COLLECTION ON LAPAROSCOPY IN BARIATRICS

Contributing Authors:

K. MILLER, H. LÖNROTH, M. KEMEN, G. TZIVRAS
R.J. ROSENTHAL, J.C. RUIZ de ADANA
J. LÓPEZ-HERRERO, A. HERNÁNDEZ-MATÍAS
D. KRAWCZYKOWSKI, R.M. TACCHINO
F. GRECO, D. MATERA, H. TILL and S. BLÜHER

Foreword by Rudolf A. WEINER
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LAPAROSCOPY
IN BARIATRICS

Contributing Authors:
Prof. Karl Miller, M.D.
Prof. Hans Löroth, M.D., PhD
Prof. Matthias Kemen, M.D., and Gerasimos Tzivras, M.D.
Raul J. Rosenthal, M.D.
J.C. Ruiz de Adana, M.D., J. López-Herrero, M.D.
and A. Hernández-Matias, M.D.
Daniel Krawczykowski, M.D.
Prof. Roberto Maria Tacchino, M.D.
Francesco Greco, M.D., and Daniele Matera, M.D.
Prof. Holger Till, M.D., and Susann Blüher, M.D.

Foreword by:
Prof. Rudolf A. Weiner, M.D.

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<td>Chairman, Department of Surgery, Sahlgrenska University Hospital, Goteborg, Sweden</td>
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<td>Herne Protestant Hospital, (Teaching Hospital for the University of Essen)</td>
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<td>Department of Surgery, Herne, Germany</td>
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<tr>
<td>Section Head of Minimally Invasive Surgery and Medical Director of the Bariatric and Metabolic Institute, Cleveland Clinic, Weston, Florida, U.S.A.</td>
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Department of General Surgery, Madrid University Hospital of Getafe (Madrid), Spain

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Foreword

The worldwide epidemic of obesity has reached such alarming proportions that a recent WHO report coined a new word to describe this phenomenon: “globesity.” It is also clear that the public and policy makers have only just begun to realize the increasing problems that emerge due to being overweight and their implications for public health.

Thus far, there have been no society-wide concepts for dealing with the steady rise of obesity in industrialized countries and developing nations. The persistence of morbid obesity implies that conservative treatment options have failed and that surgical intervention is the only approach that can offer a permanent solution to the comorbidities associated with obesity and its sequelae. In patients who are more than 30–40 kg overweight, bariatric surgery is by far superior to all conservative treatment options including multimodal regimens, behavioral therapy, exercise therapy, and even pharmacotherapy. This superiority concerns both the degree of weight reduction and its permanence.

While conservative therapies can bring about a weight loss of up to 10 kg in one year, this result is only temporary, lasting 1–2 years, and the dieters usually regain the lost weight. On the contrary, we know from the Swedish Obese Subjects (SOS) Study that modern methods of bariatric surgery can achieve a permanent weight reduction in the long term.

The acceptance of bariatric surgery is closely tied to the development of laparoscopy and the minimally invasive approach. While open weight-reduction surgery was associated with a high rate of general complications such as pulmonary complications, incision dehiscence, and pulmonary embolism, the advent of laparoscopic surgical techniques has led to a high degree of acceptance among surgeons and patients alike. The morbidity of bariatric procedures has been reduced by a factor of 10, and today laparoscopic techniques are regarded as safe and established procedures. This book, a collection of articles written by an international team of experts, covers all relevant details and technical aspects of bariatric surgery including the most important standard procedures. Given the variety and complexity of surgical treatment options – always combining the principles of restriction (reducing food ingestion) and malabsorption (decreasing the absorption of fat and nutrients) – it is clear at the outset that there is no single operation that is ideal for everyone. The most appropriate procedure should be selected based on a careful consideration of individual factors (age, sex, severity of overweight and comorbid conditions, willingness and ability of the patient to cooperate) and then carried out with high technical proficiency.

Beside the standard procedures, there are also a number of new therapeutic approaches and expert options that are not included in this volume because they have not yet been proven by clinical trials. Furthermore, this collection is highlighted by numerous intraoperative, high-definition videoendoscopic photographs using instruments, camera systems and complex operating room systems manufactured by KARL STORZ. They vividly illustrate the steps involved in bariatric procedures, pointing out high-risk phases of the operation and offering strategies for the prevention of complications. This collection provides the laparoscopist with an excellent overview of the currently established laparoscopic surgical procedures.

Obesity surgery will continue to expand more widely in the future. Given the current lack of effective options for the prevention of obesity and its ineffective conservative management, bariatric surgery will continue to remain as the most rapidly growing subspecialty of modern visceral medicine and surgery.

Prof. Rudolf A. Weiner, M.D.
President of the International Federation for Surgery of Obesity and Metabolic Disorders 2014–2015
Past President-elect, IFSO European Chapter 2010–2012
President, IFSO World Congress 2011
Introduction

As laparoscopic techniques have become prevalent in almost every surgical specialty, the number of bariatric procedures has increased dramatically during the past 10 years. The least invasive weight-loss operation is adjustable gastric banding.

Patient Selection

The indication for bariatric surgery is documented in evidence-based guidelines. A body mass index (BMI = body weight in kilograms divided by height in meters squared) of 40 or more represents clinically severe overweight, which requires medical treatment and justifies surgical treatment if the patient desires it and the attending surgeon feels that it is indicated. Patients with a BMI of 35–40 should be considered for surgical treatment if they have comorbid conditions that could improve significantly in response to weight loss. The patient should have a BMI of 40 kg/m² or more, or a body weight that is 45 kg or more above the ideal value for his or her constitution according to a standard table. (A BMI of 40 means that the patient is approximately 45 kg above the ideal weight for an individual of normal height.) If the BMI is 35–40 kg/m² (i.e., less than 45 kg above the ideal weight), a serious medical problem exists that could be significantly improved by weight reduction to justify the risk of a proposed operation. The patient must be able to care for himself or have one or more caregivers who can provide the necessary follow-up care. A high degree of patient motivation and an interdisciplinary approach are far more important for success than rigorous exclusion criteria, which may be amended or discarded from one year to the next. For patients who undergo adjustable gastric banding, follow-up measures such as band adjustments, psychological counseling, and nutritional counseling are an essential part of management. In cases where follow-up care cannot or will not be provided, the patient should not be selected for bariatric surgery. Other issues are addressed in the guidelines of the American Society for Bariatric Surgery (ASBS) and the recommendations of the International Federation for the Surgery of Obesity (IFSO), which state that centers providing bariatric surgery should have adequate experience in open and laparoscopic intestinal surgery. They should also have an infrastructure that includes trained nutritional counselors, psychologists, a motivated nursing staff, and preferably a patient support group. Other essentials are properly equipped examination tables, operating tables, beds, and necessary instruments for cases that require conversion to open surgery. Facilities for perioperative monitoring should also be available. The importance of operator training and experience is self-evident. Explaining the procedure and its risks to the patient and securing informed consent are time-consuming but imperative. There is scarcely any other situation in which the success or failure of an operation depends so strongly on patient cooperation. The patient should be educated about obesity as a disease and informed about current surgical treatment options, laparoscopic banding, possible complications, warning signs, and postoperative care. Patients with an extreme form of morbid obesity (triple obesity, BMI > 60), a severe eating disorder (e.g., binge eating), or insulin-dependent type II diabetes mellitus should be referred for a more complex surgical procedure such as gastric bypass or biliopancreatic diversion.
Preoperative Details

Endocrine disorders should be adequately treated and controlled. A medical evaluation, abdominal ultrasound scans, and spirometry are recommended. Any gallstones should be synchronously removed, because dramatic weight loss is often complicated by cholelithiasis. The patient is presented to the anesthesiologist with the results of the preoperative workup several days before the operation. Nutritional counseling is mandatory, and a psychological evaluation is recommended.

Perioperative Care

Unlike many other operations, bariatric surgery marks the starting point rather than the endpoint of treatment. Regular follow-up visits and patient cooperation are crucial for success. Perioperative antibiotics (single-shot cephalosporin prophylaxis) and low-molecular heparin (moderate to high risk) are recommended. On the day of the surgery, the patient may drink small sips of tea following the procedure. A water-soluble oral contrast examination is performed on the first postoperative day, and the liquid phase of the postoperative diet is begun, with gradual transition to a regular diet. Further nutritional counseling should be given prior to the first band adjustment whenever possible. Additional follow-ups depend on the type of procedure that was performed and, of course, on individual patient requirements.

Operative Technique

The patient is placed in a supine, slightly hyperextended position with the legs abducted. A pneumoperitoneum (12 mmHg) is created in the left mid- to upper abdomen. Once the trocars have been placed, the patient is moved to a reverse Trendelenburg position to prevent injury to the liver. A variety of trocar patterns have been described in the literature. The sites depend on the body habitus of the patient. Trocar placement in extremely obese patients will play a key role in the success of the operation. Unlike the situation in normal-weight patients, the axial alignment of trocars in the abdominal wall of obese patients can no longer be changed following placement. Preoperative ultrasound scans can be very helpful for determining the size of the left lobe of the liver. The port for the laparoscope is placed slightly to the left of the midline, approximately one handwidth below the xiphoid process. Whenever possible, this port should be created under vision to avoid hepatic injury. The liver retractor is placed in the right mid- to upper abdomen or in the epigastrium. A long needle is introduced into the epigastrium to the right of the midline to locate the optimum site for a dissecting instrument and for optional insertion of the stapler. The site for another dissecting instrument and eventual band insertion is placed in the area of the left costal arch for applying traction to the stomach wall or retracting the greater omentum. After the trocars have been placed, the left lobe of the liver is retracted proximally until the diaphragm can be seen. The band should always be placed at the level of the gastric inlet, never around the esophagus. Three main techniques are available for implanting the band. Perigastric placement following the creation of a retrogastric tunnel has been largely superseded in recent years by the “pars flaccida” technique. A combined technique (pars flaccida + perigastric) has been specially developed for cases in which there is a heavy accumulation of fat about the gastric cardia.
Perigastric Technique

A gastric tube tipped with an inflatable balloon is advanced into the stomach. The balloon is inflated with 15–20 cc of air and withdrawn to the gastroesophageal junction. A window approximately 0.5 cm large is dissected free on the lesser curvature of the stomach at the level of the balloon equator. The dissection proceeds back along the stomach wall to the angle of His, taking care not to open the lesser sac. On the greater curvature side, the left crus of the diaphragm and the gastroesophageal junction are dissected free at the angle of His. The gastrophrenic ligament should not be divided, as the band will be placed within the ligament. The dissector (we prefer the Goldfinger®, Ethicon Johnson & Johnson, Obtech) is passed along the window dissected on the lesser curvature and angled within the gastrophrenic ligament to place it in the angle of His. The gastric band should be introduced into the abdomen only through a 16-mm or 19-mm trocar. Another technique is to pass the band around the gastroesophageal junction with an atraumatic deflectable grasper. Before the band is locked into place, the balloon at the end of the stomach tube is inflated with 15 mL of air. This creates a small gastric pouch, below which the band is fastened with a self-locking mechanism. There is no need to secure the locked band with reinforcing sutures. Slippage is prevented by anchoring the band to the anterior gastric wall with three or four interrupted seromuscular sutures. The end of the tubing is brought out of the body through the 19-mm or 16-mm trocar and connected to the access port, which is secured with four nonabsorbable sutures on or below the anterior rectus sheath at the 19-mm or 16-mm trocar site. Another option is to use a port stapler (Figs. 1a, b).

The access port is fixed to the rectus fascia with nonabsorbable sutures (a) or by using a port stapler (Velocity®) (b).
Pars flaccida Technique

After the surgical site has been visualized, the lesser omentum is opened in the area of the pars flaccida, exposing the right crus of the diaphragm. A tunnel is dissected in the avascular portion of the gastrophrenic ligament in the angle between the diaphragmatic crus and gastroesophageal junction. After the band has been rinsed with saline solution and tested for leaks, it is introduced into the body through a 19-mm or 16-mm trocar. The area above the lesser sac is dissected with atraumatic forceps, and the retrogastric tunnel is developed with an atraumatic articulating instrument, the Goldfinger® (Obtech Medical AG, Baar, Switzerland, and Ethicon Johnson & Johnson) (Fig. 2). In this technique the band system encompasses the fatty tissue on the lesser curvature and the anterior vagus nerve. A 2-0 Ethibond suture on the end of the band system connects it to the Goldfinger® instrument. We recommend fixing the gastric fundus to the left crus of the diaphragm to prevent proximal slippage of the stomach wall or band (Fig. 3). We also place three or four nonabsorbable sutures in the anterior gastric wall to prevent band slippage (Fig. 4).
Combined Technique

The gastric band may be too narrow in patients who have copious fat about the cardia. After the band has been placed by the pars flaccida technique and before it is latched into place, a tunnel is dissected between the stomach wall and fat pad (Fig. 5). The gastric band is pulled through the tunnel with another instrument (dissector or Goldfinger®) and then finally locked close to the stomach wall (Fig. 6). Today the following recommendations can be offered based on developments in surgical technique:

- Reduce the pouch volume to 15 cc.
- Place the band above the lesser sac.
- The pars flaccida technique is preferred.
- Place the band within the gastrophrenic ligament.
- Place sutures in the anterior gastric wall to prevent band slippage.
- Opening the lesser sac places the band so far from the gastroesophageal junction that fixation sutures should additionally be placed in the posterior gastric wall.
- Do not inflate the band during the initial postoperative weeks, as this may cause profuse vomiting, which in turn may dislodge the fixation sutures and cause band slippage.
- If the band is too narrow, use the combined implantation technique.

A tunnel is developed between the stomach wall and fat pad. The band is placed close to the stomach wall using the “combined technique.”
Complications and Their Prevention

Complications are subdivided into perioperative complications and late complications (Table 1). Highest priority is given to the prevention of complications. Reference was made earlier to the importance of thorough training and an interdisciplinary approach to treatment. The “pars flaccida technique” has led to a significant reduction of surgical complications such as band erosion and slippage.

<table>
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<tr>
<th>Complications</th>
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<tr>
<td><strong>Perioperative complications:</strong></td>
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<tr>
<td>Death</td>
<td>0 – 2.1</td>
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<tr>
<td>Stomach wall lesion</td>
<td>0 – 3.5</td>
</tr>
<tr>
<td>Pneumothorax</td>
<td>0 – 0.2</td>
</tr>
<tr>
<td>Bleeding</td>
<td>0.5 – 2.0</td>
</tr>
<tr>
<td><strong>Late complications:</strong></td>
<td></td>
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<tr>
<td>Pouch dilatation with or without band slippage</td>
<td>0 – 13.4</td>
</tr>
<tr>
<td>Band erosion</td>
<td>0 – 4.6</td>
</tr>
<tr>
<td>Complications relating to the access port or band system</td>
<td>0.5 – 10.4</td>
</tr>
<tr>
<td>Wound infection</td>
<td>0 – 7.7</td>
</tr>
<tr>
<td>Motility disorder (clinically apparent)</td>
<td>0 – 1.5</td>
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### Perioperative Complications

#### Mortality

Perioperative deaths have been described in the literature as a result of gastric wall perforation, gastric wall necrosis, cardiogenic shock, and pulmonary embolism. A perioperative mortality rate of 0–0.1% has been reported in large series of patients fitted with an adjustable gastric band.

#### Gastric Wall Lesions

It is relatively easy to injure the gastric wall under conditions where vision is obscured. It is common for surgeons to perforate the stomach wall during the “learning curve” of the first 50 or so operations. The incidence of gastric wall perforations ranges from 0% to 3.5% in the literature. If the perforation site is distal to the gastric band, the affected site can be oversewn and the band reimplanted. A meticulous operating technique with good vision and the use of suitable atraumatic instruments can prevent this dreaded complication. We recommend testing for leaks under difficult viewing conditions by instilling methylene blue through a stomach tube before the band is placed around the gastroesophageal junction (5 mL of methylene blue diluted in 15 mL of saline solution).

#### Other Perioperative Complications

Other complications (bleeding, pneumothorax) like those occurring in conventional obesity surgery have been reported. Published reports indicate that laparoscopic obesity surgery is associated with fewer perioperative complications than conventional bariatric procedures. Effective hemostatic agents such as FloSeal® (Baxter) should always be on hand.
Late Complications

Pouch Dilatation with Gastric-Wall or Band Slippage
Numerous authors have reported pouch dilatation on the posterior gastric wall in the area of the lesser sac. This type of complication has been greatly reduced by placing sutures in the posterior gastric wall or placing the band above the lesser sac and within the gastrophrenic ligament. In a study of 350 patients, O’Brien showed that even when the band was placed in the lesser sac, the incidence of pouch dilatation and band slippage was reduced from 30% to 2.5% when sutures were placed in the posterior gastric wall. Gastric pouch dilatation typically occurs on an average of 8 months after the operation.

Pouch Dilatation without Gastric-Wall or Band Slippage
There have been only a few published reports of pouch dilatation occurring in the absence of gastric-wall or band slippage. It has been suggested that making the pouch too large is responsible for this complication. Desaive published the results of his study on two different perioperative pouch sizes, 15 and 25 cc. The reoperation rate for pouch dilatation was reduced from 33% with the 25-cc pouch to 5.1% with the 15-cc pouch. The perioperative pouch can be measured with a calibration balloon supplied with the band system (BioEnterics Corporation) or a nasogastric tube with a lateral balloon at its tip (Ethicon Endo-Surgery and Obtech AG). The volume of the pouch should never exceed 15 cc.

Pouch dilatation is often characterized by early eating difficulties. Possible causes of the dilatation may include eating past the point of satiety, eating too fast, induced vomiting, or drinking too many carbonated beverages. Chelala showed that vomiting is a frequent cause of pouch dilatation. Thus, it is best to wait several weeks after implantation before the band is tightened any further.

Treatment of Pouch Dilatation and Band Slippage
This complication can be avoided by correct band placement (above the lesser sac) and by perioperative measurement of the gastric pouch. The diagnosis is confirmed by radiographs showing asymmetrical pouch enlargement. Extreme forms lead to complete obstruction corresponding to an “internal” herniation of the stomach wall. These forms require immediate intervention.

When dilatation is detected early, the stoma can be enlarged by band adjustment (removing fluid). This measure can reverse the pouch dilatation in some cases. Alvarez-Cordero successfully treated 3 of 8 dilatations by removing fluid from the band system. If this is unsuccessful, the band should be repositioned.

If the same band cannot be repositioned, the old band can be removed and a new band placed at the correct level. Band repositioning can be successfully performed laparoscopically.
Band Erosion

In cases where the band has eroded into the stomach (Fig. 7), the system should generally be removed. In a series of 500 patients, Dargent reported three cases of band erosion that developed 17, 18, and 21 months after surgery. One patient underwent a two-thirds gastrectomy, and the other two underwent simple laparoscopic band removal. Gastric band erosion is typically manifested either by asymptomatic weight gain or by acid reflux with upper abdominal pain. An analysis of 3800 Lap-Band patients documented an erosion rate of 0.6%. Band erosion may possibly be caused by increased pressure within the band system (overfilling), trauma to the gastric wall during dissection, or by clips or sutures. A definite etiology has not yet been established, however. The gastric band can be removed gastroscopically with a band cutter (A.M.I. GmbH, Feldkirch, Austria) or laparoscopically.

Complications Relating to the Access Port and Tubing System

Nonabsorbable sutures should be used to prevent tilting of the access port. The point where the tubing system exits the abdomen and the port site should be spaced several centimeters apart to prevent kinking of the tubing. Access port infections may be caused by band erosion allowing infectious organisms to spread from the stomach to the port pocket. For this reason, gastroscopy should be performed whenever an access port infection is found. Breaks in aseptic technique during needle insertions have also been postulated as a cause. A leak in the band system is usually manifested by an asymptomatic weight gain. Generally the leak can be detected by the injection of Jopamiro® or Uromiro®. But there are also very small leaks that take several hours or days to become “symptomatic” (i.e., the patient is again able to eat much more food several days after the surgery). A minileak can be demonstrated in these cases by thallium-201 scintigraphy. When a leak is detected, the access port can be replaced under local anesthesia or the entire system can be replaced laparoscopically in patients with a leaky band.

The initial management of access port infections without band erosion consists of removing the port, filling the band system with the last documented fluid volume, sealing the tubing system, and burying the tubing in the peritoneum. Laparoscopy can then be repeated 6–8 weeks later to implant a new access port or band.
Esophageal Mobility Disorders

Greenstein claims that a preexisting hiatal hernia and/or esophageal dysmotility are associated with an increased reoperation rate. Patients with esophageal dysmotility in this study had a reoperation rate of 33%, as did patients with a hiatal hernia. It should be noted, however, that the reoperation rate in his series was 18% and that all revisions were done in the first 30 patients. We have not seen this correlation in our patients. Up to 60% of morbidly obese patients have a clinically silent motility disorder. If a clinically apparent dysmotility occurs after surgery (radiographic and manometric findings as in achalasia), we recommend draining the fluid from the band system or removing the entire band system laparoscopically and proceeding with a different bariatric procedure such as gastric bypass.

Adjuvant Medical Therapy

One option in patients with a defective band system is to administer orlistat (Xenical®, 3 x 120 mg) to prevent weight gain until the band can be revised. We were able to show in a pilot study that patients on orlistat therapy continued to lose weight despite an incompetent band or after the removal of their band.

Summary

Obesity and morbid obesity represent a chronic, multifactorial disease that requires treatment. We believe that laparoscopically implantable and adjustable gastric banding has proven to be an efficient method for the treatment of most morbidly obese patients. It does not require opening the stomach or small intestine, and it preserves the integrity of digestive anatomy and physiology. Patients do not experience long-term metabolic complications. Weight loss and food intake can be tailored to the needs of the individual patient. Eighty percent of patients may expect to lose 50–60% of their excess weight. It is much easier to remove the band and return patients to their original status than with other bariatric procedures. Laparoscopic adjustable gastric banding does involve a difficult learning curve but thereafter is easy to perform and carries relatively little risk when safety recommendations are followed. Unlike many other weight-loss operations, this procedure marks the starting point of treatment. Regular follow-ups and a cooperative patient are essential for a successful outcome.
References


5. FINIGAN KM, MARTIN LF, ROBINSON AF, ROTH N: Improvement In Quality of Life One Year After Gastric Lap-Band®, Obesity Surgery, 1997; 7, 281.


Background

Surgical treatment is the most effective method to induce weight loss in morbidly obese patients (Sjöström et al). Gastric bypass is one of the most well-documented operations in obesity treatment. Mason and Griffen presented this operation already in the 1960s. Since then, and particularly due to the advent of laparoscopic surgery, it has been further developed with the introduction of laparoscopic gastric bypass (Wittgrove et al, Lönroth et al). Gastric bypass is known to yield excellent long-term results regarding weight reduction with only few eating disturbances. However, it is considered a large operation with the potential of severe complications as well as some metabolic disturbances, mainly Vitamin B₁₂ and iron deficiency. The benefits of laparoscopy are undisputed and the procedure has shown to be also effective in the treatment of morbidly obese (Nguyen et al). To date, there are still some differences in performing the gastric bypass procedure, with a multitude of centers employing varying techniques. A few alternative options in the sequential design of the laparoscopic gastric bypass procedure will be discussed below.

Port Sites and Placement of Trocars

To gain access to the abdominal cavity can sometimes be difficult in morbidly obese patients. There are several ways described for access such as open Hasson technique at the umbilicus, use of the Verres needle, trocars with shielded tip, radial expandable trocars, optical trocars etc. According to a recent Cochrane review, however, there is no clear evidence as to which technique is to be preferred from a safety standpoint. Using the Hasson technique through a periumbilical incision can be difficult in patients with a very thick abdominal wall. Sheathed trocars and optical trocars are also reported to be potentially hazardous. As shown in Fig. 1, the suggested port placement involves the surgeon standing on the patient’s right side. If the surgeon uses a French position between the patient’s legs, the left-hand working port may have to be placed in a more lateral position to the right side of the patient. The camera port should be placed no more than a maximum of 20 cm below the xiphoid process and slightly to the left of the midline in order to spare the ligamentum teres. In the majority of obese patients, the optical trocar provides a clear image of the various layers of the abdominal wall allowing for a safe access.

Schematic depiction of port placement in laparoscopic gastric bypass surgery. The camera port is placed above the umbilicus slightly to the left of the ligamentum teres, and no further than 20 cm from the xiphoid process. A liver retractor is placed in the upper midline, close to the xiphoid.
Creation of the Gastric Pouch

In purely restrictive procedures the pouch volume is of outmost importance. An overly large pouch leads to impaired restriction with susceptibility to overeating, impaired emptying of the pouch with retention and vomiting and also an increased tendency to pouch dilatation which can be explained by the elevated tension of the pouch wall due to the oversized diameter of the pouch. In the early days of the gastric bypass procedure, the pouch was created with non-cutting staplers involving the risk of staple-line ruptures and gastro-gastric fistulas. With modern cutting staplers, the risk of fistula formation is low (Fobi 2001). Another problem, that can be seen, is stoma ulceration at the site of the gastro-entero-anastomosis. This, however, is correlated with the existence of parietal cells in the pouch. Thus, patients with stoma ulcers have an increased acid secretion in the pouch as compared to non-ulcer control patients (Hedberg et al 2005).

Therefore, in the preoperative decision-making, the size of the gastric pouch should be determined with the goal of minimizing the risk of pouch dilatation, staple-line dehiscence, reflux esophagitis and marginal ulceration. The creation of a micro-pouch is capable of eliminating these problems without impairing the patient’s ability for reasonable food intake (Table 1) (Sapala et al 2001). On the other hand, pouch size seems to be not as critical in patients undergoing gastric bypass surgery, as compared to purely restrictive banding operations. No clear correlation with regard to pouch volume and postoperative weight loss has been demonstrated so far.

<table>
<thead>
<tr>
<th>Table 1: Micropouch Gastric Bypass</th>
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<td>N = 1120  Low incidence of</td>
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Division of the Omentum

Division of omentum provides an easy access to the ligament of Treitz and also shortens the distance between the proximal jejunum and the gastric pouch when using an antecolic route of the Roux-limb construction. Even though division of the omentum may not always be necessary on a routine basis, it adds very little to the complexity of the operation or OR-time.

Creation of the Gastroenterostoma

There is some controversy about the creation of the stoma between the pouch and the small intestine. Näslund et al. failed to demonstrate any correlation between weight loss and stoma diameter in patients who underwent gastric bypass surgery, while a clear correlation could be established between stoma size and weight loss in the patient group treated by gastric banding. However, the number of patients in this randomized study was small.

Several techniques to create a gastroenterostoma have been described in the literature, including the original circular stapling (Wittgrove et al.), totally hand-sewn anastomosis (Higa et al.) or a combined technique involving linear stapling and anterior running suture of the stoma (Olbers, Lönroth). In an attempt to improve the long-term outcome of the procedure, modified techniques have evolved using banded or silastic ring-banded gastroenterostomas. Arasaki and co-workers discovered, that silastic ring-banded patients with a ring size of 62 mm lost more weight as compared to those with a ring size of 77 mm. However, the follow-up time was short and the patients with the smaller ring size frequently experienced concomitant vomiting. In another study analyzing data of a 48-months follow-up period, the mean weight loss was 77% with a range of 25–123% weight loss (Fobi et al. 1999). This outcome, however, is similar to that reported in most consecutive series published so far, even with stoma sizes excessively larger than 10 mm in diameter (Olbers, Lönroth).
In open surgery, the Roux-limb of the gastric bypass has traditionally been constructed as a retrocolic Roux-en-Y. With the laparoscopic approach this is, however, associated with certain difficulties, such as impaired visibility of the intestinal construction and involves the risk of intestinal obstruction in the passage of the mesocolon (Westling et al 2001). Bowel obstruction can occur in both retro- and antecolic constructions due to internal herniations. Closure of spaces underneath the small intestine is therefore advisable, although the incidence rate of this problem may be low, even in series where spaces underneath the Roux-en-Y limb and the end-to-end anastomosis have been left open. Cho et al. reported about a series of 1,400 patients with the incidence of internal hernias being as low as 3 patients (0.2%) (Cho et al 2006).

As depicted in Figs. 2–7, the small intestine is placed in an antecolic antegastric position and the gastro-entero-anastomosis is accomplished using a linear stapler with blue cartridge. The anterior opening is then closed with a running suture using a stay suture at the opposite side. The proximal biliopancreatic limb of the jejunum is made only long enough to reach up to the pouch. The next step is to construct an omega-loop where the entero-entero-anastomosis is fashioned in a similar way, using a posterior linear stapler with white cartridge, and placing an anterior running suture with stay suture on the opposite lateral end of the opening. To avoid the risk of bile reflux, the jejunum is then divided between the entero-entero anastomosis and the gastro-entero-anastomosis. Accordingly, the final construction will be an antecolic antegastric Roux-en-Y.
The gastro-entero-anastomosis is here constructed by posterior stapling and placement of an anterior running suture, which can be made in a single-layer fashion with sero-muscular sutures in the intestine and full thickness suture of the stomach wall.

The jejunum is divided between the two anastomotic constructions to prevent bile reflux.

Construction of the entero-entero-anastomosis with side-to-side posterior stapling and placement of an anterior running suture.

Final situation after completion of the antecolic antegastric Roux-en-Y gastric bypass with creation of a minipouch.
Controversies

The length of the different intestinal limbs in the Roux-en-Y construction is frequently under debate. A short biliopancreatic limb may reduce the risk of internal herniation underneath the Roux-limb, while a very long biliopancreatic limb may add a malabsorptive component to the gastric bypass. Various lengths of the Roux-limb have been tested, but the outcome is still unclear (Tables 2a, b). In general, most Roux-limbs are made 70 cm or longer. A longer Roux-limb does not guarantee a better outcome as far as weight loss is concerned.

Different types of staple-line reinforcement have been tested for their efficiency to reduce the risk of anastomotic leakage or bleeding. According to data published in the medical literature so far, no evidence could be provided supporting the use of these sometimes costly materials. With rates of leakage or bleeding ranging below 1%, the clinical benefit of staple line reinforcement could not be conclusively demonstrated. A study by Nguyen (Nguyen 2005) reported about a significant reduction in the number of bleeding sites along those staple lines, that were reinforced using buttressing material (Seemgard®). To date, however, it has not been demonstrated whether this has any clinical impact on the postoperative bleeding frequency.

Fibrin glue is also tested for its potential to reduce the incidence of complications, such as leaks, bleedings but also bowel obstruction. Silecchia and co-workers (Silecchia 2006) found that the total number of complications in the group treated with fibrin glue (Tissucol®) was reduced while the total number of each defined complication such as anastomotic leakage, bleeding or internal herniation with bowel obstruction was low. The average leakage rate published in more than 30 different reports, have been found to be less than 3% without the extra use of any leak-preventing materials (Baker 2004).

Prevention of leaks is best done by intraoperative leak testing with either methylene blue or air bubbling. This should be done as a matter of routine during all operations. Postoperative X-ray with gastrographine contrast may also be of value, although it is not 100% sensitive.

Postoperative intestinal obstruction can be caused by stenosis of the gastro-enteroanastomosis or entero-entero-anastomosis. Internal herniation, either behind the entero-entero-anastomosis or behind the Roux-limb, may also occur as a result of intestinal obstruction involving the risk of strangulation. This condition can be hard to diagnose while patients can have severe pain, but without signs of peritonitis and even negative findings in CT-scanning. Among the prophylactic measures that may be taken to prevent the occurrence of this complication, closure of internal hernias during the primary operation is generally recommended as well as timely intervention by diagnostic laparoscopy in patients with acute abdominal pain of unclear etiology. Patients with intestinal obstructions as well as peritonitis with intestinal paralysis may also need a gastrostomy to relieve the dilatation of the gastric remnant.

The rate of complications is related to the experience of the surgeon and the number of patients operated on per year at the institution. In high volume centers, the gastric bypass procedure is a well-documented and well-functioning weight-reducing operation, that can be suggested to most patients who are in need of surgical treatment.

<table>
<thead>
<tr>
<th>Table 2a: Roux-en-Y Gastric Bypass: Short Limb vs Long Limb</th>
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<tr>
<td>Choban 2002</td>
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<tr>
<td>Brolin 1992</td>
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<tr>
<td>A</td>
</tr>
<tr>
<td>Length of Limb (cm)</td>
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<td>EWL% (per year) *</td>
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<tr>
<th>Table 2b: Length of the Roux-limb (BMI &lt; 50)</th>
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<tr>
<td>Inabnet 2005</td>
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<tr>
<td>N</td>
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<tr>
<td>Length of Limb (cm)</td>
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*) Excess Weight Loss
Acknowledgement

Figs. 1 – 7 published with permission of Johnson & Johnson, Sweden.

References


Introduction

Obesity, once considered an “aristocratic” symbol of affluence, has now assumed the character of a life-threatening disease. It has become a serious epidemiologic health issue (Table 1) that is causing enormous psychosocial and economic problems in our consumer society.

While the growing problems of obesity have been well documented and explained in western history and their conservative treatment options are widely known, it is only in recent years that physicians have made significant progress toward mastering the challenging problem of bariatric surgery (obesity surgery, weight-loss surgery).

This challenge is compounded by the fact that morbid obesity is usually associated with intractable comorbid conditions. When we look at the numerous obesity-related diseases listed in the guidelines of the German Obesity Society, the German Diabetes Association, and the German Society for Nutrition (Table 2), we can appreciate the great complexity of the obesity problem. This problem has assumed truly alarming proportions, as evidenced by the fact that type 2 diabetes mellitus, once rare in children and adolescents, is now frequently diagnosed and treated in this age group.

Unfortunately, the conservative management of morbid obesity tends to yield poor long-term results. Everyone is familiar with the “yo-yo” effect in which an obese patient loses weight initially while dieting but then quickly regains the lost pounds. Postoperative results have confirmed that bariatric surgery can break this vicious cycle and restore the overweight patient to a healthy, normal-weight life. A striking benefit of bariatric surgery is that it not only rids patients of excess pounds but also frees them from obesity-related diseases. For example, we have seen many cases in which obese diabetics no longer needed antidiabetic medication (including insulin) after their operation. The metabolic syndrome can be successfully treated by bariatric surgery.

Table 1:
Epidemiology of obesity in Germany. Distribution by Body Mass Index (BMI).
(From “BDA Obesity Manual”, published by the Professional Society of General Practitioners in Germany (BDA), www.ifap.de).
Table 2: Comorbid conditions and complications of overweight/obesity

- Abnormalities of carbohydrate metabolism (e.g., insulin resistance, impaired glucose tolerance, type 2 diabetes mellitus) (Colditz et al. 1995, Chan et al. 1994)
- Other metabolic disorders (e.g., dyslipidemia, hyperuricemia, impaired hemostasis)
- Arterial hypertension
- Cardiovascular diseases (e.g., coronary heart disease, stroke, heart failure)
- Cancer (e.g., endometrium, cervix, ovaries, breast, prostate, kidney, colon)
- Hormonal disorders (e.g., hyperandrogenemia, polycystic ovary syndrome, low testosterone levels in males)
- Pulmonary complications (e.g., dyspnea, hypoventilation and sleep apnea syndrome)
- Gastrointestinal diseases (e.g., cholecystolithiasis, acute and chronic cholecystitis, nonalcoholic steatohepatitis, reflux disease)
- Degenerative diseases of the musculoskeletal system (e.g., osteoarthritis, spinal syndromes)
- Increased surgical and anesthesia risk
- Physical complaints (e.g., hyperhydrosis, joint pain, exertional dyspnea)
- Psychosocial complaints including proneness to depression and anxiety, social discrimination, and low self-esteem
- Impaired activities of daily living (ADLs)

Biliopancreatic Diversion and Type 2 Diabetes in Patients with a BMI < 35 kg/m²

The patients with type 2 diabetes mellitus studied by Scopinaro no longer required insulin after biliopancreatic diversion. This pioneer of obesity surgery and author of the surgical procedure named after him generally prefers a relatively “aggressive” approach that is ordinarily used only in extremely obese patients. The goal is to correct the diabetic metabolic disorder, and the results reported by Scopinaro show that this can be accomplished by surgical means.

This chapter reviews the three standard procedures used in bariatric surgery – adjustable gastric banding, sleeve gastrectomy, and the Roux-en-Y gastric bypass. All of these procedures are performed laparoscopically at the surgical unit of the Protestant Hospital in Herne, Germany.

A detailed analysis of issues relating to bariatric surgery, such as the description of postoperative complications, is beyond the scope of this chapter.
Laparoscopic Adjustable Gastric Banding (LAGB)

One of the fastest-growing forms of bariatric surgery is the laparoscopic implantation of an adjustable gastric band (Lap-Band®). This procedure has been performed “officially” in the United States since it received FDA approval in June of 2001, and it has been practiced in Europe and Australia since 1993.

Adjustable gastric banding was performed in more than 200,000 patients throughout the world from June, 2006, through 2008. The goal of this procedure is to achieve long-term weight reduction in severely obese patients.

Whenever patients consider a bariatric surgical procedure, they should first gather information on the various aspects of the surgery and on available techniques. In the course of the doctor-patient consultation, the attending surgeon can give the patient valuable information that may be of significant help in the decision-making process.

Laparoscopic adjustable gastric banding (often referred to as the Lap-Band®) employs an adjustable silicone band that is placed around the upper part of the stomach. The hollow interior of the band can be filled with a variable amount of saline solution, enabling the surgeon to adjust the size of the stoma outlet as desired.

Tightening the gastric band creates a small upper pouch at the top of the stomach. Since the pouch has a capacity of only about 25–30 mL, it fills quickly during food ingestion and signals the brain that the stomach is full. This early feeling of satiety helps the patient to achieve gradual yet constant and sustainable weight loss.

Theory and Practice

Gastric banding is a drastic step for overweight patients. It is associated with the same risks as all major surgical procedures on the gastrointestinal tract.

Weight reduction by this purely restrictive procedure ranges from a few kilograms to several kilograms, but generally less weight is lost than with a combined restrictive and malabsorptive procedure such as the Roux-en-Y gastric bypass (LGBRY), biliopancreatic diversion (BPD), or duodenal switch (BPS-DS).

Some patients achieve a normal body weight while others remain obese, though less so than before gastric banding. A major factor in achieving the desired weight reduction is active, consistent cooperation from the patient, who must adhere rigorously to postoperative guidelines on dietary modification and exercise. Genetic predisposition is another factor that should be considered in patient selection. Experience has shown that “big eaters” without a genetic predisposition are good candidates for gastric banding.

The gastric band is filled or emptied with a special transdermal needle placed through a small access port that is secured in an epifascial tunnel in the upper left quadrant of the abdomen. The band creates an adjustable stoma between the upper pouch and lower stomach, which in turn produces the desired reduction of food intake capacity. Several adjustable gastric bands are available on the market. The fill volume varies considerably in different bands, depending on the manufacturer.
If the band needs adjusting but the type of band is unknown, the best solution is to empty all the fluid, refill the band, and check for stoma patency by having the patient drink water. If the patient is unable to swallow, remove some of the fluid through the port and check again. If necessary the band can be filled with contrast medium instead of isotonic saline to permit a more detailed evaluation of band position.

A simple, informative description of the adjustable gastric band can be found at the following website:
http://www.lapband.com/local/media/videos/emmi.swf

This website presents a series of images that illustrate the laparoscopic placement of an adjustable gastric band.

**Five trocars are placed initially:**

- One 11-mm primary trocar for the laparoscope, placed at a left paramedian site above and close to the umbilicus.
- Two 11-mm or 13-mm working trocars, placed at least 15 cm apart just to the right of the xiphoid process and in the upper left quadrant near the costal arch.
- One 11-mm or 6-mm trocar in the right midabdomen for the liver retractor.
- One 13-mm trocar (expandable to 20 mm) in the right midabdomen.

The operation begins with local skeletonization of the lesser curvature just below the level of the second vascular arcade. Skeletonization is continued along the lesser curvature toward the esophagus until the omental bursa is opened. Skeletonization along the greater curvature is performed close to the hiatus and continues to the omental bursa.

The upper portion of the stomach has been skeletonized, and the bursa omentalis can be seen.

A retrieval tool with distal eyelet is tunneled beneath the gastric inlet.

The Lap-Band® is introduced into the abdominal cavity.

The end of the Lap-Band® tubing is threaded through the eyelet of the retrieval tool...

...and pulled through the retrogastric tunnel toward the lesser curvature.
The Lap-Band® is passed around the gastric inlet...

...and tightened with the closure tool.

The buckle of the Lap-Band® is locked into place.

The Lap-Band® is correctly positioned around the gastric inlet.

The Lap-Band® is fixed to the anterior stomach wall with interrupted seromuscular sutures.
The free end of the tubing is brought out of the abdominal cavity through the working trocar.

The free end of the tubing is passed behind the stomach and connected to the Lap-Band® access port, which is secured mechanically or manually in an epifascial tunnel in the upper left quadrant of the abdomen. The trocars are removed from the abdominal cavity under laparoscopic vision, and the pneumoperitoneum is released. The trocar incisions are closed with absorbable sutures.

**Laparoscopic Gastric Bypass with Roux-en-Y Limb (LGBRY)**

As early as 1991, the National Institutes of Health (NIH) held a consensus meeting with the goal of establishing mandatory guidelines and indications for the surgical treatment of morbid obesity. According to these guidelines, candidates for bariatric surgery should meet one of the following criteria:

1. A BMI of 40 or higher,
   or
2. A BMI of 35 or higher plus one or more comorbid conditions.

The consensus conference also emphasized the need for interdisciplinary cooperation in the care of bariatric surgical patients by a team of doctors and therapists in a comprehensive program that would address the multifactorial aspects of the disease in treatment and follow-up: comorbidity, diet, exercise, behavior, and psychological aspects.

The selected bariatric procedure is basically considered a “tool” for helping overweight patients change their lifestyle and eating habits and achieve effective, sustainable obesity management and personal behavior modification.
Additional conclusions:

- Bariatric surgery is currently the most effective method for the treatment of morbid obesity.
- Gastric bypass is one of the four main surgical options (along with biliopancreatic diversion, duodenal switch, and gastric banding) for the treatment of morbid obesity.
- Laparoscopic surgery is as safe and effective as conventional open surgery.
- Patients should undergo a comprehensive preoperative diagnostic workup and counseling and, as mentioned, should receive multidisciplinary care to achieve optimum results.

Gastric bypass is a restrictive and malabsorptive bariatric procedure in which a small pouch is created from the upper portion of the stomach while the much larger, lower portion of the stomach is isolated. The small intestine is divided, and gastrointestinal continuity is restored by a Roux-en-Y gastroenterostomy. Gastric bypass is performed laparoscopically throughout the world, and a great variety of techniques have been developed.

This operation generally results in a dramatic degree of weight loss, leading to a marked regression or even resolution of numerous comorbid conditions. It is not unusual for insulin-dependent diabetics to discontinue their antidiabetic medication, giving rise to the term “metabolic surgery” for bariatric operations. It has also been shown that long-term mortality is reduced by up to 40% in gastric bypass patients. It should be added, however, that 2% of the complications that arise during the initial postoperative months have a fatal outcome.

The following series of images illustrate the steps involved in a laparoscopic Roux-en-Y gastric bypass.

Five trocars are placed initially:

- One 11-mm primary trocar for the laparoscope, placed at a left paramedian site above and close to the umbilicus.
- Two 11-mm or 13-mm working trocars, placed at least 15 cm apart just to the right of the xiphoid process and in the upper left quadrant near the costal arch.
- One 11-mm or 6-mm trocar in the right midabdomen for the liver retractor.
- One 13-mm trocar (expandable to 20 mm) in the right midabdomen.
Trocar sites for laparoscopic Roux-en-Y gastric bypass:
- One 11-mm primary trocar placed at a left paramedian site above and close to the umbilicus.
- Two 13-mm working trocars, placed at least 15 cm apart just to the right of the xiphoid process and in the upper left quadrant near the costal arch.
- One 11-mm or 6-mm trocar in the right midabdomen for the liver retractor.
- One 13-mm trocar in the right midabdomen.
- Two 6-mm trocars, one in the left mid/lower abdomen just below the umbilical fossa and the other at an approximately symmetrical site on the right side.

A swath is dissected through to the greater omentum to the transverse colon.

The ligament of Treitz is located and identified.

Starting at the ligament of Treitz, a 75-cm length of small intestine is measured off (in 5-cm increments) in a counterclockwise direction.

The loop of jejunum is brought up to the stomach...

…and fixed there with a simple interrupted suture.
Another 150 cm of bowel is measured off (in 5-cm increments) in a clockwise direction.

Lateral upward traction is placed on the bowel loop.

That loop is brought up to the stomach and fixed to the previously transposed jejunum with a simple interrupted suture.

The jejunal limb is opened with an ultrasound dissector.

The linear stapler is introduced through an incision in the small bowel wall...

...and fired to create the jejunojejunal anastomosis.
The liver retractor provides access to the lesser curvature.

The afferent limb of jejunum is divided with the linear stapler just past the jejunojejunal anastomosis.

The resulting defect is closed with a running suture.

The liver retractor provides access to the lesser curvature.
The lesser curvature is skeletonized at the approximate level of the second to third vascular arcade, opening the omental bursa.

The 45-mm linear stapler is introduced transversely and fired.

The gastric pouch is divided superiorly with the roticulator.
Bariatric Surgery

The jejunum and gastric stump are opened on the lesser curvature side with the ultrasound dissector.

The divided afferent limb of jejunum is brought up and sutured to the gastric stump.
The gastroenterostomy (GE) is created with the 45-mm linear stapler.

The gastric tube is advanced into the jejunum under vision.

The defect at the GE is closed with sutures (and tested for leaks).

Laparoscopic Roux-en-Y Gastric Bypass
The Jejunojejunal Anastomosis

The limbs of jejunum are tacked together with a simple interrupted suture, which is retracted upward and to the right.

The jejunal limbs are incised with the ultrasound dissector.

The 45-mm linear stapler is introduced through the incision in the small bowel wall.
The efferent limb of jejunum is dissected free just past the jejunojejunal anastomosis (toward the stomach) and transected with the linear stapler.

The lesser curvature of the stomach is skeletonized at the approximate level of the second to third vascular arcade, opening the omental bursa.

The 45-mm linear stapler is introduced transversely and fired.

The gastric pouch is divided superiorly with the roticulator.

Small remaining tissue bridges are secured with clips.

The defect at the GE is closed with sutures (and tested for leaks).
Laparoscopic Roux-en-Y Gastric Bypass
Steps from Identifying the Ligament of Treitz to Division of the Stomach

Starting at the ligament of Treitz, a 75-cm length of small intestine is measured off (in 5-cm increments) in a counterclockwise direction.

1. The loop of jejunum is brought up to the stomach...

2. ...and fixed there with a simple interrupted suture.

3. Another 150 cm of bowel is measured off (in 5-cm increments) in a clockwise direction.

4. That loop is brought up to the stomach and fixed to the previously transposed jejunum with a simple interrupted suture...

5. ...which is retracted upward and to the right.
The resulting defect is closed with a running suture.

The liver retractor provides access to the lesser curvature.

The lesser curvature is skeletonized at the approximate level of the second to third vascular arcade, opening the omental bursa. The 45-mm linear stapler is introduced transversely and fired.

The jejunal limbs are incised with the ultrasound dissector.

The linear stapler is inserted through the incision in the small bowel wall and fired to make the jejunojejunal anastomosis.

The afferent limb of jejunum is divided with the linear stapler just past the jejunojejunal anastomosis (toward the stomach).

Small remaining tissue bridges are secured with clips.

The gastric pouch is divided superiorly with the roticulator.

The liver retractor provides access to the lesser curvature.

The linear stapler is inserted through the incision in the small bowel wall and fired to make the jejunojejunal anastomosis.
Laparoscopic Roux-en-Y Gastric Bypass with an Intragastric Balloon

Laparoscopic view of the intragastric balloon, which is pierced with a needle tip and removed gastroscopically by the internist during the operation.

The defect left by creation of the stapled jejunojejunal anastomosis is closed with a running suture.

Dissection and transection of the jejunal limb, which is brought upward to the stomach for creating the gastroenterostomy (GE).
The lesser curvature is dissected and skeletonized at the approximate level of the second to third vascular arcade.

The stomach is divided transversely on the lesser curvature side with the 45-mm linear stapler.

The pouch is created by progressively dividing the stomach up to the esophagus with the 65-mm linear stapler.

The jejunal limb of the GE is sutured to the gastric stump.
The jejunal limb and gastric stump are incised, and the 45-mm linear stapler is introduced and fired to create the gastroenterostomy.

The defect at the GE is closed with sutures (and tested for leaks).
Laparoscopic Roux-en-Y Gastric Bypass

1. Typical appearance of a fatty liver in an overweight patient (nonalcoholic steatohepatitis, NASH).

2. A tunnel is developed by dissecting through the greater omentum to the transverse colon.

3. The ligament of Treitz is located and identified.

4. Starting at the ligament of Treitz, a 75-cm length of small intestine is measured off (in 5-cm increments) in a counterclockwise direction.

5. The loop of jejunum is brought up to the stomach and fixed there with a simple interrupted suture. The efferent limb of jejunum can be marked by leaving the suture long.

6. Another 150 cm of bowel is measured off (in 5-cm increments) in a clockwise direction.

7. That loop is brought up to the stomach and fixed to the previously transposed jejunum with a simple interrupted suture.

8. The jejunal limbs are incised with an ultrasound dissector.
The jejunal limb to the stomach is divided with the linear stapler just past the jejunojejunal anastomosis. ...and fired to make the jejunojejunal anastomosis. The resulting defect is closed with a running suture.

Any defects in the serosa are repaired with interrupted seroserous sutures.

The jejunal limb to the stomach is divided with the linear stapler just past the jejunojejunal anastomosis.

The lesser curvature is skeletonized at the approximate level of the second to third vascular arcade, opening the omental bursa.
The last connection between the upper pouch and gastric fundus is undermined and divided.

The detached afferent limb of jejunum is brought up and sutured to the gastric stump. The gastric stump... ...and jejunum are incised on the lesser curvature side with the ultrasound dissector.

The GE is created with the 45-mm linear stapler. The gastric tube is advanced into the jejunum from the gastric stump.

The defect at the GE is closed with sutures (and tested for leaks).
Laparoscopic Sleeve Gastrectomy

Sleeve gastrectomy is an irreversible, restrictive bariatric procedure in which approximately 85% of the stomach is removed laparoscopically on the greater curvature side, leaving a banana-shaped gastric sleeve of greatly reduced capacity. Laparoscopic sleeve gastrectomy is generally performed in extremely overweight patients in an initial sitting in cases where other restrictive or malabsorptive bariatric procedures (e.g., gastric bypass, biliopancreatic diversion, etc.) are deemed too risky. The procedure may then be converted to a gastric bypass, for example, in a later sitting.

The sleeve gastrectomy alone may be an adequate, relatively low-risk bariatric procedure for patients who are obese but not extremely obese. Some surgeons even prefer it over gastric banding.

The following series of images illustrate the steps involved in a laparoscopic sleeve gastrectomy.

Trocar sites for laparoscopic sleeve gastrectomy:
- One 11-mm primary trocar placed at a left paramedian site above and close to the umbilicus.
- Two 13-mm working trocars, placed at least 15 cm apart just to the right of the xiphoid process and in the upper left quadrant near the costal arch.
- One 11-mm or 5-mm trocar in the right midabdomen for the liver retractor.
- One 13-mm trocar in the right midabdomen.

The operation begins with distal skeletonization along the greater curvature of the stomach.

Skeletonization of the greater curvature is continued toward the esophagus.

Retrogastric skeletonization.

Skeletonization of the greater curvature is continued toward the esophagus.
The greater curvature has been completely skeletonized.

A large-caliber gastric tube is passed into the dissected stomach and placed along the lesser curvature.

The sleeve gastrectomy is begun by placing a 45-mm linear stapler across the distal greater curvature (junction of middle and distal antrum). Another option is to use a 60-mm linear stapler placed close to the esophagus and parallel to the intragastric tube.

Remaining retrogastric adhesions are cleared until the posterior surface of the stomach wall has been dissected free.

Skeletonization of the greater curvature is continued toward the esophagus.
The sleeve gastrectomy is complete except for a narrow tissue bridge.

Thin remaining bridges of stomach wall can be clipped and divided.

The specimen has been completely detached.

If necessary, bleeding sites are oversewn with interrupted seroserous sutures.
The staple line is tested for leaks with methylene blue.

The 13-mm working trocar in the upper left quadrant is replaced with a 20-mm trocar.

The specimen is extracted from the abdominal cavity.

**Concluding Remarks**

A number of surgical solutions have been developed to solve the challenging problem of weight reduction in morbid obesity. Several studies have shown that, as a general rule, the malabsorptive procedures appear to be more effective despite their higher risks.

It is important to consider that weight reduction by bariatric surgery can also reverse the comorbid conditions that are associated with obesity, leading to a significant decline in overall mortality.

Despite the potential for postoperative complications, which require complex management in specially equipped intensive care units, bariatric surgery still offers the only hope for a definitive cure in morbidly obese patients.
Laparoscopic Sleeve Gastrectomy

Raul J. Rosenthal, M.D., FACS
Section Head of Minimally Invasive Surgery and Medical Director of the Bariatric and Metabolic Institute, Cleveland Clinic, Weston, Florida, U.S.A.
Introduction

Surgery is the most effective treatment for weight loss and improvement in some comorbid conditions in patients with morbid obesity. Currently, laparoscopic Roux-en-Y gastric bypass (LRYGBP) and laparoscopic adjustable gastric banding (LAGB) are the most commonly performed bariatric procedures in the United States. The addition of laparoscopic sleeve gastrectomy (LSG) as an alternative surgical option for morbid obesity has occurred only over the last few years.

History of Sleeve Gastrectomy

Sleeve gastrectomy (SG) was first described in 1988 when Scopinaro’s technique of biliopancreatic diversion (BPD) with distal gastrectomy and gastroileostomy was modified by Hess and simultaneously by Marceau. The BPD-duodenal switch (BPD-DS) combines a vertical SG with a gastric volume of approximately 100 to 150 mls and a duodenal switch with a common channel of 100 cm and an alimentary limb of 150 cm. The SG performed the restrictive component of the procedure replacing the need for a distal gastrectomy. This technique resulted in greater weight loss with reduced morbidity seen compared to the original Scopinaro procedure including reduction in ulcerogenicity and malabsorption with hypoproteinaemia, hypocalcaemia, and the dumping syndrome. The first part of the duodenum, pylorus, antrum, lesser curvature, and vagal nerve integrity are maintained creating moderate restriction while allowing a relatively normal eating behaviour. The BPD-DS is effective at providing and maintaining excess weight loss (EWL) in the long term. Hess et al. have reported maintenance of greater than 50% EWL in 94% of 182 patients who underwent BPD-DS with long term follow up of more than 10 years, and greater than 80% EWL in 52% of patients. With advances in minimally invasive surgery, Gagner described the first laparoscopic BPD-DS in 1999.

Due to its acceptably low complication rate and relative ease of technical performance, SG was subsequently recommended as an initial step in the management of super-obese patients or those with a high operative risk due to extensive comorbid conditions to minimize the associated morbidity and mortality. A more definitive procedure would be deferred to a later date following an initial weight loss. Regan et al. described a two stage procedure in super-super obese patients who underwent LSG as a first-stage procedure followed by LRYGB as a second-stage for more definitive treatment of obesity. Their initial experience suggested that the two stage approach was feasible, and effective in the short term in achieving significant average excess weight loss of 51 kg in 6 patients with an initial body mass index (BMI) of 58–71 kg/m². The average excess weight loss was 37 kg following LSG over an 11-months period between procedures. Cottam et al. recently published their initial experience on 126 patients with a mean BMI of 65 kg/m² (range 45–91) who underwent a two stage approach. Laparoscopic SG was performed as the first stage, followed by LRYGB after significant weight loss and reduction in co-morbidities. One patient died, and major complications occurred in 13%. The mean excess weight after LSG at 1 year was 46%. Thirty-six patients with a mean BMI of 49 kg/m² went on to have the second-stage LRYGB.

As experience with the technique increased the role of LSG evolved and many began to consider it as a primary restrictive bariatric procedure. Early reports of prospective and retrospective studies were encouraging. Mognol et al. reported their initial experience of 10 patients with a mean BMI of 64 kg/m² (range 61–80) who underwent LSG. The mean operative time was 2 hours (range 1.5–2.5), all procedures were completed laparoscopically, and there were no postoperative complications or mortality. At 1 year the average EWL was 51%. A further retrospective analysis of 60 patients who underwent LSG demonstrated an EWL of 83% at 1 year with a median weight loss of 25 kg. More importantly, there was a significant improvement in comorbid conditions including diabetes, hypertension, dyslipidemia, and joint pain. Schauer et al. recommend a SG or LAGB with an interval LRYGB, if weight loss does not continue to achieve a BMI <35 kg/m².
Operating room setup.

Preparation for surgery. The costal margin and sites of port placement are marked out with a skin pencil.

**Technique**

We use a 7-trocar technique for LSG with identical port placement to our LRYGB procedure. After induction of anesthesia and endotracheal intubation, the abdominal cavity is accessed through a 1-cm supraumbilical incision using a bladeless trocar (Figs. 1–3).

The abdominal cavity is insufflated with carbon dioxide to a pressure of 15 mmHg. The operating ports are inserted under direct vision. The liver is retracted cranially, and the gastroesophageal (GE) junction is exposed (Fig. 4).

A point on the greater curvature, approximately 6 cm proximal to the pylorus, is identified as the distal extent of the resection (Figs. 5, 6).

Start point on the greater curvature 6 cm from pylorus.

Pylorus identification.

Gastroesophageal (GE) junction is exposed.
The ultrasonic scalpel is used to divide the vessels along the greater curvature up to the angle of His (Figs. 7, 8).

A 48–52 Fr bougie is inserted transorally to the level of the distal stomach. Linear cutting staplers are used to vertically transect the stomach creating a narrow gastric tube with an estimated capacity of 150 mls (Figs. 10, 11).

The staple line is then oversewn with a running 2/0 silk suture. The resected stomach is placed in a specimen bag and extracted (Figs. 12–15).

All patients have a routine gastrografin swallow study on postoperative day 1 and are commenced on oral fluids, if normal.
Results

In our center, we have performed 105 LSG as a one-stage restrictive procedure for weight loss. The majority, n=92 were performed as primary procedures. Thirteen patients underwent LSG as a secondary procedure after failed LAGB (n=11), previous jejunoileal bypass with weight regain (n=2), or a failed LRYGB (n=1). We recently published our initial experience with LSG as a primary procedure for weight loss. A retrospective analysis of 30 patients who underwent LSG between November 2004 and March 2006, who had completed a minimum of 6 months follow up, demonstrated a mean weight loss of 22.6 kg and 30.5 kg at 3 and 6 months respectively. The mean EWL was 41% and 53% at 3 and 6 months respectively. The mean operative time was 80 min (range 65–130), and all procedures were completed laparoscopically. The mean hospital stay was 3.2 days (range 2–25). One patient required a second laparoscopy on postoperative day 1 for management of a leak from the staple line close to the GE junction detected on the gastrografin study. Three patients required readmission for mild dehydration.

Conclusion

Laparoscopic SG is an effective primary restrictive procedure to achieve weight loss. It is a relatively straightforward procedure that can be performed laparoscopically with an extremely low conversion rate. Operative time is reasonable ranging from 1 to 2 hours. Our mean operative time for LSG was 80 min. Meticulous attention to oversewing the staple line was the main factor contributing to our extended operative time, but we feel this time is well spent to achieve haemostasis, and prevent a leak which could result in significant morbidity. Laparoscopic SG is technically feasible in high-risk patients with significant morbidity, and also in very obese patients with BMI > 70 kg/m². As our experience with LSG is expanding, we are attempting to identify definitive indications for LSG in our patient population. Currently, we perform LSG in very high-risk patients with significant comorbidity, patients aged >70 years with significant comorbidity, low BMI 35–40 with comorbidity, or according to patient preference. We do not perform LSG as a staged procedure. We offer LRYGB, LSG and LAGB to all patients, but recommend LRYGB as the procedure of choice in patients with a BMI >50 kg/m² with comorbidity.

In conclusion, LSG can be performed with minor complications and low mortality. It has been demonstrated to be a safe and effective procedure in the short term. Prospective studies are required after LSG to determine the long-term outcome, and efficacy of maintenance of weight loss and resolution of comorbid conditions.
References


Introduction

Sleeve gastrectomy is a bariatric technique which converts the stomach into a (sleeve-shaped) narrow tube along the lesser curvature of the stomach and involves the dissection of the gastric remnant. The procedure is technically feasible and reproducible, however it can be fraught with difficulties in cases of extreme obesity, central obesity and in the presence of a large left hepatic lobe. It is associated with a reduced risk of major complications as compared to a gastric bypass or any other malabsorptive procedure, due to the fact that no anastomosis or manipulation of the inframesocolic compartment is necessary. Still, the procedure has an overall postoperative mortality of 0.5% and a long-term revision rate of 4.4%.

The reduction in ghrelin associated with extensive resection of the gastric fundus may explain the better results in comparison with other restrictive techniques (vertical gastroplasty and gastric banding). The mean rates of excess weight loss (EWL) are 49% after 6 months, 56% after one year and 66% after three years but are much higher in patients with a body mass index (BMI) of between 35 and 45 (Table 1). Most of the comorbidities associated with obesity, such as hypertension, dyslipidemia or diabetes mellitus, improve and are cured in 60–100% of cases. Laparoscopic sleeve gastrectomy has a low incidence of complications, revisions and mortality, although it is crucial that long-term studies (> 5 years) must be obtained to determine the efficacy of the procedure in terms of long-term maintenance of excess weight loss.

<table>
<thead>
<tr>
<th>Authors</th>
<th>Number of cases</th>
<th>Preoperative BMI (%)</th>
<th>Follow-up (months)</th>
<th>EWL* (%)</th>
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<td>40</td>
<td>39</td>
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* Excess Weight Loss

Patient Selection and Indications

- As first-line surgical treatment modality in super-obese patients (BMI > 50) or those with significant risk factors, and as part of a staged strategy of treatment, after initial weight loss and regression of obesity-related comorbidities: with duodenal switch or bypass surgery (two-stage surgery).
- As a last-resort technique in patients with severe hepatopathy, AIDS, transplants, intestinal inflammatory disease, of over 65 years of age and in patients with pathologies or history of gastric tumors who require regular endoscopic checks. Also in the presence of adverse intraoperative circumstances such as intolerance of pneumoperitoneum, hemodynamic instability, etc. calling for a reduced duration of surgery and/or a less complicated technique.
- As revision surgery after failure of a gastric banding procedure.
- Selectively in young patients or those with a BMI < 45 who do not accept the consequences of another type of bariatric surgery and who are willing to give their explicit informed consent for the implementation of this surgical treatment option without long-term scientific evidence for the efficacy of the technique.
Surgical Technique

**Patient positioning:** in French (reverse Trendelenburg) position, with the operating surgeon between the patient’s legs and the video monitor at the patient’s head (Figs. 1a–c).

**Trocar ports:** 5 trocars, sized 11–13 mm (one of 15 mm, if green loads are used). The camera port (T1) (30°-laparoscope with coupled videocamera) is placed along the midline, at approximately 15 cm from the xiphoid. An auxiliary left subcostal port (T4) and two pararectal operating ports (T2, T3) of 11–13 mm in diameter, unless (green) loads of 4.5-mm staples (16 mm) are used (Fig. 2). The last trocar for liver retraction is usually placed in the subxiphoid area (T5), however, as an alternative option, it may also be in the right subcostal area, and 6 or 11 mm in diameter, depending on the size of the retractor to be used (Fig. 1c).

**Instrumentation and Accessories:**
1. 30°-laparoscope, diameter 10 mm, length 31 cm.
2. Four blunt-tipped trocars sized 11–13 mm, one of them used for the camera, and one or two 16-mm trocars for the stapler, if green cartridges with 4.5-mm staples are applied.
3. Linear endostapler with loads of 45/60 mm in length and staples sized 3.5 mm (blue), and of larger diameter, 3.8 mm (gold) or 4.5 mm (green) for section of the pyloric antrum.
4. Vessel sealing device or ultrasonic dissector.
5. Clip applicator and needle holder.
6. 2/0 monofilament suture or
7. Bioabsorbable staple line reinforcement material (e.g., Gore Seamguard®).
8. Liver retractor.
9. 32–36 Fr esophageal catheter or bougie.

**Technique of Laparoscopic Sleeve Gastrectomy:**
The gastric reservoir is converted into a narrow tube (sleeve) extending from the esophagus to the duodenum along the entire lesser curvature of the stomach. The most important technical aspects are:
- the size of the calibrated bougie used to create the gastric tube,
- proper wound closure technique along the staple lines to prevent formation of leaks and hemorrhages and,
- the distance from the pyloris to the first line of staples, which varies among authors and is still a matter of controversy.
Once the stomach contents have been fully evacuated by aspiration, the left crus of the diaphragm is exposed and a cotton pledget is positioned, thus permitting subsequent localization of this anatomical site. (Figs. 4a,b). The vessel sealing device or the ultrasonic dissector is used to release the entire vascular attachments of the larger curvature in close proximity to the serosa of the gastric wall. Dissection then proceeds cranially toward the angle of His until the cotton pledget, the landmark for the left crus of the diaphragm, can be visualized (Figs. 5a–d). There is controversy in the literature as to how far dissection should be carried out toward the duodenum (Figs. 6a–c). It can either be extended up to a point 2 cm from the pylorus to create a regular shaped small sleeve (restrictive component), or ended at a distance of 6 cm from the sphincter. In this way, the antrum, and hence its capability to distend during ingestion, can be maintained, facilitating gastric mobility, rapid transit of food and sensation of early satiety (neurohormonal component).

Subsequently, any adhesions along the posterior gastric wall (Figs. 7a, b) have to be released until it is possible to fully mobilize the entire stomach and reflect it like “the page of a book”, with the hepatogastric ligament acting as binding margin (Figs. 8a, b). At this level, an iatrogenic lesion of the coronary artery pedicle would necessitate a total gastrectomy. As per our protocol, the standard nasogastric tube is removed and replaced with a calibration bougie, that must be small in size (32–36 Fr) to obtain a sleeve that is as narrow as possible while simultaneously preventing stenosis in the area of the incisura angularis or formation of an esophageal lesion.
Gastric transection is started at the predefined point on the pyloric antrum by introducing the endostapler through the right pararectal trocar (Figs. 9a-f). At this level the tissue thickness of the gastric wall is increased and staples larger than 3.5 mm (gold or green cartridges) should be used to avoid rupture, incomplete transection or endostapler jamming. Frequently, it can be difficult for the bougie to reach the pylorus until the first cut has been made, but it is absolutely essential to mark the lesser curvature if the transection margin abuts on the angular incisure to reduce to a minimum the risk of post-operative stenosis. Gastric transection is continued using the linear stapler loaded with cartridges of staples sized 3.5 mm or 3.8 mm. The stapler is introduced through the left pararectal trocar and is applied while advancing toward the esophagogastric junction. The first assistant mobilizes the fundus toward the spleen through the left subcostal port allowing the operating surgeon to create several stomas of 45 or 60 mm in length, matched to the size of the bougie, with the goal of removing the largest possible volume of the gastric fundus, the principal source of ghrelin. The staples must be aligned so that they are evenly aligned to each other, making sure that no dehiscences occur along the staple line. Most authors recommend the use of buttressing material along the entire length of the staple line, immediately after completion of gastric transection, because this measure is considered to minimize the incidence of post-operative hemorrhage (0–6%) and leaks (0–3%), particularly at a level just below the gastric cardia.
In women, the resected stomach can be extracted transvaginally via the fundus of the posterior cul-de-sac. This can be accomplished by using loads armed with bioabsorbable staple line reinforcement sleeves (e.g., Gore Seamguard® Glycolide copolymer) or by oversewing the staple line with continuous running sutures made of monofilament material (Figs. 10a,b). It is advisable to confirm integrity of the gastric sleeve with insufflated air and methylene blue and to leave in place a nasogastric catheter and aspiration drain during the early postoperative period (24–36h). Finally, the resected stomach can be extracted in women transvaginally via the fundus of the posterior sac (Figs. 11a–c) or by increasing the size of the trocar incision.

**Potential Complications and Precautions**

The gastric sleeve maintains gastrointestinal continuity with excellent safety and good quality of life, generates no gastrointestinal malabsorption, causes only minor nutritional deficiencies and can be converted to another weight loss procedure within the gamut of bariatric surgery, however it is an irreversible procedure and associated with potential postoperative complications that can occur secondary to the longitudinal transection and stapling of the whole stomach. Even though the procedure involves no anastomosis, the incidence of leaks is 0–3%, particularly at a level just below the gastric cardia. Such occurrence can prove to be very serious and difficult to control because the site of the leakage adjoining a narrow tube of low distension capacity and is exposed to a high degree of pressure. The formation of leaks can be prevented by fully mobilizing the posterior gastric wall to allow the endostapler to be correctly applied, using staples adjusted to the thickness of the tissue, and by reinforcing the mechanical suture line employing the methods described above. Once manifested, a fistula takes a long time to respond to conservative treatment and requires to be approached by invasive measures, such as endoscopic-assisted surgical repair, placement of a self-expanding stent or, recently, surgical shunt implantation to a Roux-en-Y loop. Iatrogenic bleeding from the spleen can occur if the organ is approached too close during dissection of the short gastric vessels, an incident, that can mandate a splenectomy. Surgical dissection of the greater omentum must be performed painstakingly, because an iatrogenic lesion of the pedicle of the coronary artery would necessitate a total gastrectomy, which – unlike other bariatric procedures – is an irreversible procedure.
Stenosis and gastroesophageal reflux (GERD) are late complications associated with this technique. The first problem can be prevented by taking great care during insertion of the calibrating bougie and visual assessment of the posterior stomach surface prior to stapling, particularly in close proximity to the angular incisure. The second problem is often linked with the first one but extensive dissection of the esophago gastric junction must be avoided and the hiatus repaired concurrently in the presence of hernia or if the crura are found to be very far apart. Finally, as mentioned above, the inherent problems associated with dilation of the sleeve can result in weight regain, and this can be prevented by fashioning the size of the sleeve, as has been stated, with a small-diameter calibrating bougie and using laparoscopic re-sleeve gastrectomy (LRSG) and/or a derived procedure (gastric bypass or duodenal switch).

**Recommended Literature**

Biliopancreatic Diversion Sleeve Gastrectomy
with/without Duodenal Switch
Daniel Krawczykowski, M.D.
Polyclinique Priollet-Courlancy, Châlons-en-Champagne, France
Definition and Historical Background of Biliopancreatic Diversion with Duodenal Switch

There are a great many causes of obesity and at the present time we do not have any etiology-based medical or surgical treatment. Surgery does not cure obesity, but by modifying the anatomy and physiology of the digestive tract, it does induce major, long-lasting weight loss, improve or resolve the comorbidities and extend life expectancy, with a good quality of life at acceptable surgical risks.

Bariatric surgery may be purely restrictive, by limiting food intake, purely malabsorptive by reducing the absorption of caloric nutrients or hybrid (mixed), if a combination of both methods is used. In other words, surgery creates either a restrictive or a malabsorptive condition, or a combination of these two, which helps patients lose weight.

By definition, biliopancreatic diversion in bariatric surgery is a procedure which diverts the biliary and pancreatic secretions to induce malabsorption by delaying the contact between the food ingested and the digestive secretions. Thus, the classic gastric bypass is a biliopancreatic diversion in which the restrictive aspect predominates and the malabsorptive aspect essentially concerns the micronutrients absorbed in the first intestinal loops.

“It should refer to an anatomical change and not to a specific operation ...”
P. Marceau et al.: Surgical Clinics of North America October 2001

Historically, bariatric surgery began in the 1950s with malabsorptive procedures (jejuno-ileal bypass and variations on it), but the malabsorption and blind limb resulting from these operations were often responsible for metabolic complications which were sometimes fatal. In 1976 after animal studies, Professor Nicolas Scopinaro rehabilitated malabsorptive bariatric surgery by calibrating the malabsorption and by avoiding the blind limb.

Scopinaro’s Biliopancreatic Diversion (BPD/Sc) (Fig. 1) consists of:

- a 250 cm alimentary limb, where sugars and proteins are absorbed. This limb is measured from the caecum and is anastomosed with the stomach, the antrum of which is resected to prevent anastomotic ulcers.
- a biliopancreatic limb, which drains the biliary and pancreatic secretions, reinjecting them into the digestive tract 50 cm from the caecum at the start of a common channel where the enterohepatic action of the bile salts produces absorption of fats.

According to the author, weight stability is explained by a sustained lower threshold of absorption for fat and starch once the digestive tract has undergone a phase of adaptation. On the other hand, this maximal capability of absorption also explains the nutritional deficiencies that result, if too much restriction is imposed on the patient. Distal gastrectomy produces a moderate reduction in food intake in the early stages of weight loss, followed by great comfort with normal eating capacity.
Biliopancreatic Diversion with Duodenal Switch

This operation, and the adaptations that the author introduced later, produce a considerable loss of weight (> 70%) which is sustainable (> 25 years)\(^9\).

In 1988, D. Hess in the United States and in 1990, P. Marceau in Canada, made modifications to the BPD/Sc to reduce the level of complications (Fig. 2).

1. To treat the problems of diarrhea and protein malnutrition, Marceau elongated the common channel to 1 m\(^9\); Hess chose to measure the alimentary limb and common channel at 40% and 10%, respectively, of the total small bowel length\(^9\).

2. Following the description of the duodenal switch by T. DeMeester\(^2\) to treat pathological duodeno-gastric reflux, a duodenal switch (DS) and a 60–65% sleeve gastrectomy (SG) were carried out to replace the distal gastrectomy and the gastroileal anastomosis of the BPD/Sc\(^8\). This second modification reduces the amount of acid at the proximal anastomosis, produces early satiety, maintains antro-pyloric function, and keeps a 4 cm length of duodenum, which improves the absorption of iron, calcium, and magnesium, removes the risk of dumping syndrome and the risk of anastomotic ulcers.

Biliopancreatic Diversion with Duodenal Switch: Results and Strategic Approach

Biliopancreatic diversion with duodenal switch (BPD/DS) is a mixed or hybrid procedure: moderately restrictive (sleeve gastrectomy) and partially malabsorptive (duodenal switch). D. Hess and P. Marceau described performing BPD/DS by laparotomy, M. Gagner\(^4\) by laparoscopy in 2000, and R. Rabkin by a combined laparoscopic-assisted approach in 2003\(^7\). Currently, BPD/DS is employed either as first-line surgery or as revision surgery by numerous teams in North and South America, Europe, Israel and Australia, whatever the patient’s age or BMI, as long as they meet the clinical indication criteria for surgery\(^1, 5, 20, 26, 32, 37, 42, 43, 58, 69, 71, 72, 88, 91\). The number of surgeons belonging to the American Society for Metabolic and Bariatric Surgery (ASMBS) who carry out BPD/DS has doubled between 2002 and 2003. In France, even though bariatric surgery has evolved rapidly in recent years, BPD/DS is reserved for patients with a BMI > 50 or where other techniques have failed.
The morbidity and mortality rates of BPD/DS are equivalent to those for major digestive surgery, and are comparable with those for gastric bypass surgery. The incidence rate of 1% is subject to experience of the team (Tables 1, 2).

The side effects are known and should be distinguished from complications (diarrhea, severe denutrition). They include flatulence, steatorrhea (often 2 to 4 bowel movements per day, usually steatorrheic, foul-smelling, sometimes associated with urgency) and metabolic changes: decrease in levels of albumin, calcium, iron, hemoglobin and liposoluble vitamins (A, D, E, K). The problems related to malabsorption, must be investigated and can be corrected by administration of supplements. Transitory discomfort can be relieved with an appropriate diet (reduction in fat content for steatorrhea and in carbohydrates for flatulence), and by taking metronidazole and pancreatic enzymes. Apart from these side effects, the comfort of feeding is excellent, the restriction allowing a normal diet without vomiting, with patient satisfaction rates beyond 95%. The rate of surgical revision for excessive weight loss, protein malnutrition or diarrhea (lengthening of the alimentary limb and common channel by a more proximal ileo-ileal anastomosis), is 0.6% when the channel is calibrated at 100 cm and between 3.7 and 5.7%, when it is shorter or if the restriction was greater. Patients with serious denutrition, with uncontrollable diarrhea or an intercurrent disabling condition should receive intravenous albumin and have their digestive functions restored by creating a latero-lateral anastomosis between the jejunum below the angle of Treitz and the proximal alimentary limb, or a restoration of gastrointestinal continuity. Taking into account patients lost to follow-up, the reversal rate for D. Hess is 0.61% after 15 years.

Buchwald’s meta-analysis has established that, at the present time, BPD/DS is the bariatric procedure yielding the best results regarding the rates of initial weight loss and long-term maintenance of weight loss: 70% of patients who underwent BPD/DS presented with sustained excess body weight loss at 10 years after surgery.

### Table 1: BPD/DS: Rates of Operative Mortality and Morbidity

<table>
<thead>
<tr>
<th>Authors</th>
<th>Marceau</th>
<th>Hess</th>
<th>Anthone</th>
<th>Rabkin</th>
<th>Baltasar</th>
<th>Krawczykowski</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients</td>
<td>1423</td>
<td>1300</td>
<td>701</td>
<td>345</td>
<td>125</td>
<td>49</td>
</tr>
<tr>
<td>Pre-op. BMI ± Sd</td>
<td>51.5±</td>
<td>(33–103)</td>
<td>–</td>
<td>52.3 ± 9.6</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Mean Age</td>
<td>40.1</td>
<td>(15–70)</td>
<td>–</td>
<td>42.3 ± 10.4</td>
<td>43</td>
<td>37</td>
</tr>
<tr>
<td>Operative Mortality Rate (%)</td>
<td>1.1</td>
<td>0.57</td>
<td>1.4</td>
<td>0</td>
<td>1.6</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>–</td>
<td>–</td>
<td>10</td>
<td>5.6</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Leaks</td>
<td>–</td>
<td>0.7</td>
<td>3.2</td>
<td>–</td>
<td>4</td>
<td>8.1</td>
</tr>
<tr>
<td>Occlusions</td>
<td>–</td>
<td>–</td>
<td>1.5</td>
<td>–</td>
<td>1.6</td>
<td>–</td>
</tr>
<tr>
<td>Hemorrhage</td>
<td>–</td>
<td>–</td>
<td>0.3</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Rhabdomyolysis</td>
<td>–</td>
<td>–</td>
<td>0.6</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Pancreatitis</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>2</td>
</tr>
<tr>
<td>PE* or Pneumopathy</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>2</td>
</tr>
</tbody>
</table>

* Pulmonary embolism.
The beneficial effects of BPD/DS are remarkable in cases of dyslipidemia (cured in nearly 99% of cases), diabetes (92% of patients have been able to stop all treatment) and other comorbidities associated with obesity: sleep apnea, cardiac risks etc. The efficacy of this treatment, greater even than that of gastric bypass, has been shown even in the super-obese.

“... BPD/DS should be considered the new gold standard. Others should strive to match those results.” Hess 2004, ASBS Consensus Conference

BPD/DS is particularly useful in a strategic management of obesity and/or its comorbidities in that it allows the gastric and intestinal operations to be performed as isolated procedures. Certain authors, therefore, advocate the use of a staged approach, i.e.: a SG in high-risk patients or, on the contrary, in patients with a moderate BMI, or for regaining weight after pure malabsorptive surgery; a DS in the case of insufficient weight loss or persistence of diabetes or hypercholesterolemia after a SG, a band gastroplasty or a vertical banded gastroplasty.

There are several benefits that accrue from a two-stage strategic approach:

- The restrictive surgery (SG) can be offered to patients reluctant or unfit to undergo a complex operation as a primary procedure.
- The malabsorptive surgery (DS) can be added without reoperating on the esophagogastric junction.
- The overall complication rate is lower when the two components of the BPD/DS are performed separately.

Table 2: BPD/DS: Long-term Results

<table>
<thead>
<tr>
<th>Authors</th>
<th>Marceau 2007</th>
<th>Hess 2005</th>
<th>Anthone 2005</th>
<th>Krawczykowski (not published)</th>
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</thead>
<tbody>
<tr>
<td>Patients</td>
<td>1423</td>
<td>618</td>
<td>451</td>
<td>284</td>
</tr>
<tr>
<td>Length of follow-up years</td>
<td>7.3 (2–15)</td>
<td>&lt;5</td>
<td>5–10</td>
<td>&gt;10</td>
</tr>
<tr>
<td>Follow-up Rate (%)</td>
<td>97</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Gastric Remnant Volume Estimation (ml)</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Length of Common Channel (cm)</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>IEWL* (%)</td>
<td>73 ± 19</td>
<td>77</td>
<td>69.4</td>
<td>68.9</td>
</tr>
<tr>
<td>Total Reversal (%)</td>
<td>0.2</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Revision for Diarrhea or Malnutrition (%)</td>
<td>0.7</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Revision for Inadequate IEWL* (%)</td>
<td>1.5</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

* Initial Excess Weight Loss.
The Two Components

Sleeve Gastrectomy (Fig. 3)

Sleeve Gastrectomy (SG) involves the resection of the greater curvature of the stomach. This is the restrictive component of BPD/DS described in 1993 by P. Marceau. SG should, therefore, not be considered a new operation, however the use of SG as isolated procedure is a new surgical approach to obesity. Nowadays, the use of isolated SG (ISG) is increasingly widespread in bariatric surgery, but has not been included in the official register of surgical procedures\textsuperscript{13}. So far, only a few clinical reports have been published about this procedure as an entity in itself, medium to long-term results are not known, and some technical details and the indications are still the subject of controversy. Nevertheless, the good results in terms of short-term weight loss (49 to 80% EWL at one year) and comorbidity\textsuperscript{84}, along with the acceptable rate of complications assure its place in the panoply of surgical procedures\textsuperscript{6,11, 27, 34, 36, 44, 47, 54, 64}. A First International Consensus Summit for Sleeve Gastrectomy was held in New York City in October 2007\textsuperscript{21}.

This longitudinal gastrectomy has some affinities with the vertical gastroplasty called “Magenstrasse and Mill Operation” which was practiced by Johnston\textsuperscript{41} since 1992, but in this latter the stomach is transected and not resected.

Speaking physiologically, the operation is restrictive (satiety occurs quickly) and “anorexigenic” (the patients feels little hunger and little interest in eating as Ghrelin secretion is reduced\textsuperscript{52}. Other effects are being studied, such as accelerated gastric emptying\textsuperscript{62} and the remarkable short-term results on diabetes, which seem to equal those of gastric bypass\textsuperscript{90, 93}.

Other advantages of this procedure are no foreign body, no adjustment required, very rare vomiting, no dumping syndrome, no major nutritional deficiencies to be expected. We have presented our results at the 6th International Obesity Surgery Expert Meeting in Saalfelden 2008: at 2 years after primary ISG, there was no major hypoalbuminemia, no vitamin B12 deficiency, no anemia, but the low serum level of ferritin increased from 4.2% before the operation to 19.5% at 2 years, probably because of low desire to eat red meat. However, a case of Wernicke’s syndrome has been reported by Makarewicz\textsuperscript{56}. Albeit rare, patients suffering from vomiting, less than 2.5%, have to be checked for thiamine deficiency.

Stomach calibration is variable, depending on the authors. The residual stomach volume is between 60 and 250 ml, depending on the bougie used to calibrate the sleeve (between 28 and 60 French) and the starting point for the resection (between 2 and 8 cm from the pylorus). If malabsorptive surgery is envisaged later, mainly in super-obese patients, the restriction must be moderate to avoid the problems of denutrition\textsuperscript{68, 89}. Baltasar identified a wide antral reservoir as a major factor that contributes to the failure of this technique. He considers, that gastric resection must start upstream of the pylorus over a 34 Fr.-calibration tube to produce a stomach with a volume of between 50 and 60 cc, and he proposes a re-SG, if the gastric pouch exceeds 4 cm in diameter at the esophagogastric junction\textsuperscript{7}. Weiner stated, that a removed gastric volume of less than 500 cc is a predictor of failure in treatment\textsuperscript{92}. In agreement with other authors\textsuperscript{86}, we advocate the notion, that a “tight” sleeve gastrectomy calibrated using a 36 Fr bougie, with the left crus entirely freed and the gastric fundus entirely removed, should not dilate and per se represents the ideal ISG.
Indications for Sleeve Gastrectomy found in the literature are:

1. **As first-stage procedure prior to DS or bypass:**
   a) For high-risk patients: BMI > 65 for whom mortality of 6.25% and morbidity of 38% have been reported for a BPD/DS in a single procedure, or for patients with cardiac, respiratory, or hepatic conditions.
   b) For patients who refuse a band or following failure or complications of a gastroplasty band.

2. **As isolated surgery** for patients with a low BMI but also for patients on anti-inflammatory treatment, or with anemia, Crohn’s disease, AIDS and those for whom a malabsorption procedure would be dangerous.

3. **Secondary to malabsorptive surgery,** such as a jejuno-ileal bypass.

The drawbacks of Sleeve Gastrectomy are:

- **Irreversible nature** of gastric resection. SG is indeed so far the only definitive non-reversible bariatric surgery.

- **The risk of hemorrhage** from the line of section. This risk can be reduced by reinforcing the stapling with a running suture, fibrin glue or by using Gore Seamguard® bioresorbable staple line reinforcement; bovine pericardium reinforcement has been used but seems to migrate. At present, we make separate Vicryl 2/0 stitches, if focal hemostasis is needed sporadically. Bleeding may also occur from spleen or liver laceration as well as from trocar-sites.

- **Leaks are the major concern of this surgery. They may occur in the range of 0 to 10%,** mainly when SG is performed secondary to gastric banding. Leaks usually occur at the esophagogastric junction. Evaluation of staple line patency should be performed by instillation of methylene blue and/or by insufflation of air. However, using these tests does not allow to reliably detect all sites of leakage, which will become apparent during oral refeeding on the 2nd or even up to the 5th day. Nevertheless, some authors reported about late leaks occurring after 3 weeks, 2 cases in our series, one in Weiner’s series and one in Silecchia’s.

The clinical signs of leakage can be mild and well-tolerated, which usually is the case, if they occur delayed, and should be controllable by administration of IV antibiotics and parenteral nutrition. A severe complication should be assumed, if the patient presents with hyperthermia, tachycardia (> 120/min) unexplained by dehydration or pain, tachypnea (>20/min), a decrease in left basal breath sounds, left lumbar pain or pain in the left hypochondrium. If not adequately treated by drainage, leaks may lead to a cascade of complications: subphrenic collection/abscess, reactive pleural effusion, fistulation into the pleural space and into the left lung, pseudoaneurysm (infectious) of the splenic artery with the potential risk of massive hemorrhage and, in turn, to rapidly deteriorating sepsis ending up with failure of multiple organs. A progressive rise in leukocytosis and serum CRP level, often associated with a fall in serum albumin, requires diagnostic assessment and appropriate treatment. Paraclinical examinations, particularly to exclude a pulmonary embolism, must not delay this revision, even if the gastrographin swallow, that we normally make on D1 or D2, is considered fine and does not show a leak.
The principal objectives in the management of this type of complication are patient safety and complete closure of the leak. The former can be achieved by creating a gastro-cutaneous fistula, that prevents fluid collection by directing the juices out of the body, the latter by reducing the output, keeping the patient well-nourished and treating the underlying cause that might compromise wound healing (formation of strictures).

Whenever possible, suturing the leak and placing an omental patch should be attempted, however these measures are often found to be ineffective. Usually, we debride the false membranes, perform thorough lavage, place a drain in contact with the leak, and, given the time for improvement, we perform an alimentary jejunostomy.

When leak drainage is found to be inadequate or protracted (more than 3 weeks), this can be controlled successfully by placing coated self-expanding stents. Among other options, that may be adopted for this purpose, drainage via a Roux-en-Y limb or total gastrectomy have been described.

The mechanism and correlated factors favoring the formation of leaks are still unclear: ischemia, thickness of the stomach, technical problems concerning the staples and stapling are issues of prime concern. A long gastric sleeve and, even more so, a distal stenosis, contribute to a delayed healing of leaks.

**Prevention of Leaks.** Fistula-related complications may be prevented by observing the principles for use of viscerosynthesis material: using stapling equipment and staples according to the standards laid down by the manufacturers (60 mm Ethicon Endo-Surgery Echelon Endopath® Stapler with green or gold cartridges or green Covidien Endo GIA staples), keeping to a tissue compression time before stapling, avoiding crossing staples, dissecting to preserve good vascularization.

It can be construed, that the calibration of the sleeve on a small-diameter Faucher bougie (36 Fr and below) promotes the formation of leaks. The final stapling must be made towards the greater curvature to avoid encroachment of the esophagus.

**Unstapling** may occur perioperatively, particularly in the antral part of the stomach which is sometime thick. This is dealt with using a running suture, because re-stapling could narrow the sleeve.

**Gastric strictures.** The incidence of gastric strictures is between 0.7 and 4%. If stapling is applied too close to the incisura angularis, this is supposed to promote stricture formation, but it is also argued, that this might be related to oversewing of the staple-line. Gastric strictures can delay the healing of a proximal fistula and, in theory, can contribute to dilatation upstream. Hematoma and oedema may lead to gastric strictures that are of transient nature. Endoscopic dilation has been advocated for non-resolving strictures, and furthermore in the case of a proximal non-healing leak. A seromyotomy may also be considered an option.

**Dilatation of the gastric sleeve** probably occurs more frequently, if the calibration was wide. Re-sleeve gastrectomies have been described with good results in patients regaining weight, particularly after BPD/DS where the stomach was calibrated with a 60-Fr bougie but also for failure after ISG. A wide proximal gastric pouch with a funnel-like appearance or the appearance of a proximal gastric diverticulum is the result of an incomplete dissection and resection of the fundus. These findings are frequently encountered in revision procedures after gastric banding. The clinical consequences of incomplete dissections are yet unknown, but it must be assumed that progressive dilatation of the proximal stomach portion will occur, with a resumption of weight gain following in its wake.
• **Weight regain or insufficient weight loss:** This is not considered a complication, but rather the fate of any restrictive surgery. Nevertheless, the excess weight loss (EWL) obtained with an ISG is, in the short term, greater than with an intragastric balloon, comparable to that of a bypass and, at 3 years, greater than that obtained with gastric banding. However, ISG remains essentially a restrictive procedure and, as for all restrictive surgery, mid- and long-term results depend on several factors. *Langer* described a case where, after an incomplete resection of the fundus, the ghrelin level did not fall post-operatively and after moderate weight reduction the patient returned to his original weight. A re-sleeve gastrectomy or the addition of malabsorptive surgery should be envisaged if the pouch poses a problem or if the patient regains weight. In agreement with other authors, it seems to us, that progressive dilatation of the stomach is not the main aspect of the problem: such dilatation is of rare incidence, and significant weight loss can be obtained with relatively wide calibrations of 48-Fr and, in our experience, to the lack of physical activity, that is suited to weight loss. That being the case, and if patient compliance could not be established, or if the patient is reluctant to bring about a radical change in the quality of his/her diet and physical activity, an additional malabsorptive procedure may be offered, as long as the patient is willing to accept the risks of a new operation, metabolic monitoring and taking vitamin and trace element supplements daily.

• **Gastro-esophageal reflux.** The procedure has the reputation of promoting gastro-esophageal reflux (GERD) by removing the anti-reflux system. Indeed, it is true that early on, certain patients (± 20%) complain of reflux occurring, which usually responds to proton pump inhibitors (PPI). Nevertheless, this problem, which appears in the early postoperative period, sometimes resolves after the phase of initial weight loss. On the other hand, some patients on medication for a symptomatic reflux prior to ISG will experience an improvement or a resolution of the GERD after the SG. In patients presenting with severe symptoms of GERD after ISG, a gastric bypass surgery can be performed. A repeat SG has been performed by *M. Gagner* for a patient complaining of GERD and a regain weight after a BPD/DS.

• **Rhabdomyolysis** has been reported, but it is related to the operating time and not specific to this procedure.

• **Mucocele of the gastric tube** has been described after conversion of a vertical banded gastroplasty to BPD/DS.

**Our experience:** We have been performing ISGs in a two-stage BPD/DS program since December 2001 in patients with a complication or failure of gastric banding, and since December 2002, in patients who do not wish to have a gastric band. In our patient group, analyzed until March 2008, we had 143 patients who underwent an ISG as first-line treatment and 66 as second-line treatment after gastric banding (failure to lose weight or complication). Our results in terms of weight loss and morbidity are comparable to those found in the literature, as shown in Table 3 (see p. 72). We have had no mortality, and in our experience, leaks have a higher incidence in revision SGs, particularly if the band had already been removed, probably because the dissection is more difficult. Our current technique has allowed us to reduce the incidence of fistulas to 1.8%, since we switched over to using the 60-mm stapler instead of the 45-mm stapler (Ethicon Endo-Surgery Echelon™ ENDOPATH™ Stapler), i.e. 1 case in the last 56 SGs). After 3 years, 23% of the patients who had an ISG as initial treatment (mean initial BMI of 50) underwent an additional DS, while this rate was as high as 43% in the patient group treated with a gastric band (mean initial BMI of 43.5). This leads us to the assumption, that even with a moderate BMI (<50), certain patients must benefit from malabsorptive surgery.
<table>
<thead>
<tr>
<th>Authors</th>
<th>Patients</th>
<th>Initial BMI</th>
<th>Bougie Calibration (Fr)</th>
<th>Starting from pylorus (cm)</th>
<th>Size of Residual Stomach</th>
<th>IEWL*** (%)</th>
<th>Morbidity (%) Major Complications</th>
<th>Leaks (%)</th>
<th>Mortality (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Johnston**</td>
<td>230</td>
<td>40–64</td>
<td>–</td>
<td>36</td>
<td>–</td>
<td>62</td>
<td>4</td>
<td>2.5</td>
<td>0</td>
</tr>
<tr>
<td>Almogy</td>
<td>21</td>
<td>57.7 (53–71.5)</td>
<td>–</td>
<td>–</td>
<td>100</td>
<td>47 at 1</td>
<td>20</td>
<td>–</td>
<td>0 late 14</td>
</tr>
<tr>
<td>Baltasar</td>
<td>31</td>
<td>3 series</td>
<td>32</td>
<td>2</td>
<td>&lt; 60</td>
<td>42–100</td>
<td>3.2</td>
<td>0</td>
<td>3.2</td>
</tr>
<tr>
<td>Berenade**</td>
<td>8 **</td>
<td>50.5 (37–74)</td>
<td>34</td>
<td>–</td>
<td>–</td>
<td>57 at 1 Y</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Braghetto**</td>
<td>50*</td>
<td>37.9 (32.9–46.8)</td>
<td>32</td>
<td>2–3</td>
<td>75 ± 22</td>
<td>–</td>
<td>2</td>
<td>?</td>
<td>0</td>
</tr>
<tr>
<td>Cottam**</td>
<td>126*</td>
<td>65.4 ± 9 (45–91)</td>
<td>46–50</td>
<td>5</td>
<td>–</td>
<td>45 ± 17 at 1 Y</td>
<td>14</td>
<td>1.6</td>
<td>0</td>
</tr>
<tr>
<td>Felberbauer**</td>
<td>126</td>
<td>48.1±8.7</td>
<td>48</td>
<td>Crow’s foot</td>
<td>–</td>
<td>At 20 mths. 64% of Pt loss; &gt; 50% 6.8% loss &lt; than 25%</td>
<td>3.17</td>
<td>2.4</td>
<td>0</td>
</tr>
<tr>
<td>Hamoui**</td>
<td>118*</td>
<td>55 (37–108)</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>49.4 (26.8–79.6) at 1 Y 47.3 at 2 Y</td>
<td>15.3</td>
<td>1.7</td>
<td>0.85</td>
</tr>
<tr>
<td>Han**</td>
<td>130*</td>
<td>30–56</td>
<td>48</td>
<td>–</td>
<td>50–60</td>
<td>83.3 at 1 Y</td>
<td>2.9</td>
<td>0.7</td>
<td>0.7</td>
</tr>
<tr>
<td>Himpens**</td>
<td>40*</td>
<td>39</td>
<td>34</td>
<td>Crow’s foot</td>
<td>–</td>
<td>57.7 (0–125.5) at 1 Y 66 (-3.1–152.4) at 3 Y</td>
<td>5</td>
<td>1 gastric ischemia</td>
<td>0</td>
</tr>
<tr>
<td>Krawczykowski (not published)</td>
<td>143*</td>
<td>44.4 ± 5.5 (34.6–60.3)</td>
<td>36</td>
<td>Crow’s foot</td>
<td>–</td>
<td>77.7 at 1 Y 73.3 at 2 Y 67.2 at 3 Y</td>
<td>8.4</td>
<td>4.9</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>66**</td>
<td>44.4 ± 6.2 (35.9–61)</td>
<td>36</td>
<td>Crow’s foot</td>
<td>–</td>
<td>68.8 at 1 Y 69.6 at 2 Y 54.4 at 3 Y</td>
<td>19.7</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>Langer**</td>
<td>23*</td>
<td>48.5 ± 6.9 (40–73)</td>
<td>48</td>
<td>Crow’s foot</td>
<td>–</td>
<td>56 at 1 Y</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Lee**</td>
<td>216*</td>
<td>49 ± 11</td>
<td>32</td>
<td>6–8</td>
<td>60–80</td>
<td>59 ± 17 at 1 Y</td>
<td>4.6</td>
<td>1.4</td>
<td>0</td>
</tr>
<tr>
<td>Regan**</td>
<td>14*</td>
<td>58–71</td>
<td>60</td>
<td>Crow’s foot</td>
<td>–</td>
<td>33 at 11 mths.</td>
<td>21.4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Skrekas**</td>
<td>93 90*</td>
<td>46.9±6.5 (37–66)</td>
<td>36</td>
<td>3</td>
<td>&lt;100</td>
<td>67.2 at 12 mths.</td>
<td>8.6</td>
<td>4.3</td>
<td>0</td>
</tr>
</tbody>
</table>

* Primary  ** Secondary  *** Initial Excess Weight Loss  Y = years
The Technique

We use 8 trocars and a 0° laparoscope, and no extra-long instruments. We work along two curvilinear paths (Fig. 4, highlighted in blue). The first (superior) path provides a perfect view of the esophagogastric junction, while the second (inferior) one allows to visualize the greater curvature of the stomach. The patient is placed in a reverse Trendelenburg position. The surgeon assumes a standing position between the lower limbs of the patient, the assistant holding the 0° scope is to the right of the patient and the scrub nurse to the left. Insufflation is performed with a Veress needle in the left hypochondrial area until a pneumoperitoneum of 15 mmHg is established. We introduce the first 11-mm trocar (T1) on the median line at 10 cm from the xiphoid process, then, under visual control, a 6-mm trocar (T2) below the xiphoid for the retractor that holds aside the left hepatic lobe and, usually, gives a perfect view of the esophagogastric junction. Between these 2 trocars, a right paramedian 6-mm trocar (T3) is placed 10 cm from the median line for the forceps held by the surgeon allowing exposure by traction on the stomach. On the left side, on the midclavicular line and in line with trocars T1 and T3, thus slightly offset downwards, a 13-mm trocar with a reducer (T4) is inserted. In the first instance, this allows the introduction of scissors or the ultrasonic dissector, and during the final stage of the operation, the stapler. On the same T1–T3 line, at the point of intersection with the anterior axillary line, a 6-mm trocar (T5) is inserted allowing traction to be applied to the omentum during the following operative maneuvers: dissection of the angle of His; division of the stomach from the omentum; holding the stomach during stapling. On the inferior path, 5 cm on either side of the umbilicus, two 13-mm trocars (T6 and T7) are inserted to accommodate the laparoscope/stapler, and vice versa. Finally, on-axis with the midclavicular line, a 6-mm trocar (T8) is placed to provide good exposure during dissection and after stapling of the greater curvature.

Port placement for Isolated Sleeve Gastrectomy (ILS).

- **T1**: Laparoscope with coupled video camera
- **T2**: Liver Retractor
- **T3**: First Surgeon; Retractor
- **T4**: First Surgeon; Dissector, Stapler
- **T5**: Assistant Surgeon; Dissector, Stapler
- **T6**: Laparoscope; Stapler
- **T7**: Laparoscope; Stapler
- **T8**: First Surgeon; Retractor
We always start with dissection of the angle of His, all the more so, if the patient has a gastric band or a history of surgery of the esophagogastric junction (Fig. 5a). The strict observance of this principle is the critical factor that contributes to the feasibility of the operation. Dissection is performed using scissors or the ultrasonic dissector. The nasogastric catheter, which was used to drain the stomach, is removed. The objective is to start the dissection of the anterior part of the left crus of the diaphragm and to reduce any hiatal hernia, if present. The fat pad covering the esophagogastric junction is usually dissected and excised, particularly if it is bulky (Fig. 5b). We then move to the greater curvature of the stomach and in continuation with Latarjet’s nerve, between 6 and 8 cm upstream of the pylorus, which may be palpated, we begin to free the stomach from its contacts using an ultrasonic dissector (Figs. 5c, d). The stomach is dissected as far as the angle of His. Particular care is taken while passing near the short gastric vessels, moving the laparoscope from trocar T7 to trocar T1 (Fig. 5e). Any posterior attachments of the stomach including the branches of the posterior gastric artery are freed from the stomach (Fig. 5f). The fundus often has a posterior development which must be perfectly dissected (Fig. 5g). The left crus must be completely in view (Fig. 5h). Under control and assistance of the surgeon the anesthetist passes down a 36 Fr.-Faucher tube, which is then guided toward the pylorus. The tube is held in contact with the lesser curvature. The stomach is stretched out and stapling is initiated by firing the 60-mm Ethicon Endo-Surgery Endopath® Echelon Stapler loaded with green or gold cartridges, depending on the thickness of the antrum. The latter maneuver is performed with the scope in T6 and the stapler in T7 port (Fig. 5i). Stenosis at the incisura angularis must be avoided. The stapler is fired twice, and then the laparoscope is placed in T7 or T1, depending on the patient’s size. Loaded with gold cartridges, the stapler is again fired via port T6 or T4, thereby staying in close contact with the calibration tube (Fig. 5j). Stapling is completed with the stomach stretched out by applying traction to the posterior wall of the fundus toward the patient’s left shoulder. This technique is employed to prevent taking in too much tissue and risking unstapling or creating too wide a residual stomach. The last stapling must be shifted onto the external side of the angle of His to avoid injuring the esophagus (Fig. 5k). We discontinued our practice of reinforcing the staple line with a running suture because, in our experience, this takes generally nearly half an hour, the appearance of the sleeve is sometimes irregular, and the incidence of fistula formation is equivalent to the rate found with the use of 45-mm staples. We assume, that placing a running suture on a narrow sleeve is a predisposing factor for complications: the start of the running suture may be the origin of tension on the bottom of the esophagus, and may cause shearing of the gastric serous membrane. According to our protocol, we therefore perform a methylene blue leak test while compressing the stomach with a clamp forceps at the pylorus. In this way, not only the suture line can be checked for signs of leakage or bleeding, this also gives us an idea of the residual gastric volume (usually between 100 and 120 ml). In addition, an intraoperative air insufflation test is performed. The stomach is extracted in a surgical bag via trocar port T4, which is enlarged and closed with Vicryl at the end of the procedure (Figs. 5l–m). We systematically take a tissue sample for hepatic biopsy; cholecystectomy is only performed if gall stones are present. We only drain occasionally. The nasogastric catheter remains in place for 24 hours to prevent vomiting and to check on the absence of bleeding. The patients are given prophylactic antibiotic medication (second generation cephalosporin) before the incision. Thrombosis prophylaxis is started the day before the operation and continued for a month, and patients wear support stockings. Patients are encouraged to walk about, once they have regained consciousness. They are allowed to begin a liquid diet after radiological checks and are discharged on the 5th postoperative day with a blended soft diet and purées up to the 3rd week.
Figs. 5a–m
Still image sequence captured while performing a biliopancreatic diversion sleeve gastrectomy.
**Duodenal Switch (Fig. 6)**

Isolated Duodenal Switch (IDS) has been described by DeMeester in the surgical treatment of primary bile reflux gastritis. In this indication the goal of surgery is to divert the bile and pancreatic secretions with a long common channel. In bariatric surgery, DS is the malabsorptive component of BPD/DS. The common channel is short (50 –150 cm) and the DS is classically combined with an SG. Nevertheless, variants have been suggested to reduce the morbidity related to SG or to improve the results of preceding restrictive surgery. Thus, DS has been carried out:

1. As Isolated Duodenal Switch (IDS) for surgically curable metabolic conditions associated with moderate obesity. In terms of Excess Weight Loss (EWL) the outcome is equivalent to less than 5 BMI points, but with regard to metabolic symptoms, the results are remarkable, with a curative rate of nearly 99% of cases of hypercholesterolemia and, to a lesser degree, of diabetes.

2. After reestablishing normal gastric capacity.

3. Simultaneously to placement of a resorbable or silicone gastric band (banded DS) (Fig. 7).

4. In addition to a well-tolerated purely restrictive surgery, which has however proven ineffective, either in terms of weight loss or comorbidity: two-step banded DS, VBG and secondary DS, SG and additional DS resulting in the classic two-stage BPD/DS.

Our experience: In our 2-stage BPD/DS program with a total number of 209 patients treated with ISG as first- or second-line procedure, 21 patients received an additional DS. The second operation was relatively easy to perform, we had few post-operative complications, and 6 months after the second procedure the initial excess weight loss (IEWL) was equivalent to that of the single-step BPD/DS. We also performed additional or isolated DS secondary to failure of weight reduction with non-SG restrictive surgery: 32 patients had gastric banding, 2 patients vertical banded gastroplasty and 3 patients who wanted prior or simultaneous removal of their gastric band. Postoperative morbidity was mainly related to the presence of the band (secondary removal of the band). The rate of IEWL was lower than that for BPD/DS (Fig. 8).

Generally speaking, it is not advisable to add a DS to a gastric band. Indeed, in our experience, even if the band is deflated, nearly half of the patients with restricted food intake will request it to be removed in the year the DS was performed. The potential risk of anastomotic (duodeno-ileal) ulceration must be added to the side effects and complications already mentioned for biliopancreatic diversion, though these findings are based on two series only. Retaining a 4 to 5 cm duodenal stump reduces this risk. Finally, in addition to the metabolic risks linked to malabsorption, the patient is exposed to the risk of complications specific to the band (adjustments, slipping, erosion). On the other hand, we did not have any severe hypoalbuminemia in this group of patients.

Peterli reported the same experiences as we had, and he also prefers to convert a failed band gastroplasty into a classic BPD/DS with an SG as restriction.
The Technique

We use between 5 and 7 trocars and a 0°-laparoscope, but no extra-long laparoscopic instruments. The patient is in the reverse Trendelenburg position. The surgeon assumes a standing position between the lower limbs of the patient, the assistant holding the 0°-scope is to the right of the patient and the scrub nurse to the left. Insufflation is performed with a Veress needle in the left hypochondrial area until a pneumoperitoneum of 15 mmHg is established. We introduce a first right paraumbilical 13-mm trocar (T1) for the laparoscope, a second left paraumbilical 13-mm trocar (T2) for the dissection and transection of the duodenum, then for the duodeno-ileal anastomosis. A third 13-mm trocar (T3) is positioned on the left midclavicular line 5 to 6 cm higher than the first two trocars, in the first instance to be used to stretch the stomach, then for performing the ileo-ileal anastomosis. A fourth 6-mm trocar (T4) allows the tissues to be presented. A fifth 6-mm trocar (T5) is placed under the xiphoid for retracting the right lobe of the liver. If required, we introduce a 6-mm suprapubic trocar and one into the left flank (T6 and T7) (Fig. 9).
Once the pylorus has been localized endoscopically, and a springing sensation can be felt while advancing the tip of an instrument through the sphincter, we measure 4 cm downstream (Fig. 10a) and, with the aid of a monopolar hook or ultrasonic dissector (Ethicon® Endo-Surgery, Norderstedt, Germany), we incise the peritoneal layer on the inferior and superior surfaces of the duodenum. The scrub nurse expands the stomach with a grasping forceps through trocar T3. We dissect the posterior surface of the duodenum aiming for the right edge of the hepatic pedicle (Figs. 10b, c). Stapling is performed with one, or occasionally, with two 45 mm cartridges of blue staples (3.5 mm ATB 45 Ethicon® Endosurgery) after removal of the nasogastric catheter (Fig. 10d). It is sometimes convenient to perform a cholecystectomy at this point.

The surgical team then moves to the left of the patient repositioned flat for the lower procedures. We systematically carry out an appendectomy, then we unroll and measure the entire ileum on its antimesenteric side (stretched) from the ileocaecal valve using forceps graduated with marks at 5 and 10 cm (Fig. 10e). At a distance of 100 cm proximal from the ileocaecal valve we pass a thread through, that serves as a marker (common channel) and we measure an additional 150 cm to obtain an alimentary limb measuring a total of 250 cm. We transect the small bowel at this level with a white cartridge (Fig. 10f). It is not necessary to incise the mesentery widely. It is important to confirm the absence of intestinal torsion and to make sure, that the alimentary limb is in the patient’s right side. The ileo-ileal anastomosis is then made either manually with a Vicryl 2/0 running suture or, mechanically, with white cartridges placing the stitches at the angles of the anastomosis to relieve tension on the staples (Fig. 10g). The alimentary limb is approximated to the proximal duodenal stump in an antecolic position. The assistant facilitates this maneuver by supporting the distal anastomosis. The team returns to the initial position with the surgeon placed between the legs of the patient in the reverse Trendelenburg position. The duodeno-ileal anastomosis is made with a Vicryl 2/0 double running suture. It is termino-lateral or sometimes termino-terminal. The patency and permeability of the anastomosis are tested by instillation of methylene blue and, at the end of the procedure, by insufflation of air (Figs. 10h–l). The ileo-ileal mesenteric opening and the space between the mesentery of the mounted limb and the greater omentum are closed with a Prolene 1 running suture (Fig. 10m). We usually leave an aspiration drain in contact with the proximal anastomosis and a nasogastric catheter for 24 hours (Fig. 10n). The change to water solubles is made on the 1st or 2nd post-operative day. The antibiotic and antithrombosis prophylaxis and dietary program are the same as for SG.

**Conclusion**

In bariatric surgery, BPD/DS is the most effective operative procedure in terms of weight loss, maintenance of weight loss, healing rate of comorbidities and dietary comfort. This operation is a modification of BPD/Sc, the 30th anniversary of which was celebrated at the 23rd Annual Meeting of the ASBS in 2006. The significant new feature is the use of the individual components of BPD/DS (i.e., SG and DS) in an isolated manner as 1st or 2nd line treatment in a strategic approach to obesity, which is a chronic incurable disease. With awareness of their results, side effects and complications, these components can be better integrated into the decision-making process.
Figs. 10a–m
Still image sequence captured while performing isolated duodenal switch.
Literature


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68. PAPADIA F: Biliopancreatic diversion and gastric restriction. (Correspondence) Obes Surg 2004; 14: 145–146.


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Introduction

Scopinaro’s biliopancreatic diversion (BPD) consists in a distal gastrectomy with a long Roux-en-Y reconstruction: the ileo-ileal anastomosis and the gastro-ileal anastomosis are placed 50 cm and 250 cm distal from the ileocecal (ICV) valve respectively, measured with intestine stretched. The initial weight loss after BPD is due to a temporary mechanism based on the reduced gastric volume which results in a significant decrease in calorie intake in the early postoperative period. After that, the essential weight loss and maintenance mechanism is due to biliopancreatic juice diversion: absorption is restricted to the common channel (50 cm from the ICV) for fats, and to the alimentary limb (250 cm from GEA* to ICV) for proteins and starches. BPD is recognized as the most powerful surgical procedure for weight loss and weight maintenance, assuring an average excess weight loss (EWL) of 70–80% at 20 years postoperatively.

Preoperative Management

- Pureed diet is recommended at the day before surgery.
- No intestinal preparation is required.
- Antibiotic prophylaxis with a second-generation cephalosporin is started during the intervention and continued for 48 hours.
- Thromboembolic prophylaxis should be administered in the form of intermittent pneumatic compression devices for the lower limbs and heparin calcium 5000 U.I. in double subcutaneous dose/day, started perioperatively and continued until discharge.
- Early mobilization after intervention is prescribed.

Instrumentation

<table>
<thead>
<tr>
<th>Recommended Instrument Set</th>
<th>KARL STORZ Item Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1x HOPKINS® 30° Forward-Oblique Telescope, diameter 5 mm</td>
<td>26046 BA</td>
</tr>
<tr>
<td>1x VERESS Pneumoperitoneum Needle</td>
<td>26120 JLL</td>
</tr>
<tr>
<td>2x 11-mm Trocar</td>
<td>30103 MP</td>
</tr>
<tr>
<td>3x 6-mm Trocar</td>
<td>30160 MP</td>
</tr>
<tr>
<td>2x Grasping Forceps</td>
<td>33322 ON</td>
</tr>
<tr>
<td>1x Scissors</td>
<td>34321 MS</td>
</tr>
<tr>
<td>1x Grasping Forceps</td>
<td>33310 AF</td>
</tr>
<tr>
<td>1x KOH Macro Needle Holder</td>
<td>26173 KAF</td>
</tr>
<tr>
<td>(and/or KOH Macro Needle Holder curved)</td>
<td>26173 KAR</td>
</tr>
<tr>
<td>1x Suction and Irrigation Device</td>
<td>37112 A and 37360 LH</td>
</tr>
<tr>
<td>1x RoBi® KELLY Grasping Forceps</td>
<td>38321 ML</td>
</tr>
<tr>
<td>1x Suture Passer</td>
<td>26173 AM</td>
</tr>
<tr>
<td>1x Dissector</td>
<td>33322 MD</td>
</tr>
<tr>
<td>1x Clip Applicator</td>
<td>30444 GA</td>
</tr>
</tbody>
</table>
**Patient Positioning**

The patient is placed in supine position with the left arm abducted and right arm alongside the body.

The laparoscopic tower is placed in proximity of the right patient's shoulder.

**Team Positioning**

The key steps of surgery can be outlined as follows:

1. Gastric resection.
2. Ileal measurement.
3. Performing of anastomosis.
   - The surgeon stands to the left of the patient while the first assistant assumes a position on the patient's right during step I and III, and changes to the left in step II.
   - The scrub nurse with the instrument tray are placed to the right bottom of the table.
Trocar Placement

The double-loop technique in laparoscopic BPD, which has been developed by our team, is performed with only four trocars, two 13-mm trocars and two 6-mm trocars. The pneumoperitoneum is established by inserting the Veress needle in the left upper quadrant and insufflating the peritoneal cavity until a maximum intraabdominal pressure of 15 mmHg is reached.

Access to the abdominal cavity is obtained with an optical trocar system once adequate distension of the abdominal cavity has been achieved. This first trocar (T1) is passed almost perpendicularly through the abdominal wall in the right upper quadrant on the midclavicular line, approximately four finger-widths from the right subcostal margin.

T1 is the port, that will be used by the operating surgeon for handling of operating instruments (vessel sealing system), for the grasping forceps and for the stapler (transection of the duodenum, ileo-ileal anastomosis).

After videoendoscopic inspection of the abdominal cavity, the second trocar (T2, 6 mm) is inserted through the left flank at an angle of approximately 30° toward the stomach.

The laparoscope with coupled video camera is placed in T2 and the third trocar (T3, 13 mm) is inserted 2–3 cm below the left subcostal margin on the anterior axillary line in the direction of the center of the greater gastric curvature.

The last trocar (T4, 6 mm) is inserted laterally in the right flank just below the costal margin.

**Step I and III:**

Trocar T1 and T3 will be used for operating instruments, T2 will be the camera port and T4 will be the port used for liver retraction, usually provided by the first assistant (Fig. 3).

**Step II:**

T1 and T2 will be used for bowel measurement, T3 will be the camera port and T4 will be occupied by the clinch holding the stomach remnant (Fig. 3).
**Gastric Resection**

The patient is placed in a slight reverse Trendelenburg position.

Once the stomach has been emptied with an orogastric tube, the margin of the greater curvature is gently grasped by the first assistant with a clinch (T4) and elevated vertically to expose the junction between the great omentum and the gastric wall (Fig. 4).

Dissection is performed with the Ligasure held in the right hand (T3), starting at the middle of the greater curvature close to the gastric wall. The omental bursa is entered by using an atraumatic grasper (T1) with the left hand (Fig. 5).

As the pylorus region is reached, the first assistant elevates the stomach with the clinch (T4) vertically to expose the inferior aspect of the gastric wall, which is freed from its posterior attachments: the pancreas is clearly visualized and the lesser omentum is put under tension (Figs. 6, 7).

Dissection of the lesser omentum starts from the posterior aspect at the level of the pyloric artery that is now coagulated.

Dissection is continued along the greater curvature. The clinch (T4) holds the gastric wall margin at the starting point of dissection and exposes the great omentum while stretching the stomach to the left of the screen. Proceeding cranially and keeping close to the gastric wall, the LigaSure™ (T1) is repeatedly applied until dissection is complete at the level of the first short gastric vessel (Fig. 8).

Dissection of the lesser curvature is completed: with the clinch placed in T4, the gastric wall is mobilized caudally, pulling it gently toward the left leg of the patient and then changing the direction of traction from the right to the left of the screen. Dissection of the lesser curvature begins at the opening of the lesser curvature, level with the pylorus, and is finished at the plane of the descending branch of the left gastric artery (Figs. 9, 10).
Likewise, the posterior margin of the lesser curvature is freed from fat: the stomach is elevated vertically (with the clinch in T4) and the dissection of the posterior aspect is completed.

The orogastric tube is removed. The clinch in T4 exposes the pylorus region by retracting the liver (Fig. 11). The 60-mm linear stapler (blue cartridge) is introduced in T1; the atraumatic grasper in T3 mobilizes the antrum vertically; the stapler is placed just below the pylorus and fired. Integrity of the staple line is checked and, if leaks or sites of hemorrhage are detected, they are managed with a coagulation electrode or oversewn with a continuous absorbable suture (Figs. 12, 13).

The stomach is now transected: with the stapler introduced in T3, two or three loads of 60-mm linear staples (blue cartridge) are fired (Figs. 14, 15).

With the clinch placed in T4 the right cut edge of the transected stomach is firmly held in place to expose the staple line and checked for bleeding or malfunction of the stapler. In case of need, the site of dehiscence or bleeding is clipped/coagulated or reinforced with a continuous absorbable suture.

The gastrotomy is created with a coagulating scissors (T3), 2 cm from the staple line, on the posterior surface of the stomach (Fig. 16).

The stomach is released, grasped by the clinch in T4, and the first assistant, handling the camera port, moves to the left side of the patient.
Small Bowel Measurement

During the second step of the intervention, the surgeon stands on the left side of the patient and proceeds with measuring of the small bowel with the aid of two atraumatic graspers (guided through T1 with the right hand, and T2 with the left hand).

The first assistant, operating the video camera via T3, stands on the left side, next to the patient’s shoulder in cephalic position relative to the operating surgeon, behind the left extended arm.

The patient is placed in a moderate Trendelenburg position. The omentum is gently mobilized toward the right hypochondrium to expose the bowel (Fig. 17). The ileocecal valve is identified and the distal ileum is grasped via T1: the small bowel is gently stretched upward with a grasping forceps in T2 and held against the 5-cm graduation mark of the other grasper (placed in T1), that assumes an almost perpendicular position. By repeating this maneuver ten times, a length of 50 cm from the ileocecal valve is measured (Fig. 18). While firmly holding the limb with the grasper (placed in T2) the last measurement point is marked with a stitch of 2/0 silk suture by using a needle holder that has been passed through T1.

An enterotomy is made just distal to this point: the bowel is suspended vertically by the grasper in T1. For creation of the enterotomy, a coagulating scissors, placed in T2, is applied to the anti-mesenteric margin of the ileum (Fig. 19).

The same technique is employed by measuring 200 cm upstream, and placing a second stitch just proximal to the enterotomy (Fig. 20).
The Double-Loop Technique: Gastro-ileal Anastomosis

At a point, 250 centimeters from the ICV, the limb is firmly held by the surgeon with the grasper placed in T1; the first assistant (operating the video camera) passes from the left to the right of the patient, and the camera changes its position from T3 to T2.

The operating surgeon introduces a 60-mm linear stapler (blue cartridge) via T3. The bowel is picked up at the site of the silk stitch and brought toward the stapler. The anvil of the stapler is inserted through the enterotomy at 250 cm from the ICV (Fig. 21). The patient is placed in a mild reverse Trendelenburg position and the stapler is maneuvered upward and rotated by about 45° toward the stomach in direction of the gastrostomy. The clinch in T4 holds the stomach vertically and exposes the opening in the posterior wall. A latero-lateral gastro-ileal anastomosis is created by advancing the loaded linear stapler into the stomach and pushing the release button. (Fig. 22).

The insertion opening is subsequently closed as follows (Fig. 23):

1. A continuous suture is made using the EndoStitch™ through T3 and clinch (T1) with 18 cm absorbable suture material: the first stitch is passed from the external margin of the opening proximal to T3 (stomach) and through the inside out in the limb (ileum): performing a double-layer continuous suture.

2. Three extra-long (120 cm, absorbable suture material) stay sutures are passed with the EndoStitch™ through the corners and the center of the opening and are pulled outside through port T3. The 60-mm blue roticator stapler is introduced through T3, articulated parallel to the opening and opened to enclose the three stitches that are gently pulled and put under tension. While making sure, that both bowel limbs have been approximated correctly, the stapler is closed and fired.
Laparoscopic Biliopancreatic Diversion

Ileo-ileo Anastomosis

An enterotomy opening is created on the afferent loop, 10 to 15 cm proximal to the gastro-ileo anastomosis (coagulating scissors in the right hand via T3; grasper in the left hand via T1) (Fig. 24).

The efferent bowel loop is gently mobilized (using the graspers in T3 and T1) cranially until the enterotomy at 50 cm from the ICV is visualized (Fig. 25). With the clinch in T4, the first assistant picks up the 2/0 silk traction suture proximal to the opening and provides for proper spacial alignment to the 60-mm roticulator stapler, which is introduced via T1. Once, the anvil of the stapler has been inserted through the enterotomy, the bowel is suspended by the clinch (T4); the stapler is introduced in the bowel in the direction of the IVC and articulated upward (Step I) by the scrub nurse. Assisted by the grasper in T3, the loaded stapler is inserted through the enterotomy on the afferent loop. The two openings are aligned, the stapler is completely articulated (Step II) and fired (Figs. 26–28).

The enterotomy can be closed as described for the gastro-ileo anastomosis:

1. A continuous suture is made using the EndoStitch™ through T3, or
2. Application of one load from the roticulator stapler (60-mm cartridge, white) introduced through T3 (Fig. 29).
End of Procedure

A methylene blue test is performed after insertion of a nasogastric tube to check for anastomotic leaks. The nasogastric tube is left in place for the first 24–48 hours.

A linear stapler, loaded with a 60-mm white cartridge, is introduced via T3 and the bowel limb between the gastro-ileal and the ileo-ileal anastomosis is interrupted, so to create the Roux-en-Y configuration (Fig. 30).

The surgical specimen is extracted via port T3. Once the trocar has been removed, a Kelly grasping forceps is introduced from outside and the fascial incision is enlarged (Fig. 31).

Two transabdominal absorbable sutures are placed via T3 and T1 with the aid of the suture passer to prevent formation of incisional hernias (Fig. 32).

A dissector is passed through T4. A Jackson-Pratt aspiration drain is then grasped from inside out via T3. The drain is maneuvered to its final position below the liver, in proximity to the gastro-ileal anastomosis and the duodenal stump, and then exits via T4 (Fig. 33).

The abdomen is deflated and all trocars are removed. The trocar incisions T3 and T1 are closed with two transabdominal absorbable sutures to prevent formation of incisional hernias.

All skin incisions are clipped with the clip applier.
Introduction

Morbid obesity has increased dramatically in children and adolescents throughout the world during the past 10 years. Both the incidence and severity (BMI) of obesity have continued to rise. This trend is also present in Germany, where the KIGGS study of children and adolescent health in 2006 confirmed a growing number of overweight and obese children during recent years. It is particularly alarming to note that obese children and adolescents, like adults, develop the "metabolic syndrome," characterized by multiple obesity-related conditions such as arterial hypertension, insulin resistance, type 2 diabetes, dyslipidemia, hyperuricemia, as well as orthopedic and emotional disorders.

The first-line treatment for all obese patients, including children and adolescents, is an interdisciplinary lifestyle-intervention program that includes nutritional analysis and education, increased physical activity, individual and family counseling, and interdisciplinary rehabilitation services. On the other hand, the international literature shows that, as in adults, even the best conservative weight-loss programs in children and adolescents often fail to achieve long-term success.

By contrast, reports on experience with bariatric surgery have shown that adults undergoing this surgery not only achieve significant postoperative weight loss but can also maintain their lower BMI at a relatively stable level for 10–15 years. Additionally, these patients experience a significant improvement in comorbid conditions, resulting in a 30–40% reduction of overall mortality in severely obese patients compared with conservative therapy.

The procedures used in bariatric surgery are classified as restrictive (reducing stomach capacity, as by gastric banding) or malabsorptive (bypassing portions of the small intestine to decrease nutritional absorption). Another type of procedure is the sleeve gastrectomy (SG), which greatly reduces the capacity of the stomach without bypassing the intestine. This method has become established as the first (restrictive) weight-loss step in patients diagnosed with super-super obesity (BMI > 50). While the SG often serves as a prelude to an eventual bypass procedure, some patients do not require a second operation, raising the question of what role SG may assume as a stand-alone procedure. Given the familiar long-term complications of standard weight-loss operations in young patients, we were the first to offer SG as a stand-alone procedure for children and adolescents with morbid obesity.

This article reviews the currently accepted medicolegal principles and selection criteria for bariatric surgery as well as the operative techniques that have been described for children and adolescents.
**Indications**

Today, there are (still) no specific guidelines in Germany for recommending bariatric surgery in children and adolescents. It is helpful, however, to review the guidelines of the Bariatric Scientific Collaborative Group (BSCG)¹³, ¹⁴, which define the following criteria:

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### Inclusion criteria

- BMI > 45 kg/m² or 3.5 SDS or BMI > 40 kg/m² and at least one severe or two less severe comorbid conditions (Table 1).
- No weight reduction achieved with a 6- to 12-month interdisciplinary outpatient treatment program (office visits, rehabilitation measures, exercise, nutritional analysis and education, psychotherapeutic counseling).
- Patient selection for bariatric surgery by an interdisciplinary team of experts (including a pediatrician, child psychiatrist, and clinical ethics committee).
- Compliance with necessary follow-up care and replacement therapy.
- Compliance with further management at an obesity center (for children and adolescents).

### Exclusion criteria

- Severe psychiatric disorder (unstable psychosis, borderline personality, severe depression and personality disorders).
- Diagnosed eating disorder.
- Alcohol or drug abuse.
- Inability to participate in long-term interdisciplinary follow-up care.

### Comorbid conditions in obese patients

#### Severe

- Type 2 diabetes or massive hyperinsulinism, impaired glucose tolerance (IGT)
- Obstructive sleep apnea
- Arterial hypertension

#### Less severe

- Osteoarthritis
- Varicose veins
- Dyslipidemia
- Hyperuricemia
- Gastroesophageal reflux
- Limitation of motion
- Panniculitis
- Steatohepatitis

---

**Table 1**

Comorbid conditions in obese patients (adapted from BLÜHER et al., Bariatric surgery in morbidly obese adolescents – proposal for an interdisciplinary concept. *Adipositas – Ursachen, Klinik und Folgeerkrankungen* 2008; 1:36—40.)
Material and Methods

The international literature (PubMed database) was analyzed with respect to patient selection criteria, operative techniques, and results of bariatric surgery in children and adolescents. We researched technical details of the standard procedures, looking for any modifications relative to the techniques used in adults.

We shall also review the technique and results of sleeve gastrectomy based on our own small clinical series. Our surgical technique was basically the same as that recommended by Deitel. Five trocars (2 x 6 mm, 2 x 11 mm, 1 x 15 mm) are placed in a semicircular pattern in the upper abdomen (Fig. 1). The procedure also requires a liver retractor (e.g., Nathanson) in the epigastrium or an additional trocar in the right upper abdomen. A Ch 26 gastroscope is introduced and placed along the lesser curvature of the stomach to protect that region during the operation. Then, the omental bursa is opened approximately 6 cm oral to the pylorus (to obtain a sufficient antrum).

Next the lesser curvature is skeletonized to the left crus of the diaphragm, and the posterior gastric wall is dissected free. The antrum, body, and fundus of the stomach are then resected with an Endo-GIA stapler (Fig. 2) (staple size matched to gastric wall thickness; green or blue cartridge, depending on manufacturer). This resection leaves a gastric remnant shaped like a hockey stick (Fig. 3) with a capacity of only 50–100 mL. The staple line is then secured by oversewing it with running sutures (Fig. 4). It is tested for leaks by the instillation of methylene blue. The specimen is extracted in a retrieval bag.
Results

Operative Techniques

On searching the PubMed database for the literature on bariatric surgery in children and adolescents from 1994 to 2007, we found 802 sites that contained 47 relevant articles (3 cohort studies, 15 case series, 6 case descriptions, 13 survey articles, 4 guidelines, and 6 letters from readers or expert opinions). By far the most common bariatric procedures, based on a detailed analysis of 22 selected original works, were gastric banding (total of 274 operations, 248 of which were laparoscopic) and the Roux-en-Y gastric bypass (total of 292 operations, 62 of which were laparoscopic). Technical details such as trocar sites, band position, and gastric pouch size were basically identical to the reports from the adult literature. The most frequent complications of gastric banding were band slippage (1.8%), need for reversal or revision (due to various causes, 2.1%), iron deficiency anemia (1.5%), and hair loss (1.8%). The main complications associated with the Roux-en-Y bypass were ulcers and abdominal wall hernias (2.4% each), iron deficiency (3.4%), and protein deficiency (4.8%). Revision was necessary in 7.5% of cases. All the procedures were of comparable efficacy in achieving postoperative weight loss, and they all allowed for sustainable weight loss over a period of several years.

Our own small series of sleeve gastrectomies involved a total of four children and adolescents (average age 14.5 years, range of 8–17 years) with an average preoperative BMI of 48.4 (range of 40.6–56.3) and multiple comorbidity in the form of metabolic syndrome. Postoperative radiographs in all patients confirmed a watertight staple line. No postoperative complications were documented over an average follow-up period of 18.75 months (range of 13–27 months, unpublished data). All the patients experienced significant weight loss (current average BMI = 34.8) and showed continuous improvement or even complete resolution of their comorbid conditions.

Discussion

When all conservative treatment options have been unsuccessful in morbidly obese children and adolescents, then (and only then) does bariatric surgery offer a reasonable alternative. The indications for bariatric surgery have been internationally established and should be swiftly adopted in Germany in the form of guidelines. This is because the Roux-en-Y bypass, gastric banding and, more recently, the sleeve gastrectomy appear to produce effective postoperative weight loss while also improving obesity-related conditions. On the other hand, experience with bariatric surgery in children and adolescents is still limited, and little is known about the long-term complications associated with specific procedures. Thus, these patients should be treated according to the American model (e.g., Cincinnati) at reputable centers which have access to age-specific (pediatric) specialists and are associated with a high-volume center that performs bariatric surgery in adults. This would yield data on efficacy, advantages/disadvantages, complications, and long-term results so that current concepts of morbid obesity surgery in children and adolescents could be continually analyzed and improved. In addition, a central registry of obesity surgery should be established in Germany for patients under 18 years of age so that the specific case histories and results in this population could be reviewed and critically assessed.
References


The nominal fee of 5 € per copy will go to “Moby Dick”, a Health Program for Obese Children and Teenagers:

**Moby Dick Club e.V.**  
Deutsche Apotheker- und Ärztebank  
Bank Code: 300 606 01  
Account No.: 0006532403  
IBAN: DE23 3006 0601 0006 5324 03  
BIC (Swift Code): DAADEDDD

For more detailed information about “Moby Dick”, please refer to the following websites:

- [www.mobydickhamburg.de](http://www.mobydickhamburg.de)  
- [www.mobydicknetzwerk.de](http://www.mobydicknetzwerk.de)

Thank you for your donation!
Instrument Sets for Laparoscopic Bariatric Surgery
Telescopes, Operating Instruments, Accessories and Units
Instruments for Gastric Banding
Recommended Set, Standard-sized Instruments
Instruments for Gastric Banding

Recommended Set, Standard-sized Instruments

- **Trocar**, with conical tip, insufflation stopcock, multifunctional valve, size 11 cm, working length 10.5 cm, color code: green
- **Reducer**, attachable, 11/5 mm
- **Trocar**, with conical tip, insufflation stopcock, multifunctional valve, size 6 mm, working length 10.5 cm, color code: black
- **HOPKINS® Forward-Oblique Telescope 30°**, enlarged view, diameter 10 mm, length 31 cm, autoclavable, fiber optic light transmission incorporated, color code: red
- **Reduction Sleeve**, reusable, instrument diameter 5 mm, trocar cannula outer diameter 13 mm, color code: black
- **Fiber Optic Light Cable**, diameter 4.8 mm, length 300 cm
- **Metal Outer Sheath**, with cm-marking, insulated, with Luer-Lock connector for cleaning, size 5 mm, length 36 cm, for use with Forceps Insert 33310KW
- **CLICKLINE® Scissors**, rotating, dismantling, insulated, with connector pin for unipolar coagulation, double action jaws, serrated, curved, conical, size 5 mm, length 36 cm

- **Scissors Insert**, for CLICKLINE® Instruments, serrated, curved, conical, package of 12 (not illustrated)
- **REDDICK-OLSEN Dissecting and Grasping Forceps**, rotating, dismantling, insulated, with connector pin for unipolar coagulation, double action jaws, robust, size 5 mm, length 36 cm, for use with trocars size 6 mm
- **KELLY Dissecting and Grasping Forceps**, rotating, dismantling, insulated, with connector pin for unipolar coagulation, double action jaws, long, size 5 mm, length 36 cm, for use with trocars size 6 mm
- **Dissecting and Grasping Forceps**, rotating, dismantling, insulated, with connector pin for bipolar coagulation, double action jaws, atraumatic, size 5 mm, length 36 cm, for use with trocars size 6 mm
- **Hook Scissors**, rotating, dismantling, without connector pin for unipolar coagulation, with irrigation connection for cleaning, single action jaws, jaws not crossing, size 5 mm, length 36 cm
- **Grasping Forceps**, rotating, dismantling, without connector pin for unipolar coagulation, single action jaws, with fine atraumatic serration, fenestrated, size 5 mm, length 36 cm
- **Grasping Forceps**, rotating, dismantling, without connector pin for unipolar coagulation, with irrigation connection for cleaning, double action jaws, atraumatic, fenestrated, size 5 mm, length 36 cm
- **ROBI® Grasping Forceps**, CLERMONT-FERRAND model, rotating, dismantling, with connector pin for bipolar coagulation, curved slender blades, double action jaws, size 5 mm, length 36 cm, color code: light blue
- **METZENBAUM Scissors**, CLERMONT-FERRAND model, rotating, dismantling, with connector pin for bipolar coagulation, straight jaws, size 5 mm, length 36 cm, color code: light blue
- **KELLY Grasping Forceps**, CLEMONT ONT-FERRAND model, rotating, dismantling, with connector pin for bipolar coagulation, curved slender blades, double action jaws, size 5 mm, length 36 cm, color code: light blue
- **BERCI Facial Closure Instrument** for subcutaneous ligature of trocar incisions, size 2.8 mm, length 17 cm
- **KOH Macro Needle Holder**, dismantling, with Luer-Lock irrigation connector for cleaning, single action jaws, straight jaws, with tungsten carbide inserts, with axial handle, disengagable ratchet, ratchet position left, size 5 mm, length 33 cm
- **Same, jaws curved to left, ratchet position right**
- **PILLING Titanium Clips**, (medium-large), box with 16 cartridges, 10 clips each, sterile, for use with applicator 30444LR
- **Applicator**, dismantling, rotating, for PILLING ligating clips 26060AL (medium-large), with ratchet to lock the jaw holding the clip
- **KOECKERLING Knot Tier**, for extracorporeal knotting size 5 mm, length 36 cm
- **Unipolar High Frequency Cord**, with 5 mm plug for HF unit, models KARL STORZ AUTOCON® system (50, 200, 350), AUTOCON® II 400 (111, 115) and Erbe type ICC, length 300 cm
- **Metal Outer Sheath**, with cm-marking, with Luer-Lock connector for cleaning, size 10 mm, length 36 cm, for use with Forceps Insert 33510BS
- **BABCOCK Grasping Forceps**, rotating, dismantling, without connector pin for unipolar coagulation, with irrigation connection for cleaning, double action jaws, rounded, long, size 10 mm, length 36 cm
- **DUVAL Grasping Forceps**, rotating, dismantling, without connector pin for unipolar coagulation, with irrigation connection for cleaning, double action jaws, size 10 mm, length 36 cm
- **Surgical Sponge Holder**, for atraumatic dissection of tissue layers, size 10 mm, length 30 cm
- **Coagulating and Dissecting Electrode**, insulated sheath, with connector pin for unipolar coagulation, L-shaped, size 5 mm, length 36 cm
- **Exchangeable Electrode Tip**, L-shaped, autoclavable, package of 6
- **Suction and Irrigation Cannula** with lateral holes, size 5 mm, length 36 cm, for use with suction and irrigation handles, autoclavable
- **Pistol Grip Handle**, with clamping valve, for suction and irrigation, autoclavable
- **CUSHIERI Retractor**, size 10 mm, length 36 cm, large contact surface
- **Retractor for Gastric Banding**, size 10 mm, length 36 cm

Optional solution for suction and irrigation

- **Pistol Grip Handle**, with clamping valve, for suction and irrigation, autoclavable
- **Suction and Irrigation Cannula** with lateral holes, size 5 mm, length 36 cm, for use with suction and irrigation handles

It is recommended to check the suitability of the product for the intended procedure prior to use.
Instruments for Laparoscopic Roux-Y-Gastric Bypass
Recommended Set, Standard-sized Instruments
## Instruments for Laparoscopic Roux-Y-Gastric Bypass

### Recommended Set, Standard-sized Instruments

<table>
<thead>
<tr>
<th>Item Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>30108MTR</td>
<td>TERNAMIAN EndoTIP Cannula, with thread and rotating stopcock, size 13.5 mm, working length 11.5 cm, color code: blue</td>
</tr>
<tr>
<td>30142HB</td>
<td>Double Reducer, 13/10 mm, 13.5/10 mm, 13/5 mm und 13.5/5 mm</td>
</tr>
<tr>
<td>26003BA</td>
<td>HOPKINS® Forward-Oblique Telescope 30°, enlarged view, diameter 10 mm, length 31 cm, autoclavable, fiber optic light transmission incorporated, color code: red</td>
</tr>
<tr>
<td>30106KP</td>
<td>Trocar, with pyramidal tip, insufflation stopcock, automatic valve, size 22 mm, working length 12 cm</td>
</tr>
<tr>
<td>30103TM</td>
<td>TERNAMIAN EndoTIP Cannula, with thread and rotatable insufflation stopcock, size 11 mm, working length 10.5 cm, color code: green</td>
</tr>
<tr>
<td>30103CS</td>
<td>Telescope Stopper, sterile, size 11 mm, for single use, package of 12</td>
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<tr>
<td>30140HB</td>
<td>Reduction Sleeve, reusable, instrument diameter 5 mm, trocar cannula outer diameter 13 mm, color code: black</td>
</tr>
<tr>
<td>495NE</td>
<td>Fiber Optic Light Cable, diameter 4.8 mm, length 300 cm</td>
</tr>
<tr>
<td>33300CM</td>
<td>Metal Outer Sheath, with cm-marking, insulated, with Luer-Lock connector for cleaning, size 5 mm, length 36 cm, for use with Forceps Insert 33310KW</td>
</tr>
<tr>
<td>34351MA</td>
<td>CLICKLINE® Scissors, rotating, dismantling, insulated, with connector pin for unipolar coagulation, double action jaws, serrated, curved, round cupped jaws, length of blades 17 mm, size 5 mm, length 36 cm</td>
</tr>
<tr>
<td>33325KW</td>
<td>CLICKLINE® MATKOWITZ Grasping Forceps, double-action jaws, diameter 5 mm, length 36 cm, with connector pin for unipolar coagulation</td>
</tr>
<tr>
<td>33325ML</td>
<td>CLICKLINE® KELLY Dissecting and Grasping Forceps, rotating, dismantling, insulated, with connector pin for unipolar coagulation, double action jaws, long, size 5 mm, length 36 cm, for use with trocars size 6 mm</td>
</tr>
<tr>
<td>33361AV</td>
<td>CLICKLINE® Anvil Grasper, rotating, double action jaws, size 5 mm, length 36 cm</td>
</tr>
<tr>
<td>33363ON</td>
<td>CLICKLINE® Grasping Forceps, rotating, dismantling, without connector pin for unipolar coagulation, single action jaws, with fine serration, fenestrated, size 5 mm, length 36 cm, 2 pcs. required</td>
</tr>
<tr>
<td>38651ON</td>
<td>ROBI® Grasping Forceps, CLERMONT-FERRAND model, rotating, dismantling, with connector pin for bipolar coagulation, with fine serration, fenestrated jaws, double action jaws, size 5 mm, length 36 cm, color code: light blue</td>
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<tr>
<td>38651MW</td>
<td>ROBI® METZENBAUM Scissors, CLERMONT-FERRAND model, rotating, dismantling, with connector pin for bipolar coagulation, curved slender blades, double action jaws, size 5 mm, length 36 cm, color code: light blue</td>
</tr>
<tr>
<td>38651MD</td>
<td>ROBI® KELLY Grasping Forceps, CLERMONT-FERRAND model, rotating, dismantling, with connector pin for bipolar coagulation, suitable for dissection, double action jaws, size 5 mm, length 36 cm, color code: light blue</td>
</tr>
<tr>
<td>26173AM</td>
<td>BERCI Fascial Closure Instrument for subcutaneous ligature of trocar incisions, size 2.8 mm, length 17 cm</td>
</tr>
<tr>
<td>30460AL</td>
<td>PILLING Titanium Clips, (medium-large), box with 16 cartridges, 10 clips each, sterile, for use with applicator 30444LR</td>
</tr>
<tr>
<td>30444LR</td>
<td>Applicator, dismantling, rotating, for PILLING ligating clips 26060AL (medium-large), with ratchet to lock the jaw holding the clip</td>
</tr>
<tr>
<td>30173FAL</td>
<td>KOH Macro Needle Holder, dismantling, with Luer-Lock irrigation connector for cleaning, single action jaws, straight jaws, with tungsten carbide inserts, with connector pin for bipolar coagulation, with cm-marking, insulated, with Luer-Lock connector for cleaning, size 5 mm, length 36 cm, working length 10.5 cm, color code: black</td>
</tr>
<tr>
<td>30173LR</td>
<td>Same, jaws curved to left, ratchet position right</td>
</tr>
<tr>
<td>33533BLS</td>
<td>CLICKLINE® BABCOCK Grasping Forceps, rotating, dismantling, without connector pin for unipolar coagulation, with irrigation connection for cleaning, double action jaws, rounded, long, size 10 mm, length 36 cm</td>
</tr>
<tr>
<td>33500CM</td>
<td>Metal Outer Sheath, with cm-marking, with Luer-Lock connector for cleaning, size 10 mm, length 36 cm, for use with Forceps Insert 33510BSL</td>
</tr>
<tr>
<td>37360LH</td>
<td>Suction and Irrigation Cannula with lateral holes, size 5 mm, length 36 cm, for use with suction and irrigation handles</td>
</tr>
<tr>
<td>30805</td>
<td>Handle with Two-Way Stopcock, suitable for irrigation and suction, for use with 5 mm suction and irrigation tubes, autoclavable</td>
</tr>
<tr>
<td>30775UF</td>
<td>Coagulating and Dissecting Electrode, insulated sheath, with connector pin for unipolar coagulation, L-shaped, size 5 mm, length 36 cm</td>
</tr>
<tr>
<td>30775UFE</td>
<td>Exchangeable Electrode Tip, L-shaped, autoclavable, package of 6</td>
</tr>
<tr>
<td>30623URL</td>
<td>CUSCHIERI Retractor, size 10 mm, length 36 cm, large contact surface</td>
</tr>
</tbody>
</table>

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**Optional solution for suction and irrigation**

* 37113A | Pistol Grip Handle, with clamping valve, for suction and irrigation, autoclavable

** 37360LH | Suction and Irrigation Cannula with lateral holes, size 5 mm, length 36 cm, for use with suction and irrigation handles*
Instruments for Bileopancreatic Diversion Sleeve Gastrectomy
Recommended Set, Standard-sized Instruments
Recommended Set, Standard-sized Instruments

- **30108MTR** TERNAMIAN EndoTIP Cannula, with thread and rotating stopcock, size 13.5 mm, working length 11.5 cm, color code: blue
- **30160MC** Trocar, with conical tip, insufflation stopcock, multifunctional valve, size 6 mm, working length 10.5 cm, color code: black
- **30103MC** Trocar, with conical tip, insufflation stopcock, multifunctional valve, size 11 cm, working length 10.5 cm, color code: green
- **30140HB** Reduction Sleeve, reusable, instrument diameter 5 mm, trocar cannula outer diameter 13 mm, color code: black
- **26003AA** HOPKINS® Straight Forward Telescope 0°, enlarged view, diameter 10 mm, length 31 cm, autoclavable, fiber optic light transmission incorporated, color code: green
- **495NE** Fiber Optic Light Cable, diameter 4.8 mm, length 300 cm
- **33300CM** Metal Outer Sheath, with cm-marking, insulated, with Luer-Lock connector for cleaning, size 5 mm, length 36 cm, for use with Forceps Insert 33310KW
- **34351MW** CLICKLINE® Scissors, rotating, dismantling, insulated, with connector pin for unipolar coagulation, double action jaws, serrated, curved, conical, size 5 mm, length 36 cm
- **34310MWP** Scissors Insert, for CLICKLINE® Instruments, serrated, curved, conical, package of 12 (not illustrated)
- **33325UL** CLICKLINE® REDDICK-OLSEN Dissecting and Grasping Forceps, rotating, dismantling, insulated, with connector pin for unipolar coagulation, double action jaws, robust, size 5 mm, length 36 cm, for use with trocars size 6 mm
- **33325ML** CLICKLINE® KELLY Dissecting and Grasping Forceps, rotating, dismantling, insulated, with connector pin for unipolar coagulation, double action jaws, long, size 5 mm, length 36 cm, for use with trocars size 6 mm
- **33325DF** CLICKLINE® Dissecting and Grasping Forceps, rotating, dismantling, insulated, with connector pin for unipolar coagulation, double action jaws, atraumatic, size 5 mm, length 36 cm, for use with trocars size 6 mm
- **34361EK** CLICKLINE® Hook Scissors, rotating, dismantling, without connector pin for unipolar coagulation, with irrigation connection for cleaning, single action jaws, jaws not crossing, size 5 mm, length 36 cm
- **33363ON** CLICKLINE® Grasping Forceps, rotating, dismantling, without connector pin for unipolar coagulation, single action jaws, with fine-serration, fenestrated, size 5 mm, length 36 cm
- **33363AF** CLICKLINE® Grasping Forceps, rotating, dismantling, without connector pin for unipolar coagulation, with irrigation connection for cleaning, double action jaws, atraumatic, fenestrated, size 5 mm, length 36 cm
- **38651ON** ROBI® METZENBAUM Dissecting and Grasping Forceps, CLERMONT-FERRAND model, rotating, dismantling, with connector pin bipolar coagulation, curved slender blades, double action jaws, size 5 mm, length 36 cm, color code: light blue
- **38651MW** ROBI® METZENBAUM Scissors, CLERMONT-FERRAND model, rotating, dismantling, with connector pin for bipolar coagulation, curved slender blades, double action jaws, size 5 mm, length 36 cm, color code: light blue
- **38651MD** ROBI® KELLY Grasping Forceps, CLERMONT-FERRAND model, rotating, dismantling, with connector pin for bipolar coagulation, suitable for dissection, double action jaws, size 5 mm, length 36 cm, color code: light blue
- **26173AM** BERCi Fascial Closure Instrument for subcutaneous ligation of trocar incisions, size 2.8 mm, length 17 cm
- **30460AL** PILLING Titanium Clips, (medium-large), box with 16 cartridges, 10 clips each, sterile, for use with applicator 30444LR
- **30444LR** Applicator, dismantling, rotating, for PILLING ligating clips 26060AL (medium-large), with ratchet to lock the jaw holding the clip
- **26005M** Unipolar High Frequency Cord, with 5 mm plug for HF unit, models KARL STORZ AUTOCON® system (50, 200, 350), AUTOCON® II 400 (111, 115) and Erbe type ICC, length 300 cm
- **33500CM** Metal Outer Sheath, with cm-marking, with Luer-Lock connector for cleaning, size 10 mm, length 36 cm, for use with Forceps Insert 33510BLS
- **33533BLS** CLICKLINE® BABCOCK Dissecting and Grasping Forceps, rotating, dismantling, without connector pin for unipolar coagulation, with irrigation connection for cleaning, double action jaws, rounded, long, size 10 mm, length 36 cm
- **33533DU** CLICKLINE® DUVAL Dissecting and Grasping Forceps, rotating, dismantling, without connector pin for unipolar coagulation, with irrigation connection for cleaning, double action jaws, size 10 mm, length 36 cm
- **32540PT** Surgical Sponge Holder, foratraumatic dissection of tissue layers, size 10 mm, length 30 cm
- **30775UF** Coagulating and Dissecting Electrode, insulated sheath, with connector pin for unipolar coagulation, L-shaped, size 5 mm, length 36 cm
- **30775UFE** Exchangeable Electrode Tip, L-shaped, autoclavable, package of 6
- **37360LH** Suction and Irrigation Cannula with lateral holes, size 5 mm, length 36 cm, for use with suction and irrigation handles
- **30805** Handle with Two-Way Stopcock, suitable for irrigation and suction, for use with 5 mm suction and irrigation tubes, autoclavable
- **30623URL** CUSCHIERI Retractor, size 10 mm, length 36 cm, large contact surface

Optional solution for suction and irrigation
- **37113A** Pistol Grip Handle, with clamping valve, for suction and irrigation, autoclavable
- **37360LH** Suction and Irrigation Cannula with lateral holes, size 5 mm, length 36 cm, for use with suction and irrigation handles
Instruments for Duodenal Switch
Recommended Set, Standard-sized Instruments
Recommended Set, Standard-sized Instruments

- 30108MTR TERNAMIAN EndoTIP Cannula, with thread and rotating stopcock, size 13.5 mm, working length 11.5 cm, color code: blue
- 30103MC Trocar, with conical tip, with insufflation stopcock, size 11 cm, working length 10.5 cm, color code: green
- 30160MC Trocar, with conical tip, insufflation stopcock, multifunctional valve, size 6 mm, working length 10.5 cm, color code: black
- 30140HB Reduction Sleeve, reusable, instrument diameter 5 mm, trocar cannula outer diameter 13 mm, color code: black
- 26003AA HOPKINS® Straight Forward Telescope 0°, enlarged view, diameter 10 mm, length 31 cm, autoclavable, fiber optic light transmission incorporated, color code: green
- 495NE Fiber Optic Light Cable, diameter 4.8 mm, length 300 cm
- 33300CM Metal Outer Sheath, with cm-marking, insulated, with LUER-Lock connector for cleaning, size 5 mm, length 36 cm, for use with Forceps Insert 33310KW
- 34351MW CLICKLINE® Scissors, rotating, dismantling, insulated, with connector pin for unipolar coagulation, double action jaws, serrated, curved, conical, size 5 mm, length 36 cm
- 34310MWP Scissors Insert, for CLICKLINE® Instruments, serrated, curved, conical, package of 12 (not illustrated)
- 33325ML CLICKLINE® KELLY Dissecting and Grasping Forceps, rotating, dismantling, insulated, with connector pin for unipolar coagulation, double action jaws, long, size 5 mm, length 36 cm, for use with trocars size 6 mm
- 33325DF CLICKLINE® Dissecting and Grasping Forceps, rotating, dismantling, insulated, with connector pin for unipolar coagulation, double action jaws, atraumatic, size 5 mm, length 36 cm, for use with trocars size 6 mm
- 33363ON CLICKLINE® Grasping Forceps, rotating, dismantling, without connector pin for unipolar coagulation, single action jaws, with fine serration, fenestrated, size 5 mm, length 36 cm
- 33363AF CLICKLINE® Grasping Forceps, rotating, dismantling, without connector pin for unipolar coagulation, with irrigation connection for cleaning, double action jaws, atraumatic, fenestrated, size 5 mm, length 36 cm
- 38651ON ROBI® Grasping Forceps, CLERMONT-FERRAND model, rotating, dismantling, with connector pin for bipolar coagulation, curved slender blades, double action jaws, single action jaws, size 5 mm, length 36 cm, color code: light blue
- 38651MW ROBI® METZENBAUM Scissors, CLERMONT-FERRAND model, rotating, dismantling, with connector pin for bipolar coagulation, curved slender blades, double action jaws, size 5 mm, length 36 cm, color code: light blue
- 38651MD ROBI® KELLY Grasping Forceps, CLERMONT-FERRAND model, rotating, dismantling, with connector pin for bipolar coagulation, suitable for dissection, double action jaws, size 5 mm, length 36 cm, color code: light blue
- 26173AM BERCI Fascial Closure Instrument for subcutaneous ligature of trocar incisions, size 2.8 mm, length 17 cm
- 30460AL PILLING Titanium Clips, (medium-large), box with 16 cartridges, 10 clips each, sterile, for use with applicator 30444LR
- 30444LR Applicator, dismantling, rotating, for PILLING ligating clips 26060AL (medium-large), with ratchet to lock the jaw holding the clip
- 26005M Unipolar High Frequency Cord, with 5 mm plug for HF unit, models KARL STorz AUTOCON® system (50, 200, 350), AUTOCON® II 400 (111, 115) and Erbe type ICC, length 300 cm
- 30173FAL KOH Macro Needle Holder, dismantling, with LUER-Lock irrigation connector for cleaning, single action jaws, straight jaws, with tungsten carbide inserts, with axial hand, disengageable ratchet, ratchet position left, size 5 mm, length 33 cm
- 30173LAR Same, jaws curved to left, ratchet position right
- 30775UF Coagulating and Dissecting Electrode, insulated sheath, with connector pin for unipolar coagulation, L-shaped, size 5 mm, length 36 cm
- 30775UFE Exchangeable Electrode Tip, L-shaped, autoclavable, package of 6
- 37360LH Suction and Irrigation Cannula with lateral holes, size 5 mm, length 36 cm, for use with suction and irrigation handles
- 30805 Handle with Two-Way Stopcock, suitable for irrigation and suction, for use with 5 mm suction and irrigation tubes, autoclavable
- 30623URL CUSCHIERI Retractor, size 10 mm, length 36 cm, large contact surface

Optional solution for suction and irrigation

- *37113A Pistol Grip Handle, with clamping valve, for suction and irrigation, autoclavable
- **37360LH Suction and Irrigation Cannula with lateral holes, size 5 mm, length 36 cm, for use with suction and irrigation handles
Instruments for Bariatric Surgery in Pediatrics
Recommended Set
**Instruments for Bariatric Surgery in Pediatrics**

**Recommended Set**

- **30108MTR** TERNAMIAN EndoTIP Cannula, with thread and rotating stopcock, size 13.5 mm, working length 11.5 cm, color code: blue
- **30142HB** Double Reducer, 13/10 mm, 13.5/10 mm, 13/5 mm and 13.5/5 mm
- **30103MC** Trocar, with conical tip, insufflation stopcock, multifunctional valve, size 11 cm, working length 10.5 cm, color code: green
- **30160MC** Trocar, with conical tip, insufflation stopcock, multifunctional valve, size 6 mm, working length 10.5 cm, color code: black
- **26003BA** HOPKINS® Forward-Oblique Telescope 30°, enlarged view, diameter 10 mm, length 31 cm, autoclavable, fiber optic light transmission incorporated, color code: red
- **30105KP** Trocar, with pyramidal tip, insufflation stopcock, automatic valve, size 15 mm, working length 12 cm
- **495NL** Fiber Optic Light Cable, diameter 3.5 mm, length 180 cm
- **33300CM** Metal Outer Sheath, with cm-marking, insulated, with LUER-Lock connector for cleaning, size 5 mm, length 36 cm, for use with Forceps Insert 33310KW
- **34351MW** CLICKLINE® Scissors, rotating, dismantling, insulated, with connector pin for unipolar coagulation, double action jaws, serrated, curved, conical, size 5 mm, length 36 cm
- **34310MWP** Scissors Insert, for CLICKLINE® Instruments, serrated, curved, conical, package of 12 (not illustrated)
- **33325ML** CLICKLINE® KELLY Dissecting and Grasping Forceps, rotating, dismantling, insulated, with connector pin for unipolar coagulation, double action jaws, long, size 5 mm, length 36 cm, for use with trocars size 6 mm
- **33325DF** CLICKLINE® Dissecting and Grasping Forceps, rotating, dismantling, insulated, with connector pin for unipolar coagulation, double action jaws, atraumatic, size 5 mm, length 36 cm, for use with trocars size 6 mm
- **33363ON** CLICKLINE® Grasping Forceps, rotating, dismantling, without connector pin for unipolar coagulation, single action jaws, with fine serration, fenestrated, size 5 mm, length 36 cm
- **33363AF** CLICKLINE® Grasping Forceps, rotating, dismantling, without connector pin for unipolar coagulation, with irrigation connection for cleaning, double action jaws, atraumatic, fenestrated, size 5 mm, length 36 cm
- **38651ON** ROBI® Grasping Forceps, CLERMONT-FERRAND model, rotating, dismantling, with connector pin for bipolar coagulation, curved slender blades, double action jaws, size 5 mm, length 36 cm, color code: light blue
- **38651MW** ROBI® METZENBAUM Scissors, CLERMONT-FERRAND model, rotating, dismantling, with connector pin for bipolar coagulation, curved slender blades, double action jaws, size 5 mm, length 36 cm, color code: light blue
- **38651MD** ROBI® KELLY Grasping Forceps, CLERMONT-FERRAND model, rotating, dismantling, with connector pin for bipolar coagulation, suitable for dissection, double action jaws, size 5 mm, length 36 cm, color code: light blue
- **26173AM** BERCI Fascial Closure Instrument for subcutaneous ligature of trocar incisions, size 2.8 mm, length 17 cm
- **30460AL** PILLING Titanium Clips, (medium-large), box with 16 cartridges, 10 clips each, sterile, for use with applicator 30444LR
- **30444LR** Applicator, dismantling, rotating, for PILLING ligating clips 26060AL (medium-large), with ratchet to lock the jaw holding the clip
- **26005M** Unipolar High Frequency Cord, with 5 mm plug for HF unit, models KARL STORZ AUTOCON® system (50, 200, 350), AUTOCON® II 400 (111, 115) and Erbe type ICC, length 300 cm
- **30173FAL** KOH Macro Needle Holder, dismantling, with LUER-Lock irrigation connector for cleaning, single action jaws, straight jaws, with tungsten carbide inserts, with axial-handle, disengageable ratchet, ratchet position left, size 5 mm, length 33 cm
- **30173LAR** Same, jaws curved to left, ratchet position right
- **30775UF** Coagulating and Dissecting Electrode, insulated sheath, with connector pin for unipolar coagulation, L-shaped, size 5 mm, length 36 cm
- **30775UFE** Exchangeable Electrode Tip, L-shaped, autoclavable, package of 6
- **37360LH** Suction and Irrigation Cannula with lateral holes, size 5 mm, length 36 cm, for use with suction and irrigation handles
- **30805** Handle with Two-Way Stopcock, suitable for irrigation and suction, for use with 5 mm suction and irrigation tubes, autoclavable
- **30623U** CUSCHIERI Retractor, size 5 mm, length 36 cm

**Optional solution for suction and irrigation**

- **37113A** Pistol Grip Handle, with clamping valve, for suction and irrigation, autoclavable
- **37360LH** Suction and Irrigation Cannula with lateral holes, size 5 mm, length 36 cm, for use with suction and irrigation handles
HOPKINS® Telescopes
Diameter 10 mm, length 31 cm and 42 cm

- **HOPKINS® Straight Forward Telescope 0°**, enlarged view, diameter 10 mm, length 31 cm, autoclavable, fiber optic light transmission incorporated, color code: green
- **HOPKINS® Forward-Oblique Telescope 30°**, enlarged view, diameter 10 mm, length 31 cm, autoclavable, fiber optic light transmission incorporated, color code: red
- **HOPKINS® Straight Forward Telescope 0°**, enlarged view, diameter 10 mm, length 42 cm, autoclavable, fiber optic light transmission incorporated, color code: green
- **HOPKINS® Forward-Oblique Telescope 30°**, enlarged view, diameter 10 mm, length 42 cm, autoclavable, fiber optic light transmission incorporated, color code: red

- **Telescope Stopper**, sterile, size 11 mm, for single use, package of 12

- **ENDOCAMELEON® HOPKINS® Telescope**, diameter 10 mm, length 32 cm, autoclavable, variable direction of view from 0°–120°, adjustment knob for selecting the desired direction of view, fiber optic light transmission incorporated, color code: gold
TERNAMIAN EndoTIP Cannulas
size 11 mm and 13.5 mm

30103TM TERNAMIAN EndoTIP Cannula, with thread and rotatable insufflation stopcock, size 11 mm, working length 10.5 cm, color code: green, including:
Multifunctional Valve Cannula
31103T4 Same, working length 15 cm

30108MTR TERNAMIAN EndoTIP Cannula, with thread and rotating stopcock, size 13.5 mm, working length 11.5 cm, color code: blue, including:
Multifunctional Valve Cannula
31108MTR Same, working length 15 cm

Trocars
size 6 and 11 mm

30160MC Trocar, with conical tip, insufflation stopcock, size 6 mm, working length 10.5 cm, color code: black, including:
Trocar only Cannula, without valve
Multifunctional Valve
31160MC Same, working length 15 cm

30103MC Trocar, with conical tip, with insufflation stopcock, size 11 cm, working length 10.5 cm, color code: green, including:
Trocar only Cannula, without valve
Multifunctional Valve
31103MC Same, working length 15 cm
Trocars and Accessoires
size 15 and 22 mm

30105KP  **Trocar**, with pyramidal tip, with insufflation stopcock, size 15 mm, working length 12 cm, including:
* Cannula, without valve
* **Trocar only**
* **Automatic Valve**

30106KP  **Same**, working length 15 cm

30140HB  **Reduction Sleeve**, reusable, instrument diameter 5 mm, trocar cannula outer diameter 13 mm, color code: black

30141DB  **Reducer**, attachable, 11/5 mm

30142HB  **Double Reducer**, 13/10 mm, 13.5/10 mm, 13/5 mm and 13.5/5 mm
CUSCHIERI Liver Retractor
size 5 and 10 mm

CUSCHIERI Retractor, size 5 mm, length 36 cm

CUSCHIERI Retractor, size 10 mm, length 36 cm

CUSCHIERI Retractor, size 10 mm, length 36 cm, large contact surface

Retractor for Gastric Banding
size 5 and 10 mm

Retractor for Gastric Banding, size 5 mm, length 36 cm

Same, size 10 mm
CLICKLINE® Scissors
Size 5 mm, length 36 cm and 43 cm

34351MA CLICKLINE® Scissors, rotating, dismantling, insulated, with connector pin for unipolar coagulation, double action jaws, serrated, curved, round cupped jaws, length of blades 17 mm, size 5 mm, length 36 cm, including:
PLastic Handle, insulated, without ratchet
Outer Sheath, insulated
Scissors Insert

34451MA Same, length 43 cm

34351MW CLICKLINE® Scissors, rotating, dismantling, insulated, with connector pin for unipolar coagulation, double action jaws, serrated, curved, conical, size 5 mm, length 36 cm, including:
Plastic Handle, insulated, without ratchet
Outer Sheath, insulated
Scissors Insert

34451MW Same, length 43 cm

34310MWP Scissors Insert, for CLICKLINE® Instruments, serrated, curved, conical, package of 12
CLICKLINE® Hook Scissors and ROBI® METZENBAUM Scissors
Size 5 mm, length 36 cm and 43 cm

CLICKLINE® Hook Scissors, rotating, dismantling, without connector pin for unipolar coagulation, with irrigation connection for cleaning, single action jaws, jaws not crossing, size 5 mm, length 36 cm, including:
- Metal Handle, with hemostat style ratchet, with larger contact area
- Outer Sheath, insulated

Scissors Insert

34461EK  Same, length 43 cm

ROBI® METZENBAUM Scissors, CLERMONT-FERRAND model, rotating, dismantling, with connector pin for bipolar coagulation, with Luer-Lock irrigation connector for cleaning, double action jaws, curved, slender blades, for cutting and bipolar coagulation, size 5 mm, length 36 cm, including:
- Ring Handle
- Metal Outer Sheath, insulated

Scissors Insert

38751MW  Same, length 43 cm
CLICKLINE® Dissecting and Grasping Forceps

Size 5 mm, length 36 cm and 43 cm

33325DF CLICKLINE® Dissecting and Grasping Forceps, rotating, dismantling, insulated, with connector pin for unipolar coagulation, double action jaws, atraumatic, size 5 mm, length 36 cm, for use with trocars size 6 mm, including:
- Metal Handle, with hemostat style ratchet, with larger contact area
- Outer Sheath, insulated
- Forceps Insert

33425DF Same, length 43 cm

33325KW CLICKLINE® MATKOWITZ Grasping Forceps, double-action jaws, diameter 5 mm, length 36 cm, with connector pin for unipolar coagulation, including:
- Metal Handle, with hemostat style ratchet, with larger contact area
- Outer Sheath, insulated
- Forceps Insert

33425KW Same, length 43 cm

33325ML CLICKLINE® KELLY Dissecting and Grasping Forceps, rotating, dismantling, insulated, with connector pin for unipolar coagulation, double action jaws, long, size 5 mm, length 36 cm, for use with trocars size 6 mm, including:
- Metal Handle, with hemostat style ratchet, with larger contact area
- Outer Sheath, insulated
- Forceps Insert

33425ML Same, length 43 cm

33325UL CLICKLINE® REDDICK-OLSEN Dissecting and Grasping Forceps, rotating, dismantling, insulated, with connector pin for unipolar coagulation, double action jaws, robust, size 5 mm, length 36 cm, for use with trocars size 6 mm, including:
- Metal Handle, with hemostat style ratchet, with larger contact area
- Outer Sheath, insulated
- Forceps Insert

33425UL Same, length 43 cm
CLICKLINE® Dissecting and Grasping Forceps

Size 5 mm and 10 cm, length 36 cm and 43 cm

33363AF CLICKLINE® Grasping Forceps, rotating, dismantling, without connector pin for unipolar coagulation, with irrigation connection for cleaning, double action jaws, atraumatic, fenestrated, size 5 mm, length 36 cm, including:
- Metal Handle, with hemostat style ratchet, with larger contact area
- Outer Sheath, insulated
- Forceps Insert

33463AF Same, length 43 cm

33363ON CLICKLINE® Grasping Forceps, rotating, dismantling, without connector pin for unipolar coagulation, single action jaws, with fine serration, fenestrated, size 5 mm, length 36 cm, including:
- Metal Handle, with hemostat style ratchet, with larger contact area
- Outer Sheath, insulated
- Forceps Insert

33463ON Same, length 43 cm

33563BLS CLICKLINE® BABCOCK Grasping Forceps, rotating, dismantling, without connector pin for unipolar coagulation, with irrigation connection for cleaning, double action jaws, rounded, long, size 10 mm, length 36 cm, including:
- Metal Handle, with hemostat style ratchet, with larger contact area
- Outer Sheath, insulated
- Forceps Insert

33563DU CLICKLINE® DUVAL Grasping Forceps, rotating, dismantling, without connector pin for unipolar coagulation, with irrigation connection for cleaning, double action jaws, size 10 mm, length 36 cm, including:
- Metal Handle, with hemostat style ratchet, with larger contact area
- Outer Sheath, insulated
- Forceps Insert
CLICKLINE® Grasping Forceps and ROBI® Grasping Forceps
Size 5 mm, length 36 cm and 43 cm

33361AV
CLICKLINE® Grasping Forceps, rotating, dismantling, without connector pin for unipolar coagulation, with irrigation connector for cleaning, double action jaws, fenestrated, with fine atraumatic serration, size 5 mm, length 36 cm, including:
- Metal Handle, with hemostat style ratchet, with larger contact area
- Outer Sheath, insulated
- Forceps Insert

38651MD
ROBI® KELLY Dissecting and Grasping Forceps, CLERMONT-FERRAND Model, rotating, dismantling, with connector pin for bipolar coagulation, with LUER-Lock irrigation connector for cleaning, double action jaws, for stapler pressure plates, size 5 mm, length 36 cm, including:
- Ring Handle, without ratchet, with larger contact area
- Metal Outer Sheath, insulated
- Forceps Insert

38751MD
Same, length 43 cm

38651ON
ROBI® Grasping Forceps, CLERMONT-FERRAND Model, rotating, dismantling, with connector pin for bipolar coagulation, with LUER-Lock irrigation connector for cleaning, double action jaws, fenestrated, with fine atraumatic serration, size 5 mm, length 36 cm, including:
- Ring Handle, without ratchet, with larger contact area
- Metal Outer Sheath, insulated
- Forceps Insert

38751ON
Same, length 43 cm
Metal Outer Sheath with cm-marking
Size 5 mm

33300CM

Metal Outer Sheath, with cm-marking, insulated, with Luer-Lock connector for cleaning, size 5 mm, length 36 cm

33400CM

Same, length 43 cm

33300CMM

Metal Outer Sheath, with cm-marking, with Luer-Lock connector for cleaning, size 5 mm, length 36 cm,

33400CMM

Same, length 43 cm

Dissecting Electrodes
with Exchangeable Electrode Tip
Insulated Sheath with Connector Pin for Unipolar Coagulation

30775UF

Coagulating and Dissecting Electrode, insulated sheath, with connector pin for unipolar coagulation, L-shaped, size 5 mm, length 36 cm

30778UF

Same, length 43 cm

30775UFE

Exchangeable Electrode Tip, L-shaped, autoclavable, package of 6
KOH Macro Needle Holder
dismantable

Cleaning and sterilization are gaining increasing importance for KARL STORZ as a manufacturer of surgical instruments. Similar to all our surgical instruments, the cleaning and hygiene of our needle holders also play an important role.

For cleaning and sterilization, the KOH macro needle holders can be disassembled into their main components.

This unique reusable three-piece design offers the user the following benefits:

- Can be disassembled into three separate components
- Autoclavable
- Cleaning adaptor
- Choice of six different handles and three different working inserts
- With tungsten carbide inserts
- In the event of damage, only the component with the defect needs to be replaced
Handles and Outer Tubes

KOH Macro Needle Holders, dismantable

Handles axial and pistol grip with disengageable ratchet

| 30173AR | Handle, axial, with disengageable ratchet, ratchet release on the right side |
| 30173AL | Handle, axial, with disengageable ratchet, ratchet release on the left side |
| 30173AO | Handle, axial, with disengageable ratchet, ratchet release on top |
| 30173PR | Handle, pistol grip, with disengageable ratchet, ratchet release on the right side |
| 30173PL | Handle, pistol grip, with disengageable ratchet, ratchet release on the left side |
| 30173PO | Handle, pistol grip, with disengageable ratchet, ratchet release on top |

Metal Outer Sheath

Size 5 mm

<table>
<thead>
<tr>
<th>30173A</th>
<th>Metal Outer Sheath Size 5 mm with LUER-Lock connector for cleaning</th>
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</thead>
<tbody>
<tr>
<td>Length</td>
<td></td>
</tr>
<tr>
<td>30173A</td>
<td>33 cm</td>
</tr>
<tr>
<td>30178A</td>
<td>43 cm</td>
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</table>
**KOH Macro Needle Holder**
dismantable

### Size 5 mm

<table>
<thead>
<tr>
<th>Working Length</th>
<th>Handle</th>
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<tr>
<td>33 cm</td>
<td>30173AR 30173AL 30173AO</td>
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<tr>
<td>43 cm</td>
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</tr>
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</table>

**Single-action jaws**

<table>
<thead>
<tr>
<th>Insert No.</th>
<th>Complete Instrument</th>
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</thead>
<tbody>
<tr>
<td>30173R</td>
<td>30173RAR 30173RAL 30173RAO</td>
</tr>
<tr>
<td>30178R</td>
<td>30178RAR 30178RAL 30178RAO</td>
</tr>
</tbody>
</table>

**KOH Macro Needle Holder**, dismantling, jaws curved to right, with tungsten carbide inserts, for use with suture material size 0/0 – 7/0

<table>
<thead>
<tr>
<th>Insert No.</th>
<th>Complete Instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td>30173L</td>
<td>30173LAR 30173LAL 30173LAO</td>
</tr>
<tr>
<td>30178L</td>
<td>30178LAR 30178LAL 30178LAO</td>
</tr>
</tbody>
</table>

**KOH Macro Needle Holder**, dismantling, jaws curved to left, with tungsten carbide inserts, for use with suture material size 0/0 – 7/0

<table>
<thead>
<tr>
<th>Insert No.</th>
<th>Complete Instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td>30173F</td>
<td>30173FAR 30173FAL 30173FAO</td>
</tr>
<tr>
<td>30178F</td>
<td>30178FAR 30178FAL 30178FAO</td>
</tr>
</tbody>
</table>

**KOH Macro Needle Holder**, dismantling, straight jaws, with tungsten carbide inserts, for use with suture material size 0/0 – 7/0
**KOH Macro Needle Holder**

dismantable

Size 5 mm

<table>
<thead>
<tr>
<th>Working Length</th>
<th>Handle</th>
</tr>
</thead>
<tbody>
<tr>
<td>33 cm</td>
<td>30173PR</td>
</tr>
<tr>
<td></td>
<td>30173PL</td>
</tr>
<tr>
<td></td>
<td>30173PO</td>
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<tr>
<td>43 cm</td>
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**Single-action jaws**

<table>
<thead>
<tr>
<th>Insert No.</th>
<th>Complete Instrument</th>
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<tbody>
<tr>
<td>30173R</td>
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<td>30178R</td>
<td>30178RPR</td>
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<td></td>
<td>30178RPL</td>
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<tr>
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<td>30178RPO</td>
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</tbody>
</table>

KOH Macro Needle Holder, dismantling, jaws curved to right, with tungsten carbide inserts, for use with suture material size 0/0 – 7/0

<table>
<thead>
<tr>
<th>Insert No.</th>
<th>Complete Instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td>30173L</td>
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<tr>
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</tr>
<tr>
<td></td>
<td>30178LPL</td>
</tr>
<tr>
<td></td>
<td>30178LPO</td>
</tr>
</tbody>
</table>

KOH Macro Needle Holder, dismantling, jaws curved to left, with tungsten carbide inserts, for use with suture material size 0/0 – 7/0

<table>
<thead>
<tr>
<th>Insert No.</th>
<th>Complete Instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td>30173F</td>
<td>30173FPR</td>
</tr>
<tr>
<td></td>
<td>30173FPL</td>
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<td></td>
<td>30173FPO</td>
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<tr>
<td>30178F</td>
<td>30178FPR</td>
</tr>
<tr>
<td></td>
<td>30178FPL</td>
</tr>
<tr>
<td></td>
<td>30178FPO</td>
</tr>
</tbody>
</table>

KOH Macro Needle Holder, dismantling, straight jaws, with tungsten carbide inserts, for use with suture material size 0/0 – 7/0
KOH Macro Needle Holder

Size 5 mm

Multiple puncture approach Operating instruments, length 33 and 43 cm, for use with trocar size 6 mm

26173KAL KOH Macro Needle Holder, with tungsten carbide insert, axial handle, with disengageable ratchet, ratchet position right, jaws curved to left, size 5 mm, length 33 cm, for use with suture material size 0/0 to 7/0 and needle sizes BV, SH or CT-1

26178KAL Same, length 43 cm

26173KAR KOH Macro Needle Holder, with tungsten carbide insert, axial handle, with disengageable ratchet, ratchet position left, jaws curved to right, size 5 mm, length 33 cm, for use with suture material size 0/0 to 7/0 and needle sizes BV, SH or CT-1

26178KAR Same, length 43 cm
Clip Applicator
size 10 mm
Multiple puncture approach
Operating instrument, length 33 cm,
for use with trocar size 11 mm

Applicator, Dismantling, Rotating,
for PILLING ligating clips 26060AL (medium-large),
with ratchet to lock the jaw holding the clip
including:
Metal handle, with ratchet
Metal outer sheath
Insert

Original Size

PILLING Titanium Clips, (medium-large),
box with 16 cartridges, 10 clips each, sterile,
for use with applicator 30444LR

Caution:
The use of other clips than indicated, can lead to damage
of the mouthpiece.

BERCI Fascial Closure Instrument
for subcutaneous ligature of trocar incisions
Handles for Suction and Irrigation
size 5 mm and 10 mm

37112A  **Suction and Irrigation Handle**, straight, with clamping valve, for suction and irrigation, **autoclavable**, including Cleaning Adaptor 8236091, for use with Suction and Irrigation Tubes diameter 3 mm, 5 mm, 10 mm, 37360 LH, 37560 LH

37113A  **Same**, pistol grip

Single-Use Tubing Sets
for use with Suction and Irrigation Handles 37112A and 37113A

031133-10*  **Tubing Set**, for single use, sterile, package of 10, for use with Suction and Irrigation Handles 37112A (straight) and 37113A (pistol grip)

031134-10*  **Tubing Set**, for single use, sterile, package of 10, for use with Suction and Irrigation Handles 37112A (straight) and 37113A (pistol grip) in combination with silicone tube inner diameter 5 mm at the patient end

031218-10*  **Tubing Set**, with two puncture cannulas, for single use, sterile, package of 10, for use with Handles 37112A (straight) and 37113A (pistol grip) in combination with HAMOU® ENDOMAT®

031219-10*  **Tubing Set**, with two puncture cannulas, for single use, sterile, package of 10, for use with Handles 37112A (straight) and 37113A (pistol grip) in combination with ENDOMAT® LC
**Instruments and Videoendoscopic Equipment**

**Irrigation and Suction Tubes**
size 5 mm, trocar size 6 mm

![Irrigation and Suction Tubes](image)

- **37360LH**  
  Suction and Irrigation Cannula with lateral holes, size 5 mm, length 36 cm, for use with suction and irrigation handles

- **37460LH**  
  Same, length 43 cm

- **30805**  
  Handle with Two-Way Stopcock, suitable for irrigation and suction, for use with 5 mm suction and irrigation tubes, autoclavable

**Surgical Sponge Holders**
size 5 mm and 10 mm

![Surgical Sponge Holders](image)

- **32540PT**  
  Surgical Sponge Holder, tissue layers, size 10 mm, length 30 cm including:  
  - Handle
  - Outer Sheath, insulated
  - Sponge Holder Insert

- **32540PTL**  
  Surgical Sponge Holder, for atraumatic dissection of tissue layers, size 10 mm, length 43 cm including:  
  - Handle
  - Outer Sheath, insulated
  - Sponge Holder Insert
Knot Tier
size 5 mm, trocar size 6 mm

26596SK
KOECKERLING Knot Tier,
for extracorporeal knotting
size 5 mm, length 36 cm

Accessories
Unipolar High Frequency Cord

KARL STORZ  High Frequency Surgery Units
26005M Unipolar High Frequency Cord,
with 5 mm plug for AUTOCON® II 400 SCB system
(111, 113, 115, 122, 125), AUTOCON® II 200,
AUTOCON® II 80, KARL STORZ AUTOCON® system
(50, 200, 350) and Erbe type ICC, length 300 cm

Bipolar High Frequency Cord

KARL STORZ  High Frequency Surgery Units
26176LE Bipolar High Frequency Cord,
for AUTOCON® II 400 SCB system
(111, 113, 115, 122, 125), AUTOCON® II 200,
AUTOCON® II 80, KARL STORZ Coagulator 26021 B/C/D,
860021 B/C/D, 27810 B/C/D, 28810 B/C/D,
AUTOCON® series (50, 200, 350), Erbe-Coagulator,
T and ICC series, length 300 cm
## Mobile Equipment Cart

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>Monitor</td>
<td>27&quot; FULL HD Monitor</td>
</tr>
<tr>
<td><strong>Camera System:</strong></td>
<td></td>
</tr>
<tr>
<td>TC200DE</td>
<td>IMAGE1 S CONNECT, connect module</td>
</tr>
<tr>
<td>TC300</td>
<td>IMAGE1 S H3-LINK, link module</td>
</tr>
<tr>
<td>TH100</td>
<td>IMAGE1 S H3-Z, Three-Chip FULL HD Camera Head</td>
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<tr>
<td><strong>Light Source:</strong></td>
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<tr>
<td>20133101-1</td>
<td>XENON 300 SCB Cold Light Fountain</td>
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<tr>
<td>495NCSC</td>
<td>Fiber Optic Light Cable</td>
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<td><strong>HF-Device:</strong></td>
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<tr>
<td>20535201-125</td>
<td>AUTOCON® II 400</td>
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<td>20017830</td>
<td>Two-Pedal Footswitch</td>
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<td><strong>Insufflation:</strong></td>
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<tr>
<td>UI400S1</td>
<td>ENDOFLATOR® 40</td>
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<tr>
<td>UP501S3</td>
<td>S-PILOT™</td>
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<td><strong>Pump System:</strong></td>
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<tr>
<td>26331101-1</td>
<td>HAMOU® ENDOMAT®</td>
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<tr>
<td><strong>Equipment Cart:</strong></td>
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<tr>
<td>UG120</td>
<td>COR™ Equipment Cart, narrow, high</td>
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<tr>
<td>UG500</td>
<td>Monitor Holder</td>
</tr>
<tr>
<td>UG609</td>
<td>Bottle Holder, for CO&lt;sub&gt;2&lt;/sub&gt;-Bottles</td>
</tr>
<tr>
<td>29005DFH</td>
<td>Foot-Pedal Holder, for Two- and Three-Pedal Footswitches</td>
</tr>
<tr>
<td>UG310</td>
<td>Isolation Transformer, 200V – 240V</td>
</tr>
<tr>
<td>UG410</td>
<td>Earth Leakage Monitor, 200V – 240V</td>
</tr>
</tbody>
</table>
**IMAGE1 S Camera System**

**Economical and future-proof**
- Modular concept for flexible, rigid and 3D endoscopy as well as new technologies
- Forward and backward compatibility with video endoscopes and FULL HD camera heads
- Sustainable investment
- Compatible with all light sources

**Innovative Design**
- **Dashboard**: Complete overview with intuitive menu guidance
- **Live menu**: User-friendly and customizable
- **Intelligent icons**: Graphic representation changes when settings of connected devices or the entire system are adjusted
- **Automatic light source control**
- **Side-by-side view**: Parallel display of standard image and the Visualization mode
- **Multiple source control**: IMAGE1 S allows the simultaneous display, processing and documentation of image information from two connected image sources, e.g., for hybrid operations

---

**Dashboard**

**Live menu**

**Intelligent icons**

**Side-by-side view**: Parallel display of standard image and Visualization mode
**IMAGE1 S Camera System**

**Videoendoscopic Imaging**
- Very high quality of endoscopic images in **FULL HD**
- Natural color rendition

**Multiple IMAGE1 S technologies for homogeneous illumination, contrast enhancement and color shifting**

* SPECTRA A: Not for sale in the U.S.
** SPECTRA B: Not for sale in the U.S.
TC 200EN* IMAGE1 S CONNECT, connect module, for use with up to 3 link modules, resolution 1920 x 1080 pixels, with integrated KARL STORZ-SCB and digital Image Processing Module, power supply 100 – 120 VAC/200 – 240 VAC, 50/60 Hz including:

- **Mains Cord**, length 300 cm
- **DVI-D Connecting Cable**, length 300 cm
- **SCB Connecting Cable**, length 100 cm
- **USB Flash Drive**, 32 GB, USB silicone keyboard, with touchpad, US

* Available in the following languages: DE, ES, FR, IT, PT, RU

**Specifications:**

<table>
<thead>
<tr>
<th>Feature</th>
<th>TC200EN</th>
</tr>
</thead>
<tbody>
<tr>
<td>HD video outputs</td>
<td>2x DVI-D, 1x 3G-SDI</td>
</tr>
<tr>
<td>Format signal outputs</td>
<td>1920 x 1080p, 50/60 Hz</td>
</tr>
<tr>
<td>LINK video inputs</td>
<td>3x</td>
</tr>
<tr>
<td>USB interface</td>
<td>4x USB, (2x front, 2x rear)</td>
</tr>
<tr>
<td>SCB interface</td>
<td>2x 6-pin mini-DIN</td>
</tr>
</tbody>
</table>

**Power supply**

| Power supply                  | 100 – 120 VAC/200 – 240 VAC |
| Power frequency               | 50/60 Hz                    |
| Protection class              | I, CF-Defib                |
| Dimensions w x h x d         | 305 x 54 x 320 mm          |
| Weight                        | 2.1 kg                     |

For use with IMAGE1 S

**IMAGE1 S CONNECT Module TC200EN**

TC300 IMAGE1 S H3-LINK, link module, for use with IMAGE1 FULL HD three-chip camera heads, power supply 100 – 120 VAC/200 – 240 VAC, 50/60 Hz, for use with IMAGE1 S CONNECT TC200EN including:

- **Mains Cord**, length 300 cm
- **Link Cable**, length 20 cm

**Specifications:**

<table>
<thead>
<tr>
<th>Feature</th>
<th>TC 300 (H3-Link)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supported camera heads/video endoscopes</td>
<td>TH100, TH101, TH102, TH103, TH104, TH106 (fully compatible with IMAGE1 S) 22220055-3, 22220056-3, 22220053-3, 22220060-3, 22220061-3, 22220054-3, 22220085-3 (compatible without IMAGE1 S technologies CLARA, CHROMA, SPECTRA*)</td>
</tr>
<tr>
<td>LINK video outputs</td>
<td>1x</td>
</tr>
<tr>
<td>Power supply</td>
<td>100 – 120 VAC/200 – 240 VAC</td>
</tr>
<tr>
<td>Power frequency</td>
<td>50/60 Hz</td>
</tr>
<tr>
<td>Protection class</td>
<td>I, CF-Defib</td>
</tr>
<tr>
<td>Dimensions w x h x d</td>
<td>305 x 54 x 320 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>1.86 kg</td>
</tr>
</tbody>
</table>

* SPECTRA A: Not for sale in the U.S.
** SPECTRA B: Not for sale in the U.S.
IMAGE1 S Camera Heads

For use with IMAGE1 S Camera System
IMAGE1 S CONNECT Module TC200EN, IMAGE1 S H3-LINK Module TC300
and with all IMAGE1 HUB™ HD Camera Control Units

**TH100**

**IMAGE1 S H3-Z Three-Chip FULL HD Camera Head**, 50/60 Hz, IMAGE1 S compatible, progressive scan, soakable, gas- and plasma-sterilizable, with integrated Parfocal Zoom Lens, focal length f = 15–31 mm (2x), 2 freely programmable camera head buttons, for use with IMAGE1 S and IMAGE1 HUB™ HD/HD

<table>
<thead>
<tr>
<th>Specifications:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IMAGE1 FULL HD Camera Heads</strong></td>
<td><strong>IMAGE1 S H3-Z</strong></td>
</tr>
<tr>
<td>Product no.</td>
<td>TH100</td>
</tr>
<tr>
<td>Image sensor</td>
<td>3x 1/3” CCD chip</td>
</tr>
<tr>
<td>Dimensions w x h x d</td>
<td>39 x 49 x 114 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>270 g</td>
</tr>
<tr>
<td>Optical interface</td>
<td>integrated Parfocal Zoom Lens, f = 15–31 mm (2x)</td>
</tr>
<tr>
<td>Min. sensitivity</td>
<td>F 1.4/1.17 Lux</td>
</tr>
<tr>
<td>Grip mechanism</td>
<td>standard eyepiece adaptor</td>
</tr>
<tr>
<td>Cable</td>
<td>non-detachable</td>
</tr>
<tr>
<td>Cable length</td>
<td>300 cm</td>
</tr>
</tbody>
</table>

**TH104**

**IMAGE1 S H3-ZA Three-Chip FULL HD Camera Head**, 50/60 Hz, IMAGE1 S compatible, **autoclavable**, progressive scan, soakable, gas- and plasma-sterilizable, with integrated Parfocal Zoom Lens, focal length f = 15–31 mm (2x), 2 freely programmable camera head buttons, for use with IMAGE1 S and IMAGE1 HUB™ HD/HD

<table>
<thead>
<tr>
<th>Specifications:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IMAGE1 FULL HD Camera Heads</strong></td>
<td><strong>IMAGE1 S H3-ZA</strong></td>
</tr>
<tr>
<td>Product no.</td>
<td>TH104</td>
</tr>
<tr>
<td>Image sensor</td>
<td>3x 1/3” CCD chip</td>
</tr>
<tr>
<td>Dimensions w x h x d</td>
<td>39 x 49 x 100 mm</td>
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<tr>
<td>Weight</td>
<td>299 g</td>
</tr>
<tr>
<td>Optical interface</td>
<td>integrated Parfocal Zoom Lens, f = 15–31 mm (2x)</td>
</tr>
<tr>
<td>Min. sensitivity</td>
<td>F 1.4/1.17 Lux</td>
</tr>
<tr>
<td>Grip mechanism</td>
<td>standard eyepiece adaptor</td>
</tr>
<tr>
<td>Cable</td>
<td>non-detachable</td>
</tr>
<tr>
<td>Cable length</td>
<td>300 cm</td>
</tr>
</tbody>
</table>
Monitors

9619NB

19" HD Monitor,
color systems PAL/NTSC, max. screen resolution 1280 x 1024, image format 4:3, power supply 100–240 VAC, 50/60 Hz, wall-mounted with VESA 100 adaption, including:
External 24 VDC Power Supply
Mains Cord

9826NB

26" FULL HD Monitor,
wall-mounted with VESA 100 adaption, color systems PAL/NTSC, max. screen resolution 1920 x 1080, image format 16:9, power supply 100–240 VAC, 50/60 Hz including:
External 24 VDC Power Supply
Mains Cord
## Monitors

<table>
<thead>
<tr>
<th>KARL STORZ HD and FULL HD Monitors</th>
<th>19&quot;</th>
<th>26&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall-mounted with VESA 100 adaption</td>
<td>9619NB</td>
<td>9826NB</td>
</tr>
</tbody>
</table>

**Inputs:**
- DVI-D
- Fibre Optic
- 3G-SDI
- RGBS (VGA)
- S-Video
- Composite/FBAS

**Optional accessories:**
- 9826SF Pedestal, for monitor 9826NB
- 9626SF Pedestal, for monitor 9619NB

**Specifications:**

<table>
<thead>
<tr>
<th>KARL STORZ HD and FULL HD Monitors</th>
<th>19&quot;</th>
<th>26&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desktop with pedestal</td>
<td>optional</td>
<td>optional</td>
</tr>
<tr>
<td>Product no.</td>
<td>9619NB</td>
<td>9826NB</td>
</tr>
<tr>
<td>Brightness</td>
<td>200 cd/m² (typ)</td>
<td>500 cd/m² (typ)</td>
</tr>
<tr>
<td>Max. viewing angle</td>
<td>178° vertical</td>
<td>178° vertical</td>
</tr>
<tr>
<td>Pixel distance</td>
<td>0.29 mm</td>
<td>0.3 mm</td>
</tr>
<tr>
<td>Reaction time</td>
<td>5 ms</td>
<td>8 ms</td>
</tr>
<tr>
<td>Contrast ratio</td>
<td>700:1</td>
<td>1400:1</td>
</tr>
<tr>
<td>Mount</td>
<td>100 mm VESA</td>
<td>100 mm VESA</td>
</tr>
<tr>
<td>Weight</td>
<td>7.6 kg</td>
<td>7.7 kg</td>
</tr>
<tr>
<td>Rated power</td>
<td>28 W</td>
<td>72 W</td>
</tr>
<tr>
<td>Operating conditions</td>
<td>0–40°C</td>
<td>5–35°C</td>
</tr>
<tr>
<td>Storage</td>
<td>-20–60°C</td>
<td>-20–60°C</td>
</tr>
<tr>
<td>Rel. humidity</td>
<td>max. 85%</td>
<td>max. 85%</td>
</tr>
<tr>
<td>Dimensions w x h x d</td>
<td>469.5 x 416 x 75.5 mm</td>
<td>643 x 396 x 87 mm</td>
</tr>
<tr>
<td>Power supply</td>
<td>100–240 VAC</td>
<td>100–240 VAC</td>
</tr>
<tr>
<td>Certified to</td>
<td>EN 60601-1, protection class IPX0</td>
<td>EN 60601-1, UL 60601-1, MDD93/42/EEC, protection class IPX2</td>
</tr>
</tbody>
</table>

**Signal Format Display:**
- 4:3
- 5:4
- 16:9
- Picture-in-Picture
- PAL/NTSC compatible
Cold Light Fountains and Accessories

For use with telescopes, diameter 10 mm:
495NE  Fiber Optic Light Cable,
with straight connector, diameter 4.8 mm,
length 300 cm

For use with telescopes, diameter 5 mm:
495NL  Fiber Optic Light Cable,
with straight connector, diameter 3.5 mm,
length 180 cm

Cold Light Fountain XENON 300 SCB

20133101-1  Cold Light Fountain XENON 300 SCB
with built-in antifog air-pump, and integrated
KARL STORZ Communication Bus System SCB
power supply:
100–125 VAC/220–240 VAC, 50/60 Hz
including:
Mains Cord
Silicone Tubing Set, autoclavable, length 250 cm
SCB Connecting Cord, length 100 cm
20133027  Spare Lamp Module XENON
with heat sink, 300 watt, 15 volt
20133028  XENON Spare Lamp, only,
300 watt, 15 volt

Cold Light Fountain XENON NOVA® 300

20134001  Cold Light Fountain XENON NOVA® 300,
power supply:
100–125VAC/220–240VAC, 50/60 Hz
including:
Mains Cord
20132028  XENON Spare Lamp, only,
300 watt, 15 volt
ENDOFLATOR® 40 with KARL STORZ SCB
with High Flow Insufflation (40 l/min.)

| UI400S1 | ENDOFLATOR® 40 SCB, Set, with integrated SCB module, power supply 100–240 VAC, 50/60 Hz including: ENDOFLATOR® 40 Mains Cord, length 300 cm SCB Connecting Cable, length 100 cm Universal Wrench Insufflation Tubing Set, with gas filter, sterile, for single use, package of 5* Subject to the customer's application-specific requirements additional accessories must be ordered separately. |

HAMOU® ENDOMAT® with KARL STORZ SCB
Suction and Irrigation System

| 26331101-1 | HAMOU® ENDOMAT® SCB, power supply 100–240 VAC, 50/60 Hz including: Mains Cord 5x HYST Tubing Set*, for single use 5x LAP Tubing Set*, for single use SCB Connecting Cable, length 100 cm VACUsafe Promotion Pack Suction*, 2 l Subject to the customer's application-specific requirements additional accessories must be ordered separately. |
Notes:
WITH COMPLIMENTS OF KARL STORZ—ENDOSKOPE