



# Learning About the Laparoscopic Sleeve Gastrectomy (ISG) The Birth and Evolution of Laparoscopic Sleeve Gastrectomy

Michel Gagner

Is sleeve gastrectomy the result of an omphaloskepsis? Omphaloskepsis or navel contemplation of one's self is known to be an aid to meditation. The word originates from the Greek omphalos, signifying “navel” and skepsis, meaning “viewing”. In Hinduism, the navel is the site of a powerful chakra, focal point of mediation, the site of the universe, but it is also the exit of the sleeve gastrectomy specimen, transcending a powerful individual change.

The sleeve gastrectomy follows the duodenal switch evolution, but its originators did not create the concept of a stand alone or staged procedure called “sleeve gastrectomy”. Doug Hess and Picard Marceau altered the open biliopancreatic diversion, modified it, and called it duodenal switch, generally called “DS”, in 1988–90, with the needs for a major gastrectomy to diminish the acid load on the duodenal ileal anastomosis, causing dramatically less anastomotic ulcers [1, 2]. In Marceau’s description, the BPD distal gastrectomy is replaced with a “65% parietal cell gastrectomy” along the greater curvature; note that this was not called “sleeve gastrectomy” at the time, leaving a stomach of at least 200 mL [3].

I initiated, as a principal investigator, a small animal swine pilot project in May 1999 at Mount Sinai School of Medicine where I had been an attending and professor of surgery, with the help of Dr. Gregg Jossart who was a clinical fellow in laparoscopic/bariatric surgery at Mount Sinai School of Medicine in New York under my directorship, has since served as the Director of Minimally Invasive Surgery at California Pacific Medical Center in San Francisco since 1999, assisted by Dr. John de Csepel, who was my research fellow and resident at the time from the same organization, who is now the Chief Medical Officer & Vice President of Medical Affairs for Medtronic’s Minimally Invasive Therapy Group’s for a

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M. Gagner (✉)

Department of Surgery, Sacré-Coeur Hospital, Montréal, QC, Canada

e-mail: [Gagner.Michel@cliniqueMichelGagner.com](mailto:Gagner.Michel@cliniqueMichelGagner.com)

diverse portfolio (\$9 billion in annual revenues) in New York City, and Dr. Stephen Burpee, resident at the time who is now an attending bariatric surgeon in private practice in Tucson Arizona, Laparoscopic Duodenal Switch Feasibility study in 6 pigs was realised in the institution research centre, which was ultimately published later in 2001 [4].

This laboratory effort was to comprehend the complexities and technical impediments of performing such surgeries in real patients. After I initiated the first laparoscopic Roux-en-Y gastric bypass program at Mount Sinai in 1998, strong from my experience with the same surgery since 1995 at the Cleveland Clinic in Ohio, and preceding animal experiment on laparoscopic Roux-en-Y gastric bypass with our clinical fellow Dr. Mario Potvin at the Centre de Recherche de l'Hotel-Dieu de Montreal in 1993 [5], who is now an attending surgeon in the Marshfield Clinic Health System in Wisconsin, I embarked on July 2, 1999, 21 years ago, to perform the first Laparoscopic DS at Mount Sinai Hospital in New York. Dr. Christine Ren, our newest fellow of 1 day, following Dr. Jossart's fellowship year, a finishing general surgery resident from the NYU program, assisted me, NYU had no or minimal laparoscopic bariatric surgery experience at the time.

- This entailed a laparoscopic sleeve gastrectomy, using a bougie in place of 60Fr and multiple serial firings of laparoscopic linear staplers, followed with duodeno-ileostomy using a transabdominal circular stapler, end to side, antecolic, and a side-to-side ileo-ileostomy using a linear stapler and hand-sewn closure of the enterostomy. Initially, mesenteric defects were not closed, but later than a year afterwards, a 2.6% mesenteric internal hernia incidence was observed, mostly Petersen's, and routine closure of both mesenteric defects was initiated in 2000. It is amazing today, looking back at this era, that I had introduced this on patients with BMI >60 kg/m<sup>2</sup>, as it was my conviction at the time, even today, that hypoabsorptive procedures should be completed in this class of super to super super obesity [7]. After her 1999–2000 fellowship with us, Dr. Christine Ren subsequently became Professor in the Department of Surgery at NYU Grossman School of Medicine and Division Chief of Bariatric Surgery.

We therefore initiated quite a series of patients such by December 1999, an abstract was submitted to the 2000 annual meeting of ASBS, not called ASMBS at the time, American Society of Bariatric Surgery, usually held in June, and accepted for an official podium presentation [8]. Dr. Gregg Jossart returned for an operating room visit to Mount Sinai NY in the fall of 1999, just before the annual meeting of the American College of Surgeons held in San Francisco, accompanied by Dr. Robert Rabkin, his new partner at the time in San Francisco, interested in learning and observing a live case of laparoscopic DS procedure, which they initiated afterwards with a hand assisted technique, not with complete laparoscopy. Dr. Jossart and Rabkin have displayed their preliminary experience at SAGES 2001, with 79 cases done, 27 lap assisted and 52 hand assisted which started in October 1999 until July 2000 [9]. At the Annual meeting of ASBS in June 2000, a short

video presentation was produced from Dr. Jossart, Dr. R. Rabkin, and Dr. Donald Booth from Biloxi, and with an abstract revealing that they had started the complete laparoscopic technique in January of the same year [10].

By serendipity and providence, I could not perform a complete laparoscopic DS early in our experience, due to ventilator pressure problems, and tight pneumoperitoneum in spite of utmost muscular relaxation, and I decided to abandon after completion of the sleeve gastrectomy, which to this day, was constantly done first. My observation of weight loss, disappearance of co-morbidities, led me to believe that this group of high-risk patients, those with BMI > 60 kg/m<sup>2</sup>, it would be preferable to realize the long and tedious operation in 2 steps instead, with a 6 months interval as a minimum. As, a later review of our data had substantiated the higher mortality and morbidity rate of full laparoscopic DS in BMI > 60 kg/m<sup>2</sup>, much higher than a 2 stage procedure [11]. This led me to do the first presentation on laparoscopic sleeve gastrectomy “alone” at Dr. Phillip Schauer’s meeting in Feb 20–25 2001, MISS Minimally Invasive Symposium in Snowbird, Utah, on sleeve gastrectomy as a 2 stages procedure. The reception was tepid, unenthusiastic, and because nobody was really doing laparoscopic duodenal switch at the time, as a large part of this crowd had been invited and paid by laparoscopic adjustable gastric band companies, it had generated no awareness from the audience, except for one individual in attendance. I suppose, it was either Dr. Peter Crookes or Dr. Gary Anthone who were working at USC Los Angeles at the time, who came forward during the coffee break, and confided to me that they had done a handful of patients with an open technique, as a salvage, but that they were not published and thought there was no interest in the subject at the time. They subsequently published this experience in 2004 and 2006, but I pondered if they would have published it, if it were not from my experience laparoscopically, and subsequent hype of the subject [12, 13].

Consequently, with Dr. Christine Chu, another clinical fellow, who is now working for Kaiser Permanente Northern California Bariatric Surgery Center, an abstract was sent for presentation at the annual meeting of SAGES in the spring of 2002. The abstract was published in *Surgical Endoscopy*, and this constitute the first official publication on the subject, entitled “Two-stage laparoscopic BPD/DS. An Alternative Approach to Super-Super Morbid Obesity”, many co-authors represented my faculty partners and bariatric fellows at the time 2001–2002, at Mount Sinai hospital and School of Medicine in NY, NY [14]. From July 1999 until July 2001, 102 laparoscopic duodenal switches had been achieved, of which 7 were by two stages completed, and did not include also the sleeve alone that had not been converted for numerous motives, including patients who declined a second stage. On March 15th 2002, at the New York Hilton Hotel, the presentation of the first series, at an official societal meeting, on laparoscopic sleeve gastrectomy, took place.

I was part of the World Congress program in 2002, as it was combined for IFSES, the International Federation of Societies of Endoscopic Surgery, and this was a few months after the tragically September 11, 2001 events, which still attracted a large crowd in New York City, in spite of the fear of traveling and

flying, they were even discussions to delay or cancelled the meeting. Fortunately, we had put an outstanding postgraduate laparoscopic bariatric course at Mount Sinai School of Medicine, with countless live surgeries, which encompassed laparoscopic Roux-en-y gastric bypasses, duodenal switch and sleeve gastrectomy as a stand-alone procedure. There was also an animal lab and a cadaver laboratory, where those techniques were tutored. Many participants remembered and reminisced, still exchange with me about this event as one of the turning point in their profession. During the same congress, Dr. Shoji Fukuyama, MD, Christine Chu, MD, Won Woo Kim, MD, and myself also presented a video of the two-stage procedure at the video session V02 on March 15th, 2002 [15]. Dr. Kim returned to Seoul Korea where he was an early adopter of sleeve gastrectomy in Asia, starting in 2003. Further, Dr. David Voellinger presented a poster, another clinical fellow that year, who did just before his residency at the University of Alabama in Birmingham, is now an attending bariatric surgeon and the Medical Director for the Novant Health Bariatric Center and Vice Chief of Staff at Presbyterian Medical Center in Charlotte, NC, entitled “Laparoscopic Sleeve Gastrectomy is a safe and effective Primary Procedure for Biliopancreatic Diversion With Duodenal Switch”, because it had been turned down for a podium oral presentation, it was a poster abstract [16]. It included a series of 24 patients; initial mean weight was 414 lbs., with mean BMI of 65 (range 58–76 kgm<sup>2</sup>). Mean operative time was 114 min with an average length of stay of 3 days (range 2–7) with a median of 3 days. Follow-up at 3 weeks, 3 months, and 6 months after sleeve resulted in an excess total body weight loss of 11, 23, and 32% and mean BMI of 60, 56 and 49 kgm<sup>2</sup>. No major morbidity and no mortality ensued in this population. The conclusion was: Laparoscopic sleeve gastrectomy is feasible and can be performed with minimal morbidity as the primary stage of LBPDDS in the superobese. It also results in substantial short-term weight loss and should allow for a safer operation during second stages [16].

Dr. Bruce V. MacFadyen Jr. from the University of Texas-Houston Medical School, who was the main co-editor of Surgical Endoscopy at the time with Sir Alfred Cuschieri, turned down the manuscript submitted, for lack of long-term follow-up!! This infuriated me, as Surgical Endoscopy had an earlier tradition of publishing pioneering concepts a decade before. And this is why our second series has been published 1 year after, in 2003, in a distinct journal, more open minded to bariatric subjects, in Obesity Surgery, by our clinical fellow at the time Dr. Joseph Patrick Regan, and Barry Inabnet pushing for its publication on “Early experience with two-stage laparoscopic roux-en-Y gastric bypass as an alternative in the super-super obese patient” which is much quoted in the bariatric surgical literature [17]. As much commercial medical insurances were denying duodenal switches, although accepted by CMS, patients ended up, after their approval, with a second stage Roux-en-Y gastric bypass, which I considered an inferior operation for super-obeses. As I said, this was not my first cohort of patients, in this short paper in obesity Surgery, there were only 7 patients who had an initial sleeve followed several months later, with a mean of 11 months, a lap Roux-en-y gastric bypass, where the upper sleeve was transected, from a BMI of 63 to 50 kg/m<sup>2</sup>

after a sleeve, and then to 44 kg/m<sup>2</sup>, 2.5 months later. The very first sleeve gastrectomy series was published as a book chapter, with considerable delays, in 2005, which many referenced today, as the first series of laparoscopic sleeve gastrectomy [18] of note, Dr. Regan is now attending staff at Columbia St. Mary's Hospital Columbia, in Milwaukee, WI, as well as medical director and assistant Clinical Professor of Surgery of the Medical College of Wisconsin and member of the Milwaukee Institute of Minimally Invasive Surgery.

As I said earlier, Dr. Gregg Jossart who is now Director, Minimally Invasive Surgery, California Pacific Medical Center, San Francisco, California and Dr. Gary J. Anthone who as since left private bariatric surgery practice to be the chief medical officer and director of public health of Nebraska, have composed a short piece on the history of sleeve gastrectomy in the *Bariatric Times* in 2010 [19]. In 1997, Dr. Gary Anthone was performing an open duodenal switch on a 13-year-old girl with a history of common bile duct stones [12]. Intraoperatively, the common bile duct stones could not be completely cleared, and elected to just do an open sleeve gastrectomy in order to leave access for a postoperative endoscopic retrograde cholangiopancreatography (ERCP). From 1997 to 2001, he performed 21 open sleeve gastrectomies in high-risk patients with super-morbid obesity [12]. The lesser curve stomach left was approximately 100 mL in volume (presently the pouch volume is approximately 60 cm<sup>3</sup> or less) and the patients reached 40–50% excess weight loss (EWL). By October 2005, he had narrated on 118 open sleeve gastrectomies with similar outcomes [13].

Professor Michael J. McMahon, previously from the General Infirmary at Leeds, robust from the experience of Professor Johnston with Margenstrasse & Mill gastroplasty, had executed from January 2000 until December 2001, laparoscopic sleeve gastrectomy in 20 patients. Of note, Prof Michael J. McMahon had visited me at Mount Sinai School of Medicine during this time interval, where the laparoscopic sleeve gastrectomy had been performed 7 months earlier in duodenal switch patients. The technique described in their manuscript of 8-years results, is identical to the technique used at Mount Sinai, except for a smaller bougie of 32 Fr, the one that was currently used for M&M in Leeds. At 8 years, 55% of patients had more than 50% EWL [20].

In San Francisco, Dr. Gregg Jossart, our former fellow, was an early adopter of sleeve gastrectomy in the West coast, he had started to offer the stand-alone procedure with a 32 French calibre pouch (30–60 cm<sup>3</sup>) to lower BMI patients, in November 2002 [21]. I had several conversations with him encouraging them to start the laparoscopic two stage procedure in San Francisco. The results of 216 patients compared successfully the other stapling procedures and certainly against adjustable gastric banding, with 75–85% EWL at two years of follow up [21].

Adjustable gastric banding has been almost abandoned, and performed less than 1% of the time in North America. Dr. Jacques Himpens from Brussels Belgium, an early adopter of the technique, has been convinced after video transmission of surgeries performed from Mount Sinai NY to Brussels and Europe, and had published some 6 years results in the *Annals of Surgery*, a landmark paper, where sleeves were performed between November 2001 and October 2002, in

which the early technique was not fully understood, especially concerning the extent of fundus and crus dissections, giving its worst results [22].

Two additional posters at SAGES annual meeting in 2002 mentioned some aspects of early sleeve gastrectomy developments. Dr. Hazem Elariny from Virginia started in 2001 and had presented 30 patients of a laparoscopic non-banded vertical gastroplasty with sleeve gastrectomy [23]. Dr. Val Andrei from New Jersey, was our clinical fellow at Mount Sinai NY, at the same time as Dr. Jossart in 1998–1999, and described 3 cases of laparoscopic duodenal switches, one laparoscopic, one hand assisted and another converted from laparoscopic to open [24].

But this was antedated by one year, the SAGES annual meeting of 2001, where Dr. Theresa Quinn, who is working as a general surgeon in Wisconsin, our clinical fellow that year, presented on our updated experience “Laparoscopic Biliopancreatic Diversion with Duodenal switch: The early Experience” [25].

Since it had been clearly established that two stage procedures, with a laparoscopic sleeve gastrectomy performed first, had slashed impressively the mortality to zero, and gave an acceptably low morbidity rate in these high risk patients, I fully embraced the procedure from the very commencement [26].

I then embarked on the big task of educating a large population of bariatric, minimally invasive and gastro-intestinal surgeons worldwide in this new procedure. We started to display and teach this technique to visitors at Mount Sinai from 1999, and in official bariatric courses we had regularly. The very first international specific course on Laparoscopic Sleeve Gastrectomy was at Doral Golf Course in 2005, and Dr. Jacques Himpens was an invited foreign faculty. Afterwards, six International consensus conferences were established under my leadership and directorship, starting with the first one in New York City in October 25–27, 2007. The proceedings were published in obesity surgery in 2008 [27].

Following this great triumph, five more International Consensus conferences were held in New York City, Miami, Montreal and London, of which the first 5 ones have been published. Each of them had a sizeable component of live surgeries from countless expert surgeons demonstrating the easiness and convolutions of their operation, emanating from all continents. A didactic portion of the meeting had sessions on mechanisms, indications, and contraindications of that particular year, followed by management and detection of complications, conversions and revisions [28–31]. Worth stating, was also the Expert consensus meeting planned by Dr. Raul Rosenthal in Florida, sponsored by Ethicon Endosurgery, to establish consistency in the technical performance of sleeve gastrectomy, led to highly cited paper in 2012 [32].

The rest is history; ASMBS and IFSO have recognized Sleeve Gastrectomy as an acceptable option for a primary bariatric procedure or as a first-stage procedure in high-risk patients as part of a planned, staged approach. As with any bariatric procedure, long-term weight regain can occur after and may require one or more of reinterventions. Informed consent should be consistent with the other bariatric

procedures and, as such, should include the risk of long-term weight regain and GERD.

I did organized the International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO) annual meeting of 2014 and Fifth International Consensus Conference on Laparoscopic Sleeve Gastrectomy, in Montréal at the end of August 2014. An international expert panel was surveyed in 2014 and compared with the 2011 Sleeve Gastrectomy Consensus and with survey data taken from a general bariatric surgical group. The expert surgeons (based on having performed >1000 cases) completed an online anonymous survey. The following indications were endorsed: as a stand-alone procedure (97.5%); in high-risk patients (92.4%); in kidney and liver transplant candidates (91.6%); in patients with metabolic syndrome (83.8%); body mass index 30–35 with associated co-morbidities (79.8%); in patients with inflammatory bowel disease (87.4%); and in the elderly (89.1%) [31]. Significant differences occurred between the expert and general surgeons groups in favouring several contraindications: Barrett's esophagus (80% versus 31% [ $P < 0.001$ ]), gastroesophageal reflux disease (23% versus 53% [ $P < 0.001$ ]), hiatal hernias (12% versus 54% [ $P < 0.001$ ]), and body mass index >60 kg/m<sup>2</sup> (5% versus 28% [ $P < 0.001$ ]). Mean reported weight loss outcomes 5 years postoperative were significantly greater for the expert surgeons group ( $P = 0.005$ ), as were reported stricture ( $P = 0.001$ ) and leakage ( $P = 0.005$ ) rates. This conference emphasized areas of novel and enriched best practices on various aspects of laparoscopic sleeve gastrectomy performance among experts and bariatric surgeons [31].

In 2016, the numbers of bariatric procedures have been estimated to be 216,000 in USA alone [33]. Of these 58% have been sleeve gastrectomy, but if one looks at the number of primary laparoscopic procedures, sleeve gastrectomy has attained 73% of all, nearly 3 quarters of them, and still rising. But USA was unhurried to fully embrace it, because of private insurances slow processes. In countries where a national health system happens, like Chile, Kuwait or France, it has been the uppermost procedure before 2016.

Globally, the total bariatric surgical figures have approached 685,874; 634,897 (92.6%) of which were primary and 50,977 were revisional (7.4%) [34]. My estimate is that bariatric/metabolic surgeries are closer to 1 million procedures a year, as most nations do not have a countrywide registry of bariatric procedures. According to the latest IFSO assessment, the most performed primary procedure was sleeve gastrectomy ( $N = 340,550$ ; 53.6%), followed by Roux-en-Y gastric bypass ( $N = 191,326$ ; 30.1%), and single anastomosis gastric bypass ( $N = 30,563$ ; 4.8%). In 2016, sleeve gastrectomy remains the most performed surgical procedure in the globe, with probably more than half a million cases done annually. It has the promise to grow to 5–10 times those numbers if they are being welcomed by national health care systems, and not restrained, due to biases and financial constraints, like in Canada or the UK for example.

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