Review Article

Sleeve gastrectomy for the treatment of Asian type II diabetics: long term results

Shirley Yuk-Wah Liu, Simon Kin-Hung Wong

Department of Surgery, Prince of Wales Hospital, Faculty of Medicine, Chinese University of Hong Kong, Hong Kong, China

Contributions: (I) Conception and design: SY Liu; (II) Administrative support: None; (III) Provision of study materials or patients: None; (IV) Collection and assembly of data: SY Liu; (V) Data analysis and interpretation: All authors; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Simon Kin-Hung Wong. Department of Surgery, Prince of Wales Hospital, Faculty of Medicine, Chinese University of Hong Kong, 30-32 Ngan Shing Street, Shatin, New Territories, Hong Kong, China. Email: wongkhmo@surgery.cuhk.edu.hk.

Abstract: Laparoscopic sleeve gastrectomy (LSG) is a restrictive bariatric procedure that is gaining increasing favor among bariatric surgeons in Asia due to its lower technical complexity, limited complication profiles, and good efficacy on weight reduction. Type II diabetes mellitus (T2DM) is a global epidemic that is strongly linked with obesity. While the prevalence of T2DM and obesity has been rapidly cumulating in Asia, more and more research attentions are raised on the long-term metabolic impact of LSG on Asian T2DM patients. Although emerging systematic reviews on the long-term results of LSG have been recently published, most of these results were focusing on data from North America, Latin America and Europe. Specific attention on the long-term results of LSG on Asian T2DM patients was lacking in the literature. In this review, the current literature evidence about the long-term results of LSG on weight reduction and diabetic remission in Asian T2DM patients was analyzed.

Keywords: Diabetes mellitus; sleeve gastrectomy; obesity; weight loss; bariatrics

Received: 31 December 2016; Accepted: 25 January 2017; Published: 24 February 2017.
doi: 10.21037/ales.2017.02.03
View this article at: http://dx.doi.org/10.21037/ales.2017.02.03

Introduction

Laparoscopic sleeve gastrectomy (LSG) is a restrictive bariatric surgical technique that was first introduced in 1988 as an integral part of biliopancreatic diversion with duodenal switch (1-3). Because of the advantages of lower technical complexity, limited complication profiles and remarkable efficacy on weight reduction (4,5), LSG has quickly established its popularity worldwide as a standalone bariatric procedure (6-8). It has now become one of the first-choice options for many morbidly obese patients in the bariatric surgery armamentarium (6,7).

Type II diabetes mellitus (T2DM) is a global epidemic that is strongly linked with obesity. More than 60% of diabetic people live in Asia (9,10). Due to the ethnic differences, Asians are more predisposed to higher percentage of body fat at a given body weight and the onset of T2DM occurs at lower levels of body-mass-index (BMI) (11-13). In the literature, the efficacy of LSG on hormonal modulation and disease remission of T2DM had been extensively investigated. Systematic reviews on short-term and long-term follow-up data suggested that LSG was highly effective and durable in maintaining high T2DM remission rates of approximately 60% (14,15). Yet, majority of these evidences was originated from North America, Latin America or Europe. The long-term impact of LSG on Asian T2DM patients was poorly investigated. This review aims to analyze the current literature evidence about the long-term results of LSG on weight loss and diabetic remission in Asian T2DM patients. Specific focus was made on the 5-year follow-up outcomes.

Asian studies on long-term data

The long-term follow-up data of LSG in Asia was lacking

in the literature. In an earlier systematic review evaluating the long-term data of 492 patients in 16 studies, only 6 cases (1.0%) were from Asia (5,16). In another recent systematic review analyzing 1,626 patients in 20 studies, 74 patients (4.6%) from 2 studies were Asians (4,17,18). In the present review, the literature was further examined to identify the long-term follow-up data of LSG from Asian centers. Altogether, 11 studies were identified, including 4 studies from Taiwan (16,19-21), 2 studies from India (22,23), and one respective study from China, Japan, Korea, Hong Kong and Malaysia (17,18,24-26). The main characteristics of these studies are summarized in *Table 1*. All except two studies were retrospective analyses on prospectively collected databases that were subjected to compliance problem on follow-up. Similar to other long-term studies on bariatric surgery, the lost-to-follow-up rates at 5 years were as high as 15.3% to 70.0%. Only two studies were prospective randomized trials (17,19). Their lost-to-follow-up rates were therefore acceptably lower (6.4% and 20.0% respectively). Almost all studies had a female predominance in the recruited patients. The mean age of patients was 20.3 to 46.4 years. Their mean BMI varied from 30.6 to 43.3 kg/m^2.

Weight loss outcomes

The long-term weight loss outcomes after LSG in 11 Asian studies are presented in *Table 2*. Based on the assumption of using BMI 25 kg/m^2 as the ideal body weight, the mean percentage of excess weight loss (%EWL) achieved at 5 years was sustained at >50% in all Asian studies (16-26). Three studies were able to achieve a high %EWL at >70% at 5 years (24-26).

Seki *et al.* reported the largest Japanese LSG study on 179 patients (24). They produced the best weight loss outcomes of LSG among all Asian studies. Their %EWL was 83.5% at 1 year (n=132), 91.2% at 3 years (n=32), and 77.3% at 5 years (n=19). Despite some weight rebound, their percentages of excess weight loss (EWL) were maintained at above 75% over the 5-year postoperative period. In another Japanese survey including 831 patients from 9 Japanese centers, Haruta *et al.* concluded the percentage of excess BMI loss (%EBMIL) in a total of 501 LSG patients (27). The %EBMIL was 72.0% at 1 year, 71.0% at 3 years, and 63% at 5 years. Yet, the number of patients and the follow-up rate at each follow-up time point were not described.

Excellent long-term weight loss outcomes were also achieved in a Korean study by Hong *et al.* (25). They presented their 5-year results on 75 LSG patients with low BMI (BMI 30–35 kg/m^2). Similar to the Japanese data from Seki *et al.* (24), their weight loss outcomes were excellent and durable in long-term follow-up. Their %EWL was 84.1% at 1 year (n=63), 79.8% at 3 years (n=46), and 78.5% at 5 years (n=27). In a study of 669 Malaysian patients by Pok *et al.*, LSG was also found to have excellent and sustainable weight loss outcomes in long-term follow-up (26). Their percentages of EWL were similarly maintained at above 70% throughout the postoperative period till 7 years. Their % EWL was 76.0% at 1 year (n=289), 77.3% at 3 years (n=66), 71.6% at 5 years (n=61), and 70.0% at 7 years (n=12).

A vast majority of the long-term results of LSG on Asian patients was generated from Taiwan (16,18-21). Lee *et al.* reported the long-term results of LSG in three Taiwanese studies (19-21). All these studies were comparative analyses between LSG and gastric bypass and one of them was prospective randomized comparison. In their randomized trial, the percentage of total weight loss (%TWL) was maintained throughout the postoperative period for 5 years and their %TWL at 5 years was 20.1% (n=24) (19). In another comparative study by the same group, the mean %TWL at 5 years for 34 LSG patients was 25.9% (21). In their other comparative study analyzing 519 LSG patients, their %TWL was 24.6% at 1 year (n=419), 30.0% at 3 years (n=309), and 28.8% at 5 years (n=116). Their %EWL at 5 years was 68.7% (20). In a Taiwanese study on 228 LSG patients by another group, Zachariah *et al.* reported a high %EWL of 72.4% at 1 year (n=129) (16). Their %EWL was maintained at 71.9% at 3 years (n=33) but dropped to 63.7% at 5 years (n=6). Although the long-term weight loss outcomes were reported, their long-term sample size was considered too small for interpretation.

In many studies, a gradual decline in weight loss over time was observed during long-term follow-up (17,18,23). Despite a decline in the extent of weight loss, many studies could still achieve a %EWL at above 50% at 5-year follow-up. In a prospective randomized study comparing LSG and Roux-en-Y gastric bypass (RYGB), Zhang *et al.* reported the long-term follow-up data of 32 LSG patients with a relatively younger mean age of 20.3 years (17). With a low lost-to-follow-up rate of 6.3%, their results showed a gradual decline in %EWL over time. Their %EWL was 73.9% at 1 year (n=32), 68.0% at 3 years (n=32), and 63.2% at 5 years (n=30). Besides, our group had investigated the long-term outcomes of LSG

Table 1 Main characteristics of the reviewed studies from Asia

Author/year	Country	Study period (year)	Sample size	Follow-up duration (years)	No. of patients with ≥5-yr FU[†]	Lost-to-follow-up rate (%)	Gender ratio (male to female)[‡]	Mean age (years)	Mean BMI (kg/m^2)	Mean WC (cm)	No. of patients with T2DM[‡]	No. of patients with HT[‡]	No. of patients with dyslipidemia[‡]	No. of patients with metabolic syndrome[‡]	Bougie size (Fr)
Lee *et al.*, 2016 (21)	Taiwan, China	2007–2014	109	5	34/NR	NR	48 (44.0): 61 (56.0)	43.2	35.7	113.9	109 (100.0)	NR	NR	NR	36
Seki *et al.*, 2016 (24)	Japan	2005–2013	179	5	18/NR	NR	90 (50.3): 89 (49.7)	40.7	43.3	NR	NR	NR	NR	NR	36–45
Jammu *et al.*, 2016 (22)	India	2007–2014	339	4.5	NR	27.8	185 (54.6): 154 (45.4)	23.0	35.0	NR	83 (24.5)	90 (26.5)	79 (23.3)	NR	36–48
Liu *et al.*, 2015 (18)	Hong Kong, China	2006–2014	140	5	44/52	15.3	49 (35.0): 91 (65.0)	37.9	41.0	124.4	65 (46.2)	75 (53.6)	48 (34.3)	94 (67.1)	Varies
Pok *et al.*, 2015 (26)	Malaysia	2006–2012	667	5	61/NR	NR	169 (25.3): 498 (74.7)	34.5	37.5	102.1	NR	NR	NR	NR	36
Lee *et al.*, 2015 (20)	Taiwan, China	2006–2012	519	5	116/154	24.7	132 (25.4): 387 (74.6)	36.0	37.5	112.6	NR	NR	NR	314 (60.5)	36
Zhang *et al.*, 2014 (17)	China	2007–2008	32	5	30/32	6.3	12 (37.5): 20 (62.5)	20.3	38.5	NR	NR	NR	NR	NR	34
Hong *et al.*, 2014 (25)	Korea	2003–2013	71	5	27/NR	57.1	4 (5.6): 67 (94.4)	33.7	32.4	NR	11 (14.7)	21 (28.0)	64 (85.3)	NR	36–48
Kular *et al.*, 2014 (23)	India	2007–2013	118	5	NR	NR	NR	NR	42.0	NR	61 (51.7)	56 (47.3)	64 (54.3)	NR	37
Lee *et al.*, 2014 (19)	Taiwan, China	2007–2008	30	5	24/30	20.0	8 (26.7): 22 (73.3)	46.4	30.6	102.1	30 (100.0)	17 (56.7)	17 (56.7)	30 (100.0)	28
Zachariah *et al.*, 2013 (16)	Taiwan, China	2007–2012	228	5	6/20	70.0	83 (36.4): 145 (63.6)	34.7	37.4	NR	30 (13.2)	61 (26.8)	105 (46.0)	NR	36

[†], data are number of patients attended follow-up over number of patients with ≥5-year follow-up; [‡], data are count (percentage). FU, follow-up; BMI, body-mass-index; WC, waist circumference; T2DM, type 2 diabetes mellitus; HT, hypertension; NR, not reported.

Table 2 Weight loss outcomes at 5-year follow-up

Author/year	Mean body weight (kg)		Mean BMI (kg/m^2)		Mean waist circumference (cm)		Mean %EWL or % EBMIL at 1 years† (%)	Mean %EWL or % EBMIL at 3 years† (%)	Mean %EWL or % EBMIL at 5 years† (%)	Mean %TWL at 5 years† (%)
	Baseline	5 years	Baseline	5 years	Baseline	5 years				
Lee *et al.*, 2016 (21)	NR	NR	35.7	29.2	113.9	93.4	NR	NR	NR	25.9 (n=34)
Seki *et al.*, 2016 (24)	120.4	92.0	43.3	32.7	NR	NR	83.5 (n=132)	91.2 (n=32)	77.3 (n=19)	29.5 (n=19)
Jammu *et al.*, 2016 (22)	NR	NR	35.0	NR	NR	NR	NR	NR	53.0 (n=NR)	NR
Liu *et al.*, 2015 (18)	112.3	89.1	41.0	33.7	124.4	107.7	70.5 (n=123)	60.2 (n=77)	57.2 (n=44)	NR
Pok *et al.*, 2015 (26)	100.6	72.4	37.5	26.2	102.1	83.6	76.0 (n=289)	77.3 (n=66)	71.6 (n=61)	27.8 (n=61)
Lee *et al.*, 2015 (20)	NR	NR	37.5	27.1	112.6	NR	NR	NR	68.7 (n=116)	28.8 (n=116)
Zhang *et al.*, 2014 (17)	NR	NR	38.5	33.2	NR	NR	73.9 (n=32)	68.0 (n=32)	63.2 (n=30)	NR
Hong *et al.*, 2014 (25)	85.7	65.9	32.4	25.1	NR	NR	84.1 (n=63)	79.8 (n=47)	78.5 (n=27)	NR
Kular *et al.*, 2014 (23)	NR	NR	42.0	NR	NR	NR	69.0 (n=NR)	61.0 (n=NR)	51.2 (n=NR)	NR
Lee *et al.*, 2014 (19)	NR	NR	30.6	25.1	102.1	85.8	NR	NR	NR	20.1 (n=24)
Zachariah *et al.*, 2013 (16)	103.5	NR	37.4	27.9	NR	NR	72.4 (n=129)	71.9 (n=33)	63.7 (n=6)	NR

†, data are mean values and reported number of patients at follow-up in bracket. BMI, body-mass-index; %EWL, percentage of excess weight loss; %EBMIL, percentage of excess body-mass-index loss; %TWL, percentage of total weight loss; NR, not reported.

on 140 Chinese patients (18). A similar trend of decline in the extent of weight loss was also observed. Our %EWL was 70.5% at 1 year (n=123), 60.2% at 3 years (n=77), and 57.2% at 5 years (n=44).

One comparative study from India by Kular *et al.* had reported a declining trend of weight loss during long-term follow-up on 118 LSG patients (23). Their %EWL was 69.0% at 1 year, 61.0% at 3 years, and 51.2% at 5 years. However, the lost-to-follow-up rates at each follow-up time point were not specified. In the other Indian study by Jammu *et al.* on a subset of 339 LSG patients, the %EWL achieved was 53.6% in a mean follow-up duration of 53.5 months (22). Only about 13.3% (45 out of 339) of patients failed to achieve a %EWL >50% during postoperative follow-up. Nevertheless, the trend of %EWL change, the details of weight rebound, and the lost-to-follow-up rates were not explicitly described. The durability of LSG on weight loss outcomes was therefore unable to be determined in this study.

Based on all the above findings, LSG was effective in achieving good weight loss outcomes in morbidly obese Asian patients. The %EWL achieved at short-term and medium-term follow-up was as high as 70% to 90%. Despite a gradual decline in the extent of weight loss over time, the mean %EWL achieved at 5 years was well above 50% among all the available data. These suggested that LSG was effective in maintaining durable weight loss in morbidly obese Asian patients.

Remission of T2DM

Among all studies, the remission rates of T2DM at 5-year follow-up were reported in six studies (*Table 3*). Due to the differences in their preoperative age, BMI, duration of T2DM, glycemic control, and background pancreatic reserve of the patient cohorts, the reported rates of T2DM remission were highly variable between 35.3% and 81.0%. More importantly, the available Asian data were invariably heterogeneous and were associated with three major weaknesses. First, the reported number of T2DM patients at 5-year follow-up in many available studies was relatively small (16). Such results might inevitably be associated with selection bias and became non-representative. Second, the measurement of T2DM remission was not clearly and objectively defined in many studies (16,19,20,22). In some studies that had specified their modes of measurement for T2DM remission, their definitions were often heterogeneous (17,18,21,23). While some studies regarded cessation of anti-diabetic medical therapy as remission, others adopted a strict criteria of glycosylated hemoglobin (HbA1c) <6.5% or <6.0% as their definitions. Some studies also failed to report their individual T2DM remission rate at a specific follow-up time point (23). Direct comparison on the T2DM remission rates among different studies was thus difficult and impossible. Third, majority of the available studies did not analyze the changes in glycemic control after LSG. Although the crude T2DM remission rate was one of the key parameters to measure, it is also equally important to elucidate the improvement of glycemic control in patients without T2DM remission.

In the Hong Kong study on 65 T2DM patients by our group, our T2DM remission rates were found to be sustainably high throughout the postoperative period (18). Using the American Diabetes Association 2009 criteria to define T2DM remission (28), our T2DM remission rates were 34.5% at 1 year (n=55), 52.7% at 3 years (n=36), and 70.6% at 5 years (n=17). Using HbA1c <6.0% to define T2DM remission, Lee *et al.* reported a T2DM remission rate of 35.3% at 5 years in a cohort of 34 LSG patients (21). Yet, the trend of changes was not shown. Kular *et al.* reported a T2DM remission rate of 81% on 61 T2DM patients after LSG (23). However, their timing of measurement was missed. Although a definition of T2DM improvement or remission was provided, Zhang *et al.* did not report their T2DM remission rate at 5 years (17). Instead, they reported a crude rate of 88.9% for both T2DM resolution and improvement at 5 years.

Zachariah *et al.* had analyzed the T2DM remission rate on 30 T2DM patients without clearly defining their mode of measurement for T2DM remission (16). There was a progressive drop in T2DM remission rate from 86.7% at 1 year (n=15) to 71.4% at 3 years (n=7) and 66.7% at 5 years (n=3). Yet, the number of patients analyzed at 5-year follow-up was considered too small to be representative. In a mean follow-up of 53.5 months on 23 LSG patients with T2DM, Jammu *et al.* reported a T2DM remission rate of 56.5% (22). However, their definition of T2DM remission was not provided.

Improvement in glycemic control for T2DM patients was only demonstrated in two Taiwanese studies by Lee *et al.* and the Hong Kong study by our group. Although the T2DM remission rates were not reported, Lee *et al.* found that the mean HbA1c of 30 T2DM patients reduced from 9.9% preoperatively to 7.1% at 5 years (19). Such improvement was sustained throughout the 5 postoperative years. Up to 30% of T2DM patients could maintain optimal

Table 3 Glycemic outcomes at 5-year follow-up

Author/year	No. of T2DM patients (%)	Mean HbA1c (%)		Mean FBG (mg/dL)		Mean fasting C-peptide (ng/mL)		Definition of T2DM remission	T2DM remission rate† (%)	T2DM recurrence rate† (%)
		Baseline	5 years	Baseline	5 years	Baseline	5 years			
Lee *et al.*, 2016 (21)	109 (100.0)	8.8	5.9	184.4	103.6	4.8	1.7	HbA1c <6.0%	35.3 (n=34)	NR
Jammu *et al.*, 2016 (22)	83 (24.5)	NR	NR	NR	NR	NR	NR	NR	56.5 (n=23)	NR
Liu *et al.*, 2015 (18)	65 (46.2)	8.2	6.3	NR	NR	3.4	NR	American Diabetes Association 2009 criteria (28)	70.6 (n=17)	5.9 (n=17)
Lee *et al.*, 2015 (20)	NR	6.4	5.7	108.0	90.5	NR	NR	NR	NR	NR
Zhang *et al.*, 2014 (17)	NR	NR	NR	NR	NR	NR	NR	Discontinuation of T2DM drugs	88.9*	NR
Kular *et al.*, 2014 (23)	61 (51.7)	NR	NR	NR	NR	NR	NR	Discontinuation of T2DM drugs	81.0 (n=NR)	NR
Lee *et al.*, 2014 (19)	30 (100.0)	9.9	7.1	230.6	122.4	3.2	27.1	NR	NR	NR
Zachariah *et al.*, 2013 (16)	30 (13.2)	NR	NR	NR	NR	NR	NR	NR	66.7 (n=3)	NR

†, data are rates and reported number of T2DM patients at 5-year follow-up in bracket; *, only improvement in T2DM control was reported. T2DM, type 2 diabetes mellitus; HbA1c, glycosylated hemoglobin; FBG, fasting blood glucose; NR, not reported.

glycemic control with HbA1c ≤6.5%. In another study of 109 LSG patients with T2DM by Lee *et al.*, 34 patients completed follow-up for 5 years (21). Their mean HbA1c levels dropped from 8.8% at baseline to 6.1% at 1 year and maintained at 5.9% at 5 years. Hence, such improvement in HbA1c levels was durable in long-term follow-up. As for our study on 65 T2DM patients, the trend of HbA1c change was also illustrated (18). Our mean HbA1c levels were 8.2% at baseline (n=65), 6.3% at 1 year (n=55), 6.7% at 3 years (n=45), and 6.3% at 5 years (n=17). Regardless of the T2DM remission rates, our results showed that the glycemic control of T2DM patients was more or less sustained throughout the postoperative period. After LSG, there was no worsening of glycemic control over time in long-term follow-up.

Despite the significant heterogeneity in the reported T2DM remission rates, remarkable improvement in glycemic control was observed in Asian diabetic patients after LSG. The available long-term follow-up data suggested that the glycemic improvement from LSG was sustainable in long-term follow-up at 5 years.

Recurrence of T2DM

Recurrent T2DM after initial remission during long-term follow-up was evaluated in one Asian study only (18). That was a study conducted by our group on 65 T2DM patients after LSG. After initial remission, two patients (3.1%) developed recurrent T2DM at 3 years and 5 years respectively. Based on the strict criteria, one patient fell into recurrent T2DM status at 3 years but she was managed by diet therapy alone. Out of 17 patients, another patient (5.9%) developed recurrent T2DM at 5 years but was treated solely by oral anti-diabetic drugs. Based on these available evidences, the long-term recurrence rate of T2DM after initial remission in Asian patients was not high. Even with recurrent T2DM, the glycemic control of the recurrent patients was not difficult. Nevertheless, the current evidence on the recurrence rate of T2DM in Asian diabetic patients after LSG was disappointingly inadequate. Further observational studies are desperately needed before unequivocal conclusions can be drawn.

In the global literature, analyses on the long-term

Table 4 Revisional surgery after LSG

Author/year	No. of patients undergoing LSG	No. of patients undergoing revision	Revision rate (%)	Reasons for revision†					
				Failed weight loss	Weight regain	Leakage	Stricture	Intractable GERD	Persistent T2DM or inadequate control
Seki *et al.*, 2016 (24)	179	6	3.4	5 (2.8)	0 (0)	0 (0)	0 (0)	1 (0.6)	0 (0)
Pok *et al.*, 2015 (26)	669	18	2.3	0 (0)	6 (0.9)	0 (0)	2 (0.3)	8 (1.2)	2 (0.3)
Lee *et al.*, 2015 (20)	519	16	3.1	0 (0)	6 (1.2)	0 (0)	1 (0.2)	8 (1.5)	1 (0.2)
Liu *et al.*, 2015 (18)	140	8	5.7	4 (2.9)	1 (0.7)	0 (0)	2 (1.4)	1 (0.7)	0 (0)
Lee *et al.*, 2014 (19)	30	4	13.3	1 (3.3)	0 (0)	0 (0)	0 (0)	1 (3.3)	2 (6.7)
Kular *et al.*, 2014 (23)	118	16	13.6	0 (0)	13 (11.0)	0 (0)	0 (0)	3 (2.5)	0 (0)
Total	1,655	68	4.1	10 (0.6)	26 (1.6)	0 (0)	5 (0.3)	22 (1.3)	5 (0.3)

†, data are count (percentage) in the whole cohort. LSG, laparoscopic sleeve gastrectomy; GERD, gastroesophageal reflux disease; T2DM, type 2 diabetes mellitus.

recurrence rate of T2DM after LSG were also extremely limited (18,29). Apart from our study, one American study evaluating a subset of 23 LSG patients had also reported the recurrence rate of T2DM (29). In their study, Brethauer *et al.* identified an overall T2DM recurrence rate of 19% for 217 patients undergoing metabolic surgery in a median follow-up of 6 years. For LSG in particular, the recurrence rate was as high as 38%. Despite such a high recurrence rate, the glycemic control and cardiovascular risk of those recurrent patients were significantly improved compared with their baseline status. Hence, it is noteworthy that recurrence of T2DM may be a concern in long-term follow-up. Nevertheless, the major improvement in glycemic control even after recurrence still supports the role of LSG in treating T2DM patients.

Revisional surgery

Revision of LSG to other bariatric procedures was generally indicated in patients with failed weight loss, weight regain, intractable complications, and inability to control comorbidities (30-37). The need of revisional surgery after LSG in Asian patients was discussed in 6 studies (*Table 4*) (18-20,23,24,26). In a total of 1,655 cases reported, 68 patients (4.1%) required revisional surgery after LSG. While 27 conversions (39.7%) were related to intractable complications, 26 (38.2%) and 10 (14.7%) revisions were attributed to postoperative weight regain and inadequate weight loss respectively. Almost all of these patients were converted to gastric bypass or duodenal switch. Interestingly, 5 patients (7.4%) were converted to gastric bypass due to persistent T2DM or inability to achieve optimal glycemic control. For the three converted patients reported by Lee *et al.* and Pok *et al.*, all of them had improvement in HbA1c levels after revision and one patient could achieve T2DM remission at 1 year after conversion to RYGB (19,26).

Conclusions

In conclusion, LSG was an effective bariatric and metabolic surgery for morbidly obese Asian patients. In terms of weight loss, LSG could achieve sustainably good %EWL of 50–78% at 5-year follow-up. As for Asian diabetic patients in particular, remarkable improvement in glycemic control was observed from 1 year till 5 years after LSG. Despite significant heterogeneity in the study populations and definitions, the reported T2DM remission rates were highly

durable and were maintained at about 56–81% at 5 years after LSG. Long-term recurrence of T2DM after initial remission in Asian T2DM patients was not common.

Acknowledgments

Funding: None.

Footnote

Provenance and Peer Review: This article was commissioned by the Guest Editor (Wei-Jei Lee) for the series "Laparoscopic Metabolic Surgery for the Treatment of Type 2 Diabetes in Asia" published in *Annals of Laparoscopic and Endoscopic Surgery*. The article has undergone external peer review.

Conflicts of Interest: Both authors have completed the ICMJE uniform disclosure form (available at http://dx.doi.org/10.21037/ales.2017.02.03). The series "Laparoscopic Metabolic Surgery for the Treatment of Type 2 Diabetes in Asia" was commissioned by the editorial office without any funding or sponsorship. The authors have no other conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

References

1. Hess DS, Hess DW. Biliopancreatic diversion with a duodenal switch. Obes Surg 1998;8:267-82.
2. Lagacé M, Marceau P, Marceau S, et al. Biliopancreatic diversion with a new type of gastrectomy: some previous conclusions revisited. Obes Surg 1995;5:411-8.
3. Marceau P, Hould FS, Simard S, et al. Biliopancreatic diversion with duodenal switch. World J Surg 1998;22:947-54.
4. Juodeikis Ž, Brimas G. Long-term results after sleeve gastrectomy: A systematic review. Surg Obes Relat Dis 2016. [Epub ahead of print].
5. Diamantis T, Apostolou KG, Alexandrou A, et al. Review of long-term weight loss results after laparoscopic sleeve gastrectomy. Surg Obes Relat Dis 2014;10:177-83.
6. Gagner M, Hutchinson C, Rosenthal R. Fifth International Consensus Conference: current status of sleeve gastrectomy. Surg Obes Relat Dis 2016;12:750-6.
7. Angrisani L, Santonicola A, Iovino P, et al. Bariatric Surgery Worldwide 2013. Obes Surg 2015;25:1822-32.
8. Brethauer SA, Hammel JP, Schauer PR. Systematic review of sleeve gastrectomy as staging and primary bariatric procedure. Surg Obes Relat Dis 2009;5:469-75.
9. Guariguata L, Whiting DR, Hambleton I, et al. Global estimates of diabetes prevalence for 2013 and projections for 2035. Diabetes Res Clin Pract 2014;103:137-49.
10. Nanditha A, Ma RC, Ramachandran A, et al. Diabetes in Asia and the Pacific: Implications for the global epidemic. Diabetes Care 2016;39:472-85.
11. Park YW, Allison DB, Heymsfield SB, et al. Larger amounts of visceral adipose tissue in Asian Americans. Obes Res 2001;9:381-7.
12. Chang CJ, Wu CH, Chang CS, et al. Low body mass index but high percent body fat in Taiwanese subjects: implications of obesity cutoffs. Int J Obes Relat Metab Disord 2003;27:253-9.
13. Deurenberg P, Yap M, van Staveren WA. Body mass index and percent body fat: a meta analysis among different ethnic groups. Int J Obes Relat Metab Disord 1998;22:1164-71.
14. Gill RS, Birch DW, Shi X, et al. Sleeve gastrectomy and type 2 diabetes mellitus: a systematic review. Surg Obes Relat Dis 2010;6:707-13.
15. Switzer NJ, Prasad S, Debru E, et al. Sleeve gastrectomy and Type 2 diabetes mellitus: a systematic review of long-term outcomes. Obes Surg 2016;26:1616-21.
16. Zachariah SK, Chang PC, Ooi AS, et al. Laparoscopic sleeve gastrectomy for morbid obesity: 5 years experience from an Asian center of excellence. Obes Surg 2013;23:939-46.
17. Zhang Y, Zhao H, Cao Z, et al. A randomized clinical trial of laparoscopic Roux-en-Y gastric bypass and sleeve gastrectomy for the treatment of morbid obesity in China: a 5-year outcome. Obes Surg 2014;24:1617-24.
18. Liu SY, Wong SK, Lam CC, et al. Long-term results on weight loss and diabetes remission after laparoscopic sleeve

gastrectomy for a morbidly obese Chinese population. Obes Surg 2015;25:1901-8.
19. Lee WJ, Chong K, Lin YH, et al. Laparoscopic sleeve gastrectomy versus single anastomosis (mini-) gastric bypass for the treatment of type 2 diabetes mellitus: 5-year results of a randomized trial and study of incretin effect. Obes Surg 2014;24:1552-62.
20. Lee WJ, Pok EH, Almulaifi A, et al. Medium-term results of laparoscopic sleeve gastrectomy: a matched comparison with gastric bypass. Obes Surg 2015;25:1431-8.
21. Lee WJ, Chong K, Aung L, et al. Metabolic surgery for diabetes treatment: sleeve gastrectomy or gastric bypass? World J Surg 2017;41:216-23.
22. Jammu GS, Sharma R. A 7-year clinical audit of 1107 cases comparing sleeve gastrectomy, Roux-en-Y gastric bypass, and mini-gastric bypass, to determine an effective and safe bariatric and metabolic procedure. Obes Surg 2016;26:926-32.
23. Kular KS, Manchanda N, Rutledge R. Analysis of the five-year outcomes of sleeve gastrectomy and mini gastric bypass: a report from the Indian sub-continent. Obes Surg 2014;24:1724-8.
24. Seki Y, Kasama K, Hashimoto K. Long-term outcome of laparoscopic sleeve gastrectomy in morbidly obese Japanese patients. Obes Surg 2016;26:138-45.
25. Hong JS, Kim WW, Han SM. Five-year results of laparoscopic sleeve gastrectomy in Korean patients with lower body mass index (30-35 kg/m²). Obes Surg 2015;25:824-9.
26. Pok EH, Lee WJ, Ser KH, et al. Laparoscopic sleeve gastrectomy in Asia: Long term outcome and revisional surgery. Asian J Surg 2016;39:21-8.
27. Haruta H, Kasama K, Ohta M, et al. Long-term outcomes of bariatric and metabolic surgery in Japan: results of a multi-institutional survey. Obes Surg 2017;27:754-62.
28. Buse JB, Caprio S, Cefalu WT, et al. How do we define cure of diabetes? Diabetes Care 2009;32:2133-5.
29. Brethauer SA, Aminian A, Romero-Talamás H, et al. Can diabetes be surgically cured? Long-term metabolic effects of bariatric surgery in obese patients with type 2 diabetes mellitus. Ann Surg 2013;258:628-36.
30. Casillas RA, Um SS, Zelada Getty JL, et al. Revision of primary sleeve gastrectomy to Roux-en-Y gastric bypass: indications and outcomes from a high-volume center. Surg Obes Relat Dis 2016;12:1817-25.
31. Quezada N, Hernández J, Pérez G, et al. Laparoscopic sleeve gastrectomy conversion to Roux-en-Y gastric bypass: experience in 50 patients after 1 to 3 years of follow-up. Surg Obes Relat Dis 2016;12:1611-5.
32. Felsenreich DM, Langer FB, Kefurt R, et al. Weight loss, weight regain, and conversions to Roux-en-Y gastric bypass: 10-year results of laparoscopic sleeve gastrectomy. Surg Obes Relat Dis 2016;12:1655-62.
33. Abdemur A, Han SM, Lo Menzo E, et al. Reasons and outcomes of conversion of laparoscopic sleeve gastrectomy to Roux-en-Y gastric bypass for nonresponders. Surg Obes Relat Dis 2016;12:113-8.
34. Homan J, Betzel B, Aarts EO, et al. Secondary surgery after sleeve gastrectomy: Roux-en-Y gastric bypass or biliopancreatic diversion with duodenal switch. Surg Obes Relat Dis 2015;11:771-7.
35. Silecchia G, De Angelis F, Rizzello M, et al. Residual fundus or neofundus after laparoscopic sleeve gastrectomy: is fundectomy safe and effective as revision surgery? Surg Endosc 2015;29:2899-903.
36. Moszkowicz D, Arienzo R, Khettab I, et al. Sleeve gastrectomy severe complications: is it always a reasonable surgical option? Obes Surg 2013;23:676-86.
37. Iannelli A, Schneck AS, Noel P, et al. Re-sleeve gastrectomy for failed laparoscopic sleeve gastrectomy: a feasibility study. Obes Surg 2011;21:832-5.

doi: 10.21037/ales.2017.02.03
Cite this article as: Liu SY, Wong SK. Sleeve gastrectomy for the treatment of Asian type II diabetics: long term results. Ann Laparosc Endosc Surg 2017;2:29.

