscopic adjustable gastric banding (LAGB) is characterized by low perioperative morbidity and mortality rates and gradual weight loss and has the potential to benefit this specific population. The aim of the current study was to evaluate the long-term results of LAGB in older compared to younger patients.

**Methods:** A retrospective cohort study of LAGB among patients aged < 65 years old compared to a younger control group aged 18 to65. Safety and effectiveness and Bariatric Analysis and Reporting Outcome System (BAROS) scores were calculated and compared.

**Results:** 225 patients were enrolled, of which 59 (26.2%) were < 65 years old. Mean follow-up was 5.88 yrs. Prior to surgery, the older group (OG) suffered from a higher prevalence of hypertension (*P*<0.001) and bone density disturbances (*P*<0.001). Following surgery, early complications were rare (1.8*%, P*=0.955); Late complication and reoperation rates were 26.7% and 18.2% respectively (*P*=0.552, *P*=0.280). Mean reduction in excess body weight was 38% for the EG compared to 28% in the control group (CG) (*P*=0.026). A marked improvement in comorbidities was demonstrated in both groups. Mean BAROS scores were 4.03 and 4.42 for the EG and CG, respectively (*P*=0.302).

**Discussion:** LAGB results in a substantial long-term weight loss in older patients, as well as improvement in comorbidities and quality of life. The procedure is safe in older patients similar to those aged 18 to 65. Thus, we urge bariatric surgeons to consider LAGB as a valid option for older patients.

**Introduction**

The population of older adults is growing and becoming a substantial part of the population in developed countries.1–5 Aging is associated with increased prevalence of numerous diseases, including cardiovascular diseases, type 2 diabetes mellitus and many types of cancer.4–6 Obesity prevalence among the older people is rising as it is in the general population,1,7–9 and there is a substantial overlap between old age-related diseases and obesity comorbidities.1,4,6,8–11 Thus, obesity in the older individuals often aggravates medical conditions and further psychological deterioration, as well as lack of independence and reduced quality of life.1,4,6,9,11

Bariatric procedures have been shown to be effective and preferable to both conservative and medical treatment in terms of long-term weight reduction, and decrease in morbidity and mortality in morbidly obese patients.12 Nevertheless, these procedures are still considered a controversial treatment for the older obese adults: Older patients have reduced physiological reserve and thus prone to more anesthesia-related complications and difficulty recovering after surgical interventions.9,13–15 The impact of intentional weight loss on bone and muscle mass is another concern in the older obese adults, as these patients often suffer from sarcopenic obesity as a result of parallel muscle and bone mass deterioration, due to aging processes.1,5,9,13,14,16–18 Physical activity is known to minimize this potential damage; therefore, weight loss accompanied by regular physical activity is an effective way of preserving bone and muscle.1,14,16,18,19

Laparoscopic adjustable gastric banding (LAGB) is a restrictive bariatric procedure and is considered safe compared to other bariatric techniques due to a relative technical ease and short duration of surgery, and low perioperative morbidity and mortality rates.15,20–22 Prior studies have shown a low early and perioperative mortality rate after bariatric surgery among the elderly, particularly after LAGB.2,15,23 Long-term data demonstrated health benefits in terms of comorbidities without increasing prominent safety issues.15,24,25

The aim of the current study was to evaluate the long-term effect of LAGB on morbidly obese patients over 65 years, in terms of weight loss, change in comorbidities, QOL, complications and overall patient-satisfaction, compared to younger patients for whom there is more sufficient data.

We hypothesized that older morbidly obese patients undergoing LAGB will have comparable long-term results similar to younger patients undergoing LAGB.

**Methods**

Study Design

This was a retrospective cohort study done in Soroka University Medical Center (SUMC), Beer-Sheva, Israel, approved by SUMC IRB (0100-11-SOR). Inclusion criteria incorporated patients who underwent LAGB (ICD-9 code 44.95) in the Department of Surgery A, Soroka University Medical Center, Beer-Sheva, Israel, from 1/2007 to 12/2014. All participants met accepted indications for bariatric surgery (BMI>40 or BMI>35 with obesity-related comorbidities).19 The study group (older group - EG) was randomly selected from the complete cohort of patients above the age of 65 years meeting the aforementioned criteria. The control group (CG) were similarly selected but were aged 18 to 65 years. Patients who were unreachable by telephone or did not consent to participate were excluded from sample. The data were coded into an anonymous database and stored in accordance with the local IRB protocol.

All LAGB procedures were performed by an experienced surgeon (E.A.) as described previously (see supplement 1).26

Data collected from medical records included date of birth, height, baseline weight, baseline comorbidities, prior operations and perioperative complications. Long-term data were collected via structured telephone interview including minimal and current weight, current comorbidities, smoking status, physical activity, complications and reoperations. Excess body weight and excess body weight loss percentage were calculated assuming BMI = 25 kg/m2 as normal BMI.

For metabolic syndrome-related diseases, including type 2 diabetes mellitus (DM), hypertension, dyslipidemia, obstructive sleep apnea (OSA) or snoring, and bone density disturbances (BDD) such as osteopenia or osteoporosis, both prevalence and change in severity were documented. Additionally, presence of either heartburn incidents or diagnosed gastroesophageal reflux disease (GERD) were documented as GERD symptoms, and prevalences prior to and following the surgery were compared.

Surgical outcome as reflected by weight loss, change in comorbidities, quality of life and complication rate was assessed per the Bariatric Analysis and Reporting Outcome System (BAROS) questionnaire, which is a standardized questionnaire for assessing bariatric surgery results.27–29 Quality of life for BAROS scoring was evaluated using the Moorehead-Ardelt Quality of Life Questionnaire (mAQLQ) (see supplement 2).27 Additional questions designed to evaluate patient overall satisfaction from the procedure and its consequences were added (see supplement 3).

Statistical Analysis

Data analysis was performed using SPSS 23.0 (SPSS, Chicago, IL, US) software.

For descriptive and analytical statistics: independent samples *t test,* 1-way ANOVA, and Scheffe comparisons were used. Groups were compared using Pearson’s chi-square test for categorical variables and Fisher exact test for dichotomous variables when applicable. Comparison of quantitative variables was done using parametric (*t test*) nonparametric tests (Mann-Whitney test). Differences were considered statistically significant at *P* < 0.05. A multivariate logistic regression model was used in order to identify a connection between failure of LAGB (defined as BAROS score ≤1) to few selected variables, including age upon surgery, gender, follow-up period with band, and the patients’ answers to the hypothetical question of whether they would choose to undergo the surgery again.

Statistical power was calculated by the ‘compare’ function in ‘Winpepi’ software,30 using the difference between a group’s mean change in BMI from the day of surgery to the minimal BMI achieved. Based on these assumptions, the power is 85.94%. Level of significance was set as *P* < 0.05.

**Results**

A total of 225 patients were included in the study, of them 59 (26.2%) were in the older group (EG), and 166 (73.8%) were controls (CG) (see figure 1). Of all patients included, 158 (70.2%) were female and 165 (73.3%) were married. Residency in an urban region was common with 184 (81.8%) patients residing in cities, and 114 patients (50.7%) were born in Israel. Active or past smokers constitute 82 (36.4%) patients and 88 (39.1%) patients practiced regular physical activity prior to surgery. Mean BMI and mean excess weight were 44.0 kg/m2 and 51.8 kg respectively. Fifty-eight patients (25.8%) suffered from GERD or heartburn; 85 (37.8%) from diabetes mellitus; 119 (52.9%) from hypertension; 103 (45.8%) patients had dyslipidemia; 83 (36.9%) suffered from obstructive sleep apnea or night snoring, and 24 (10.7%) patients had bone density disturbance (BDD) including osteopenia and osteoporosis. Table 1 demonstrates the demographics, baseline obesity parameters, and comorbidities at time of surgery according to groups. The EG group was more likely to be born abroad (*P*˂0.001), have a history of hypertension (*P*˂0.001), and suffer from bone density disorders (*P*˂0.001).

Average follow-up for all participants was 5.88 years. Mean hospitalization duration for initial surgery was 1.3 days and early complications were documented in four (1.8%) patients. Late complications occurred in 60 (26.7%) patients, according to the following distribution: 26 suffered from band malfunction (11.6%); band slippage occurred in eleven patients (4.9%); band intolerance in eight cases (3.6%); band infection in six patients (2.7%), and two patients experienced port problems (0.9%). Reoperations were performed in 41 (18.2%) patients. Mean BMI at interview was 31.22 kg/m2 (reduction of 12.75 kg/m2 from surgery to the end of the follow-up period) and mean minimal BMI achieved during the follow-up period was 28.48 kg/m2 (Maximal BMI reduction of 15.49 kg/m2). Mean excess weight loss percentage was 30.7%. Anthropometrics compared between groups revealed a higher minimal and final BMI values for the EG but with a higher percentage of excess weight loss (*P*<0.001, *P*=0.044, and *P*=0.026 respectively). Table 2 shows the complications, reoperations and long-term anthropometrics at the time of interview for both groups.

Long-term assessment of the prevalence of each comorbidity following the surgery revealed a few trends: prevalence of type 2 DM, hypertension and dyslipidemia decreased in both groups, but these changes were statistically significant only for the CG. OSA or snoring prevalence significantly decreased in both EG and CG. There was a mild rise in GERD symptoms and BDD prevalence, but these were not statistically significant. Moreover, a significant rise in regular physical activity was observed in EG. Figure 2 presents the percentage of patients in each group who suffered from the aforementioned comorbidities regardless of the degree of the disease, prior to surgery and at the end of the follow-up period. This demonstrates in detail the observed effects on each comorbidity for each group.

In order to further appreciate the effects of LAGB on patients aged 65 and over, compared to younger patients, trends in metabolic syndrome-related diseases were also compared between groups (EG and CG). Table 3 shows the medical implications of LAGB as observed in the EG compared to those observed in the CG. Overall, 72 (32.0%) of all patients experienced an improvement or even full recovery from type 2 DM, 80 (35.6%) experienced the same for hypertension, 69 (30.7%) for dyslipidemia and 63 (28.0%) for OSA or night snoring. No significant differences between the EG and CG were found in the course of these comorbidities.

Table 4 depicts parameters of satisfaction from the procedures as subjectively graded by the patients. Overall most patients were satisfied from the procedure, did not have pain, physical limitations or regrets, and would consider undergoing LAGB again if needed. Comparing between groups, physical limitation following the procedure was more prominent among the EG (*P*=0.001). All other parameters showed no significant difference between the two groups.

BAROS scores were calculated,28 and are presented in tables 5.1-5.3. No difference between groups was observed in total BAROS score.

Multivariate logistic regression revealed a connection between the patients who declared that in retrospect they would not choose to undergo the operation again and a lower failure rate, compared to those who would (OR=0.04, *P*<0.001). No connection between older age (>65), gender, or period of follow-up with band to surgical failure was found (see table 6).

**Discussion**

This long-term cohort study demonstrated that older patients with morbid obesity benefit from LAGB in terms of improvement in comorbidities and quality of life, and objectively and subjectively do as well as their younger counterparts. The older patients in this study enjoyed significant weight loss accompanied by a marked improvement of comorbidities and fair satisfaction rates. The complication rate was low, similar to younger patients.

BMI Reduction

In the current study, although there was no significant difference in mean BMI reduction at the end of the follow-up period between the EG and CG, final BMI was lower in the CG. These findings are consistent with previous studies: In their literature review, Haywood & Sumithran reported the efficacy of bariatric surgery according to 28 studies comparing weight outcomes for young versus older (≥60 years old) patients.9 Sixteen of these studies did not reveal a significant difference in weight loss between groups, while seven studies found a greater weight loss in younger patients.

The Metabolic Syndrome

Prior studies have shown an improvement in comorbidities following LAGB in elderly patients,2,13,15,23 though only a few examined LAGB’s long-term influence on elderly patients as opposed to younger patients.2,23 Busetto L. et al compared patients aged 60+ with younger patients one year after LAGB, and found beneficial results regarding type 2 DM, dyslipidemia and OSA for both groups, and a diminished (yet beneficial) response regarding hypertension in older patients compared to younger patients.13 Marihart C.L. et al performed a survey among 534 patients who underwent bariatric surgery at least 18 months prior to the survey.25 They divided the responders into 4 age groups: 24 to49, 50 to 59, 60 to 69, and ≥ 70 years. The survey results demonstrated similar weight loss and comorbidities improvement among the older and oldest compared to the younger groups. In the current study, hypertension and bone density disturbance were significantly more common among EG compared to younger patients prior to surgery. This is not surprising as these diseases are increasingly more common with aging in obese individuals.7 Following surgery, all obesity-related diseases, except for reflux, improved, or in some cases, patients even fully recovered for both groups. The prevalence of GERD, a possible complication of restrictive procedures like LAGB and one of its disadvantages,21 increased in both for the EG and CG. The decrease in overall percentage of older patients suffering from type 2 DM, hypertension, and dyslipidemia was not statistically significant (as opposed to younger patients in whom these trends reached significance). It is likely that the observed decrease failed to achieve statistical significance among the older study participants due to the relatively smaller sample. There was no significant difference in the course of these comorbidities and severity dynamics when comparing the groups to each other, suggesting a comparable improvement. OSA and night snoring prevalence reduced significantly in both groups.

Hence, notwithstanding the diminished success in terms of anthropometrics, older patients enjoyed a marked improvement in comorbidities. These findings suggest that a satisfactory change in metabolic syndrome can be achieved in the older patients even with milder weight loss.

Mean BAROS score for medical conditions was satisfactory and comparable between the older study participants and their younger counterparts (+1.356 and +1.355 respectively, *P*=0.998).

Complications and Reoperations

LAGB's main disadvantage compared to other bariatric procedures is probably its relatively high long-term complication and reoperation rate.22,31 In the current study, long-term complication and reoperation rates were 31% and 18.1% respectively. Both were more prevalent in the CG (with no significant difference), but this may be affected by the shorter follow-up period among the EG.

Sarcopenic Obesity, Physical Function and Physical Activity

Weight loss and deficient nutrition are independent known causes for BDDs and increased risk for fractures.1,7,13 While regular physical activity was found to be an effective means to minimize destructive influences of weight loss on bone density and muscle mass,1,14 older patients are often restricted in their ability to engage in physical activity due to age-related comorbidities and muscle mass decline.6,7,13 Therefore, intentional weight loss among older people might harm muscle and bone, yet at the same time it has a potentially protective effect by ultimately allowing these patients to be more physically active. In addition, the combination of obesity with bone and muscle disturbances was found to be more detrimental than the latter alone.11 For these reasons, it seems reasonable to treat obesity and diminish its harmful effects.

Indeed, in the current study, following the surgery, a higher prevalence of regular physical activity was observed. In the EG, this encouraging trend reached statistical significance (*P*=0.01). On the other hand, a mild rise in BDD prevalence was observed in both groups, and reported physical limitation was more prominent in the EG compared to the CG (*P*=0.001). It is hard to determine whether this is related to weight loss after the LAGB, aging during follow-up period, or most likely their combination.4 Trends in the course and severity of BDD following LAGB were very mild and inconclusive.

Being solely a restrictive procedure, nutrient deficiency is less profound in the case of LAGB compared to other bariatric procedures.22 Moreover, LAGB is known to yield slower and milder weight loss compared to other bariatric surgeries.20–22 This is actually an advantage in terms of BDD as with greater weight loss, bone and muscle damage is more severe, and this is even more prevalent in older people.1,7

Older patients tend to lose more bone and muscle mass when losing weight than they gain when gaining weight; hence recurrent fluctuations in weight are more harmful than stable weight.1,14 Here, while the maximal BMI reduction was significantly higher in the CG (*P*=0.001), there was no significant difference between groups in BMI reduction to the end of the follow-up (*P*=0.078). These findings reveal that the EG enjoyed similar BMI reduction with milder fluctuations in weight throughout the study period.

In summary, LAGB provides effective though gradual and cautious treatment for older morbidly obese adults prone to BDD.

Obesity Paradox

Some studies have shown a protective effect of overweight among older study participants (a phenomenon known as the obesity paradox).17,32 Nevertheless, it is difficult to eliminate confounders such as smoking, cancers, etc., which are related to lower weight and higher mortality rates, and survivors bias may also play a significant role in these findings.17,32–34 Other studies argue that overweight causes morbidity and is harmful at any age.17,18,33,34 A recent analysis of 10.6 million adults from four continents, of which four million were otherwise healthy nonsmokers, revealed increased mortality among overweight and obese patients.33 Although the hazard ratio for older patients was relatively lower compared to younger patients, still overweight and obesity among the older patients correlated with higher mortality rate. The current study revealed high recovery or improvement rates of most metabolic syndrome-related diseases among the older patients. This in turn could stop the multiorgan damage that these diseases cause3,10,15 and potentially lead to increased longevity. The mean preoperation BMI among the older study participants was 44.21 (morbid obesity) and the mean final BMI in this group was 32.6 kg/m2 (obesity). Hence, following LAGB, the patients in this study lost enough weight to improve their health without reaching lower BMI values, which have been suggested to correlate with higher mortality rates.

Quality of Life

This study also examined LAGB’s influence on quality of life (QOL) using two questionnaires: the first being part of the BAROS and the second devoted to patient satisfaction. LAGB has been previously shown to improve QOL in the general population.31 While evaluation of quality of life after bariatric surgery has been studied, few studies dealt with patients’ subjective feelings about their decision to undergo the procedure and their satisfaction with its consequences.35 Clough A. et al compared QOL in patients aged ≥ 60 before and five years after LAGB operation, to QOL in nonobese controls aged 55 to 64,2 and showed a marked improvement in QOL score 5 years after surgery, with scores comparable to those of the nonobese controls.2 The current study strengthens and adds to this existing knowledge: a substantial and similar improvement in most BAROS QOL parameters was demonstrated for both EG and CG. Moreover, our study shows a high overall satisfaction score with similar results between groups for most satisfaction parameters examined. As discussed earlier and not surprisingly, EG was characterized by more prominent restriction in daily physical activity according to the satisfaction questionnaire (*P*=0.001). All other satisfaction parameters did not show a significant difference between groups. As to the QOL part of the BAROS, the only parameter in which a significant difference between EF and CG was observed is pleasure in sex, for which the CG score was higher, again not something unexpected. Physical limitation and sexual satisfaction are both very challenging to isolate as older age might be a significant confounder.7,36 It is worth noting that on the bottom line, when asked if they would choose the same again in retrospect and undergo the LAGB procedure, the great majority of patients, old as well as young, answered “yes.”

Limitations

As in any study, the current study has limitations. The EG was characterized by a shorter follow-up period. This might have influenced the results of comparison between groups. Furthermore, a substantial part of this research was based on questionnaires, which are inherently prone to bias.

Our study has shown good midterm results for LAGB as a procedure for patients older than 65, with as results as good as LAGB for younger patients and with no added risk than seen in LAGB in younger age groups (which has the lowest life-threatening complications rate to start with). This is not to say that other surgical procedures for older patients should be abandoned, but this study shows that LAGB is a viable option for older patients. Considering this, we recommend that bariatric surgeons do not drop LAGB from their armamentarium for older patients, as others have advocated before.37

Conclusions

LAGB as a restrictive operation brings about a more gradual loss of weight than other restrictive or combined procedures, and it might have a relatively high long-term complication rate. That said, in older patients, a more moderate weight reduction may be an advantage since this population is prone to bone density and muscle mass depletion with the more aggressive procedures. This study has shown that LAGB is less effective in older study participants in terms of weight loss; however, this difference does not mitigate the operation’s positive influence on obesity-related diseases. Moreover, we believe that the low early- and life-threatening complication rates make this procedure preferable in older patients as they suffer from more background diseases and are more prone to early and severe anesthesia and surgery-related complications. Even after considering the high long-term complication rate, older patients reported having a good and improved quality of life after LAGB, to a degree not lower than that of younger patients. We conclude that LAGB is a safe and effective way to reduce weight, improve comorbidities , and enhance quality of life and may be the procedure of choice for morbidly obese patients aged 65 or older.

**Bibliography**

1. Kyrou I, Tsigos C. Obesity in the elderly diabetic patient: is weight loss beneficial? No. *Diabetes Care*. 2009;32 Suppl 2:S403-9. doi:10.2337/dc09-S348

2. Clough A, Layani L, Shah A, Wheatley L, Taylor C. Laparoscopic gastric banding in over 60s. *Obes Surg*. 2011;21(1):10-17. doi:10.1007/s11695-010-0158-3

3. Prince MJ, Wu F, Guo Y, et al. The burden of disease in older people and implications for health policy and practice. *Lancet*. 2015;385(9967):549-562. doi:10.1016/S0140-6736(14)61347-7

4. Ghosh S, Sinha J, Raghunath M. “Obesageing”: Linking obesity & ageing. *Indian J Med Res*. 2019;149(5):610-615. doi:10.4103/ijmr.IJMR\_2120\_18

5. Jura M, Kozak LP. Obesity and related consequences to ageing. *Age (Omaha)*. 2016;38(1). doi:10.1007/s11357-016-9884-3

6. Boateng GO, Adams EA, Boateng MO, Luginaah IN, Taabazuing MM. Obesity and the burden of health risks among the elderly in Ghana: A population study. *PLoS One*. 2017;12(11). doi:10.1371/journal.pone.0186947

7. Villareal DT, Apovian CM, Kushner RF, Klein S. Obesity in older adults: Technical review and position statement of the American Society for Nutrition and NAASO, the Obesity Society. *Obes Res*. 2005;13(11):1849-1863. doi:10.1038/oby.2005.228

8. Chooi YC, Ding C, Magkos F. The epidemiology of obesity. *Metabolism*. 2019;92:6-10. doi:10.1016/j.metabol.2018.09.005

9. Haywood C, Sumithran P. Treatment of obesity in older persons—A systematic review. *Obes Rev*. 2019;20(4):588-598. doi:10.1111/obr.12815

10. Finer N. Medical consequences of obesity. *Med (United Kingdom)*. 2015;43(2):88-93. doi:10.1016/j.mpmed.2014.11.003

11. Öztürk ZA, Türkbeyler İH, Abiyev A, et al. Health-related quality of life and fall risk associated with age-related body composition changes; sarcopenia, obesity and sarcopenic obesity. *Intern Med J*. 2018;48(8):973-981. doi:10.1111/imj.13935

12. American College of Cardiology/American Heart Association Task Force on Practice Guidelines, Obesity Expert Panel, 2013. Expert panel report: Guidelines (2013) for the management of overweight and obesity in adults. *Obesity*. 2014;22(SUPPL. 2):S41-410. doi:10.1002/oby.20660

13. Busetto L, Angrisani L, Basso N, Favretti F, Furbetta F, Lorenzo M. Safety and efficacy of laparoscopic adjustable gastric banding in the elderly. *Obesity*. 2008;16(2):334-338. doi:10.1038/oby.2007.85

14. Kalish VB. Obesity in Older Adults. *Prim Care - Clin Off Pract*. 2016;43(1):137-144. doi:10.1016/j.pop.2015.10.002

15. Loy JJ, Youn HA, Schwack B, Kurian MS, Fielding GA, Ren-Fielding CJ. Safety and efficacy of laparoscopic adjustable gastric banding in patients aged seventy and older. *Surg Obes Relat Dis*. 2014;10(2):284-289. doi:10.1016/j.soard.2013.06.022

16. Zamboni M, Rubele S, Rossi AP. Sarcopenia and obesity. *Curr Opin Clin Nutr Metab Care*. 2019;22(1):13-19. doi:10.1097/MCO.0000000000000519

17. Bosello O, Vanzo A. Obesity paradox and aging. *Eat Weight Disord*. 2019. doi:10.1007/s40519-019-00815-4

18. DiMilia PR, Mittman AC, Batsis JA. Benefit-to-Risk Balance of Weight Loss Interventions in Older Adults with Obesity. *Curr Diab Rep*. 2019;19(11). doi:10.1007/s11892-019-1249-8

19. Yumuk V, Tsigos C, Fried M, et al. European Guidelines for Obesity Management in Adults. *Obes Facts*. 2015;8(6):402-424. doi:10.1159/000442721

20. Chakravarty PD, McLaughlin E, Whittaker D, et al. Comparison of laparoscopic adjustable gastric banding (LAGB) with other bariatric procedures; a systematic review of the randomised controlled trials. *Surgeon*. 2012;10(3):172-182. doi:10.1016/j.surge.2012.02.001

21. Medical Advisory Secretariat. Bariatric surgery: an evidence-based analysis. *Ont Health Technol Assess Ser*. 2005;5(1):1-148. http://www.ncbi.nlm.nih.gov/pubmed/23074460. Accessed February 14, 2020.

22. Kissler HJ, Settmacher U. Bariatric Surgery to Treat Obesity. *Semin Nephrol*. 2013;33(1):75-89. doi:10.1016/j.semnephrol.2012.12.004

23. O’Keefe KL, Kemmeter PR, Kemmeter KD. Bariatric surgery outcomes in patients aged 65 years and older at an American society for metabolic and bariatric surgery center of excellence. *Obes Surg*. 2010;20(9):1199-1205. doi:10.1007/s11695-010-0201-4

24. Mathus-Vliegen EMH. Obesity and the elderly. *J Clin Gastroenterol*. 2012;46(7):533-544. doi:10.1097/MCG.0b013e31825692ce

25. Marihart CL, Brunt AR, Marihart SA, Geraci AA. What’s Age Got to Do With It? A Comparison of Bariatric Surgical Outcomes Among Young, Midlife, Older and Oldest Adults. *Gerontol Geriatr Med*. 2016;2:233372141562181. doi:10.1177/2333721415621812

26. Mizrahi S, Avinoah E. Technical tips for laparoscopic gastric banding: 6 years’ experience in 2800 procedures by a single surgical team. *Am J Surg*. 2007;193(2):160-165. doi:10.1016/j.amjsurg.2006.08.071

27. Moorehead MK, Ardelt-Gattinger E, Lechner H, Oria HE. The Validation of the Moorehead-Ardelt Quality of Life Questionnaire II. *Obes Surg*. 2003;13(5):684-692. doi:10.1381/096089203322509237

28. Oria HE, Moorehead MK. Bariatric Analysis and Reporting Outcome System (BAROS). *Obes Surg*. 1998;8(5). doi:10.1381/096089298765554043

29. Oria HE, Moorehead MK. Updated Bariatric Analysis and Reporting Outcome System (BAROS). *Surg Obes Relat Dis*. 2009;5(1):60-66. doi:10.1016/j.soard.2008.10.004

30. WINPEPI (PEPI-for-Windows). http://www.brixtonhealth.com/pepi4windows.html. Accessed February 14, 2020.

31. O’Brien PE, Brown WA, Dixon JB. Obesity, weight loss and bariatric surgery. *Med J Aust*. 2005;183(6):310-314. doi:10.5694/j.1326-5377.2005.tb07061.x

32. Javed AA, Aljied R, Allison DJ, Anderson LN, Ma J, Raina P. Body mass index and all-cause mortality in older adults: A scoping review of observational studies. *Obes Rev*. 2020;21(8). doi:10.1111/obr.13035

33. Di Angelantonio E, Bhupathiraju SN, Wormser D, et al. Body-mass index and all-cause mortality: individual-participant-data meta-analysis of 239 prospective studies in four continents. *Lancet*. 2016;388(10046):776-786. doi:10.1016/S0140-6736(16)30175-1

34. Bowman K, Atkins JL, Delgado J, et al. Central adiposity and the overweight risk paradox in aging: Follow-up of 130,473 UK Biobank participants. *Am J Clin Nutr*. 2017;106(1):130-135. doi:10.3945/ajcn.116.147157

35. Ballantyne GH. Measuring Outcomes following Bariatric Surgery: Weight Loss Parameters, Improvement in Co-morbid Conditions, Change in Quality of Life and Patient Satisfaction. *Obes Surg*. 2003;13(6):954-964. doi:10.1381/096089203322618867

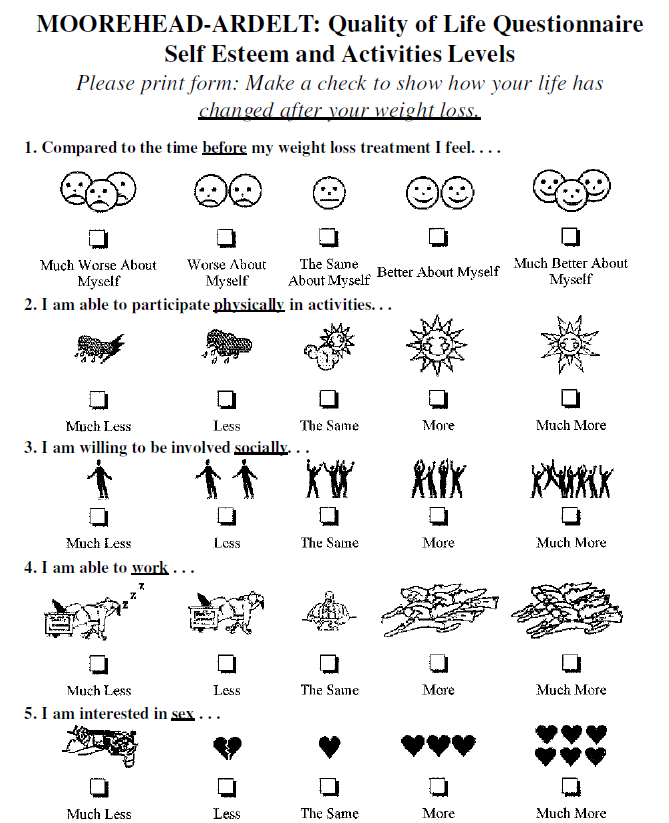
36. Lochlainn MN, Kenny RA. Sexual activity and aging. *J Am Med Dir Assoc*. 2013;14(8):565-572. doi:10.1016/j.jamda.2013.01.022

37. Brown WA, O’Brien PE. The Band Must Not Be Abandoned. *Obes Surg*. 2017;27(8):1911-1913. doi:10.1007/s11695-017-2625-6

**Appendix**

**Supplement 1**26 **– LAGB surgical technique**

**Supplement 2**27 **– The Original Moorehead-Ardelt Quality of Life Questionnaire**



**Supplement 3 – Overall Patient Satisfaction Questionnaire**

1. To what extent did the band fill your expectations? choose 1-5 if [1= not at all] and [5= answered all expectations).
2. Are you satisfied by the procedure? Choose 1-5 if [1= not satisfied at all] and [5=fully satisfied].
3. Do you suffer from pain as a result of the procedure? Choose 1-5 if [1= not at all], [2=rarely], [3=from time to time], [4=often] and [5=constantly].
4. Do you have any physical limitations following the procedure? Choose 1-5 if [1= not at all], [2=rarely], [3=from time to time], [4=often] and [5=constantly].
5. Do you regret undergoing LAGB? Choose 1-5 if [1= not at all] and [2= fully regrets].
6. Would you undergo this procedure again if needed? Yes / No