



Five-Year Outcomes with Stand-alone Primary Sleeve Gastrectomy

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Published online: 5 February 2019

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Abstract

Purpose Sleeve gastrectomy is now the commonest bariatric procedure worldwide, making it important to determine 5-year weight loss and micronutrient deficiency outcomes following primary, stand-alone sleeve gastrectomy (SG) with adequate follow-up. The purpose of this study was to evaluate weight loss, co-morbidity resolution, and haematological outcomes at 5 years with primary, stand-alone SG in our unit.

Materials and Methods Baseline data were obtained from our prospectively maintained database and patients were invited for a 5-year follow-up. For those who could not attend, further information was obtained by telephoning them and contacting their general practitioners.

Results A total of 92 patients (66 females) underwent primary SG at our centre in 2011. The median age was 46.0 years. The median weight and the body mass index (BMI) were 133.0 kg and 47.0 kg/m² respectively. After 5 years, 7 (7.6%) patients had died due to unrelated causes and 11 (12.0%) had been converted to Roux-en-Y gastric bypass (RYGB). Of the remaining 74, we were able to obtain follow-up data on 64 (86.5%). Despite all efforts, 10 (13.5%) patients were lost to follow-up. The median total weight loss was 21.9% and median excess weight loss (EWL) was 48.0%. Patients developed a range of micronutrient deficiencies over the follow-up period.

Conclusion This study shows acceptable results with SG at 5 years in our unit, but a large number of patients experienced GORD and some patients needed additional micronutrient supplementation over and above our unit recommendation of a single multivitamin/mineral A–Z tablet daily.

Keywords Bariatric surgery · Obesity surgery · Sleeve gastrectomy · Weight loss · Micronutrient deficiency

Introduction

Sleeve gastrectomy (SG) is now the most commonly performed primary bariatric procedure in the world [1] making it important to understand medium- to long-term weight loss and micronutrient deficiency outcomes after primary stand-alone SG. Many published studies on this topic include both primary and revisional patients [2–9] making it difficult to clearly understand the outcomes of primary procedures. Others have only a small proportion of patients actually reaching the 5-year follow-up [10–14]. Yet, other groups include the outcomes of those subsequently converted to other procedures [15, 16] and

cannot, therefore, be used to accurately suggest what we can expect with stand-alone SG at 5 years.

Then, there are studies either exclusively reporting on patients with BMI < 35 kg/m² [17, 18] or including those with < 35 kg/m² [19], thus making it difficult to extrapolate the data to those who meet the globally agreed NIH consensus criteria for surgery [20]. Another group of studies solely focus on diabetics [21, 22] or super obese [23]. Furthermore, very few studies [19, 24–36] report on 80.0% or more of the initial cohort, considered to be a benchmark of adequate follow-up [37]. Others do not even describe follow-up percentage at 5-year mark [38–44]. There are only a handful of studies reporting 5-year results with stand-alone, primary SG in an unselected bariatric cohort of BMI ≥ 35 kg/m² that have ≥ 80.0% follow-up [45–48].

The primary objective of this study was to determine the 5-year weight loss outcomes with primary, stand-alone SG in our unit. The secondary objectives were to evaluate the co-morbidity resolution and haematological outcomes at 5 years with SG.

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Methods

We retrospectively analysed our prospectively maintained database to identify all the patients who underwent a primary SG in our unit in the year 2011. Patients were invited to a 5-year clinic follow-up with our dietitians in 2017, and reminders were sent to those who could not attend. For those who could not attend even after the reminder, further information was obtained by telephoning them or contacting their general practitioners (GPs). Where needed, data were further supplemented by interviewing team members and reviewing clinical notes and from hospital computerised records. Standard descriptive statistics were used. Since the dataset was not normally distributed, both mean and median have been described as measures of central tendency.

The Technique of Procedure

Closed pneumoperitoneum was established using our standard technique of Veress needle insufflation and optical insertion of a 12-mm port. Two further 12-mm and one 5-mm ports were also placed in the upper abdomen as working ports. A subxiphoid tract was created using a 5-mm port for placement of Nathanson liver retractor. Greater omentum was detached from the stomach using Harmonic[®] dissector. A sleeve was then fashioned over a 36-Fr orogastric tube using Echelon[®] 60-mm staplers, starting at 5 cm from the pylorus. The final stapling was carried out just lateral to the gastro-oesophageal fat pad. In the end, a leak test was performed using a dilute methylene blue solution. No drains and nasogastric tubes were used.

Patients were allowed sips on day 0 and 1.0 l of water orally on day 1 and allowed home on day 2 with instructions to stay on pureed diet for 4 weeks according to our standard protocol. Food consistency was gradually increased over the next few months. Patients were advised to take lansoprazole 30 mg daily for 6 months and a multivitamin/mineral tablet for the rest of their life. Ursodeoxycholic acid 600 mg twice daily was used for prophylaxis of gallstones for 6 months. We routinely follow up all our patients at 6 weeks, 6 months, 12 months, 18 months, and 24 months with close input from bariatric dietitians and surgeons in the clinics. After 2 years, patients are transferred to their GPs for ongoing care.

Results

Basic Demographics

We performed 92 primary SG in our unit in 2011. Out of these, 66 (71.7%) were females. The median age of the patients was 46.0 (range 24–72, mean 46.0 ± 11.8) years. The median

weight was 133.0 (range 95.4–228.4, mean 138.4 ± 29.9) kg, and the median BMI was 47.0 (range 35.3–84.2, mean 49.9 ± 9.1) kg/m² respectively.

Follow-up

Seven (7.6%) patients had died due to unrelated causes and a further 11 (12.0%) had been converted to Roux-en-Y gastric bypass (RYGB) for either gastro-oesophageal reflux disease (GORD) ($n = 8$) or inadequate weight loss ($n = 3$). These were excluded from analysis as per our study objective.

Of the remaining 74, we were able to obtain recent weight on 64 patients. Thirty-seven (50.0%) patients attended our clinic for their 5-year follow-up. For 27 (42.0%), data were obtained by telephoning patients and/or their general practitioners. Despite all efforts, 10 (13.5%) patients were lost to follow-up—8 could not be contacted and 2 either did not know their weight or did not want to be weighed. Thirty-seven of these attended for their 5-year follow-up and for the remaining, information was obtained by phoning them and contacting their GPs.

The median age at the time of surgery of these 64 patients for whom we had 5-year weight loss data was 46 (range 24–67, mean 47.0 ± 12.0) years. The median weight was 131 (range 95–228, mean 136.0 ± 28.0) kg and median BMI was 47.0 (range 37.0–84.0, mean 50.0 ± 9.0) kg/m².

Surgical Outcomes

There was no early (30-day) mortality in this series. There were two major 30-day complications in this series—one patient underwent 30-day reoperation for postoperative bleeding that was controlled laparoscopically, and another patient had a haematoma managed conservatively. There were no leaks. There were no major late (> 30 days) complications or reoperations.

Weight Loss Outcomes

After excluding those who had died or been converted to RYGB, we were able to obtain the recent weight for 64/74 (86.5%) patients. The median total weight loss (TWL) was 21.9% (range 1.7–51.6%, mean 22.9 ± 11.87), and median excess weight loss (EWL) was 48.0% (range 3.0–128.0%, mean 50.0 ± 17.0%). The median weight at 5 years was 95.0 (range 51–209, mean 105.8 ± 31) kg, giving a median weight loss of 29.0 kg (range 2.2–78.8 kg, mean 30.2 kg ± 15.5 kg) in our patients at 5 years. The median BMI at 5 years was 35.0 (range 21–70, mean 37.5 ± 10.0) kg/m². Table 1 attempts to provide a breakdown of the patients depending on the EWL achieved.

Table 1 Breakdown of patients according to excess weight loss achieved at 5 years

Excess weight loss (%)	Number of patients	Percentage of patients
≤25	15	23.4
26–50	19	29.7
51–75	17	26.6
76–100	11	17.2
> 100	2	3.1

Co-morbidity Outcomes

Robust co-morbidity data were available for 52/74 (70.3%) patients. Of these, 16 patients were suffering from type 2 diabetes mellitus before surgery. After 5 years, 6 (11.5%) were off all their anti-diabetic medications and the remaining 8 (15.3%) were able to reduce them. Two patients (3.8%) noticed an increase in their anti-diabetic medications. One patient, who was suffering from type 1 diabetes mellitus before surgery reported reduced insulin requirement.

Similarly, 50.0% (26/52) patients were suffering from hypertension before surgery. After 5 years, 6 of them (11.5%) were off all their anti-hypertensive medications and 3 (5.7%) were able to reduce them. Seventeen patients (32.7%) reported no change in their anti-hypertensive medications.

Approximately, 23.0% (12/52) patients were suffering from GORD prior to surgery and 8 (15.4%) of them were taking daily PPI and 4 (7.7%) were taking them intermittently. After 5 years, 25 of them (48%) were on daily PPI and 5 (9.6%) were taking them intermittently. As noted above, 8 patients were converted to RYGB for GORD. Including these 8 patients in the analysis of GORD as a co-morbidity, 38/60 (63.3%) patients either were taking PPI for GORD or were already converted to RYGB in this series.

Haematological Outcomes

We were able to obtain information regarding current vitamin and mineral regimen on 56/74 (75.6%) patients. Of these, thirty-one (31/56, 55.4%) were compliant with the unit recommendation of a complete multivitamin/mineral A–Z tablet daily. Seven (7/56, 12.5%) of these patients were on additional iron supplements, 11 (11/56, 19.6%) were on vitamin D and

calcium supplements, and five (5/56, 9.0%) were having vitamin B₁₂ injections.

We were able to obtain recent complete haematological laboratory results on 52.7% (39/74) patients who underwent a primary SG in our unit in 2011. Folate was the most prevalent deficiency found in 15 (15/39, 38.5%) of the 39 patients. Only four of those with folate deficiency were compliant with the multivitamin and mineral A–Z tablet. Table 2 presents our complete haematological outcomes for these 39 patients.

Discussion

SG is now worldwide the commonest bariatric procedure [1], but scientific literature only contains records of 652 with ≥7 years of follow-up [49]. We found only six other studies [45–48, 50, 51] in the scientific literature that report 5-year results with primary SG in an unselected, bariatric cohort with BMI ≥ 35 kg/m² and have ≥ 80.0% follow-up [Table 3]. Interestingly, none of them report any data on micronutrient deficiency.

We were able to contact 86.5% (64/74) of our patients, and in-clinic follow-up of 50.0% in this study compares favourably with other similar studies depicted in Table 3. Despite all efforts, we were unable to obtain weight loss data on 10 (13.5%) patients. This is a recognised problem in the scientific literature [24, 25]. Zhang et al. [45] reported 5-year weight loss data on 84.3% (*n* = 27/32) of their sleeve patients in their randomised study comparing it with RYGB. In comparison, we report 5-year weight loss outcomes on 64/74 (86.5%) patients. We were further able to get 37/74 (50.0%) of our patients to attend a 5-year clinic visit. In comparison, an in-person follow-up in the study by Zhang et al. [45] was only 37.0%.

The mean EWL of 50.0 ± 17.0% and mean weight loss of 30.2 kg ± 15.5 kg at 5 years in this study compare well with the randomised controlled trial by Salminen et al. [50] where authors reported an EWL of 49.0% and a mean weight loss of 32.1 kg. This is all the more significant because mean BMI of our patients at 50.0 ± 9.0 kg/m² was slightly higher than that of patients in this trial which was 48.5 ± 9.6 kg/m². Furthermore, these authors included patients converted to RYGB or single anastomosis duodeno-ileal bypass with

Table 2 Complete haematological laboratory outcomes (*n* = 39/74) at 5 years

Iron status	On iron supplement	4/39 (10.3%)
	Iron deficient on blood tests	4/39 (10.3%)
Vitamin B ₁₂ status	On B ₁₂ injections	4/39 (10.3%)
	B ₁₂ deficient on blood tests	3/39 (7.7%)
Vitamin D and calcium status	On vitamin D/calcium supplement	8/39 (20.5%)
	Raised parathyroid hormone levels on blood tests	11/39 (28.2%)
	Low vitamin D levels	12/39 (30.8%)

Table 3 Studies on 5-year results after sleeve gastrectomy that have at least 80.0% follow-up

Study characteristics	Bougie size, distance from pylorus	Conversions	5-year weight loss outcomes	Micronutrient deficiency data
Zhang et al. [45] Study type: RCT Level of evidence: level I N: 32 F/M: 18/14 Age: 32.2 ± 9.2 Weight: NA BMI: 39.3 ± 3.8 January 2007–July 2008	34 Fr 5 cm	Nil	BMI at 5 years: 32.2 ± 4.4 EWL at 5 years: 63.2% ± 24.5 TWL at 5 years: NA FU at 5 years: 84.3% In-person FU at 5 years: 37.0%	NA
Rawlins et al. [46] Study type: cohort N: 55 F/M: NA Age: NA Weight: NA BMI: 65.0 January 2005–December 2006	26.4 Fr 3 cm	4 converted to DS	BMI at 5 years: NA EWL at 5 years: 86.0% TWL at 5 years: 53.0% FU at 5 years: 100.0% In-person FU at 5 years: NA	NA
Perrone et al. [47] Study type: case-control study N: 162 F/M: 98/64 Age: 41.8 ± 4.6 Weight: NA BMI: 47.4 ± 4.2 January 2006–December 2009	36 Fr NA	NA	BMI at 5 years: NA EWL at 5 years: 78.8% ± 23.5 TWL at 5 years: NA FU at 5 years: 99.0% In-person FU at 5 years: NA	NA
Dakour Aridi et al. [48] Study type: cohort study N: 66 F/M: 41/25 Age: 36.5 ± 13.3 Weight: 123.1 ± 29.0 BMI: 42.8 ± 7.1 April 2007–March 2010	36 Fr 3–5 cm	Nil	BMI at 5 years: 31.6 ± 7.0 EWL at 5 years: 69.8% ± 28.7% TWL at 5 years: 26.5% ± 8.7% FU at 5 years: 90.4% In-person FU between 5 and 7 years: 42.0%	NA
Salminen et al. [50] Study type: RCT Level of evidence: level I N: 121 F/M: 87/34 Age: 48.5 ± 9.6 Weight: 130.1 ± 21.5 BMI: 45.5 ± 6.2 March 2008–June 2010	33–35 Fr 4–6 cm	3 converted to SADI for inadequate weight loss 7 converted to RYGB for GORD	BMI at 5 years: 36.5 EWL at 5 years: 49.0% TWL at 5 years: NA FU at 5 years: 81.0% In-person FU at 5 years: NA	Authors reported levels of some micronutrients at 5 years without reporting deficiency rates
Peterli et al. [51] Study type: RCT Level of evidence: level I N: 107 F/M: 77/30 Age: 43.0 ± 11.1 Weight: 123.5 ± 19.4 BMI: 43.6 ± 5.2 January 2007–November 2011	35 Fr 3–6 cm	3 converted to BPD/DS and 2 to RYGB for inadequate weight loss 9 converted to RYGB for GORD	BMI at 5 years: 32.5 EWL at 5 years: 61.1% TWL at 5 years: 25.0% FU at 5 years: 94.4% In-person FU at 5 years: NA	

DS, duodenal switch; SADI, single anastomosis duodeno-ileal bypass; RYGB, Roux-en-Y gastric bypass; GORD, gastro-oesophageal reflux disease

sleeve gastrectomy which may have enhanced the weight loss outcomes in their study.

Peterli et al. [51] reported a higher EWL of 61.0% compared with this study at 5 years in their randomised study, but their patients had a mean BMI of 43.0 kg/m² in

comparison to 50.0 ± 9.0 kg/m² in this study. These authors also included data of 14 patients converted to duodenal switch or RYGB which may have magnified their weight loss outcomes. We excluded patients who have been converted to RYGB in our unit because the purpose of this

study was to find out the results with primary, stand-alone SG. This is an important piece of information patients seek whilst making decisions regarding which procedure to opt for in our experience.

Our results seem inferior to that reported by Rawlins et al. [46] even though the starting BMI of their patients at 65 kg/m² was much higher. This may be explained by differences in surgical techniques. Rawlins et al. [46] used a 26.4-Fr bougie compared with 36 Fr in our study, and they started stapling 3 cm from pylorus compared with 5 cm in this study. But those authors also report a 1.9% leak rate which can be very difficult to treat.

There are very few studies in the scientific literature reporting on the level of a range of micronutrients 5 years after SG [52]. We were able to obtain recent haematological results and levels of a range of micronutrients on 52.7% of our patients. In comparison, Saif et al. [27] were only able to obtain long-term micronutrient levels in 36.5% (30/82) of their patients. Gillon et al. [52] reported that only 54.0% of their patients were compliant with daily multivitamin supplements. We also found that only 55.4% of our patients were compliant with the unit recommendation of a daily multivitamin/mineral tablet. Just like others [52, 53], we also found that a number of SG patients go on to need additional supplementation with a range of other micronutrients like iron, vitamin B₁₂, and vitamin D with increasing follow-up. We are reviewing our unit protocol for nutritional supplementation after SG on the back of this data, but more importantly, we need focused studies to evaluate appropriate doses of supplementation for each micronutrient after SG given that it is now the commonest bariatric procedure in the world.

There are several limitations of this study that need to be highlighted. The most obvious limitation of this study is the small sample size, but other published studies [Table 3] on this topic suffer from the same problem. The problems with follow-up are well recognised in bariatric surgery. At the same time, our in-patient follow-up, though low, compares favourably with other studies [45] on this topic. Furthermore, since our objective was to analyse outcomes with primary, stand-alone SG at 5 years, we necessarily had to exclude those who had died ($n = 7$) and those who were converted to RYGB ($n = 11$) from our analysis. This effectively means that we only have weight loss data on 64 of 85 (75.3%) live patients. But, including those who have died or been converted to other procedures does not really allow us to determine what exactly happens with primary, stand-alone SG after 5 years, and our methodology is similar to what other authors have adopted whilst reporting long-term experience with SG [48].

As a result of our study design and the fact that we were not able to obtain the full set of data on everybody, we have different denominators in this study. For example, we only had robust co-morbidity data for 52/74 (70.3%) patients and complete haematological laboratory data for 39/74

(52.7%) patients. One must hence use caution whilst interpreting our data and not extrapolate it to the whole cohort. Our non-randomised design is a further weakness, but once again, there is only one published randomised study in the literature [45] on this topic and that study has far fewer patients than our study. Lastly, our follow-up though satisfactory is not complete as we could not obtain any weight loss data on 10 of our patients.

Despite these weaknesses, our study adds to the very few studies on 5-year data following primary SG in an unselected bariatric cohort with adequate follow-up of $\geq 80.0\%$ follow-up. Furthermore, since we have excluded patients converted to other procedures, our data provide a clearer idea of what patients can expect with stand-alone SG after 5 years. Lastly, this study adds meaningful data on micronutrient deficiency rates 5 years after SG which is almost completely missing from most of the similar studies (Table 3).

Conclusion

This study reports satisfactory outcomes with primary SG at 5 years in our unit. A large number of patients experienced symptoms of GORD that either needed converting to RYGB or needed treatment with PPI. Another group needed additional micronutrient supplementation over and above our unit recommendation of a single multivitamin/mineral tablet daily.

Acknowledgements The authors would like to acknowledge Fiona MacLeod and David Hopson for their help with data collection and analysis.

Author Contribution MB and NC collected the data, analysed it, and helped with manuscript writing. KM conceived the study and wrote most of the manuscript. All authors participated in the departmental discussions on the topic. All authors have seen the final manuscript and approve of it.

Compliance with Ethical Standards

Conflict of Interest Ms. Boyle and Mrs. Carruthers have no conflicts of interests to disclose. Mr. Mahawar reports he has been paid honoraria by Medtronic and Olympus for educational activities.

Statement of Human and Animal Rights For this type of study, formal consent is not required.

Statement of Informed Consent Does not apply.

Abbreviations SG, sleeve gastrectomy; BMI, body mass index; RYGB, Roux-en-Y gastric bypass; EWL, excess weight loss; GP, general practitioner; TWL, total weight loss; GORD, gastro-oesophageal reflux disease

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