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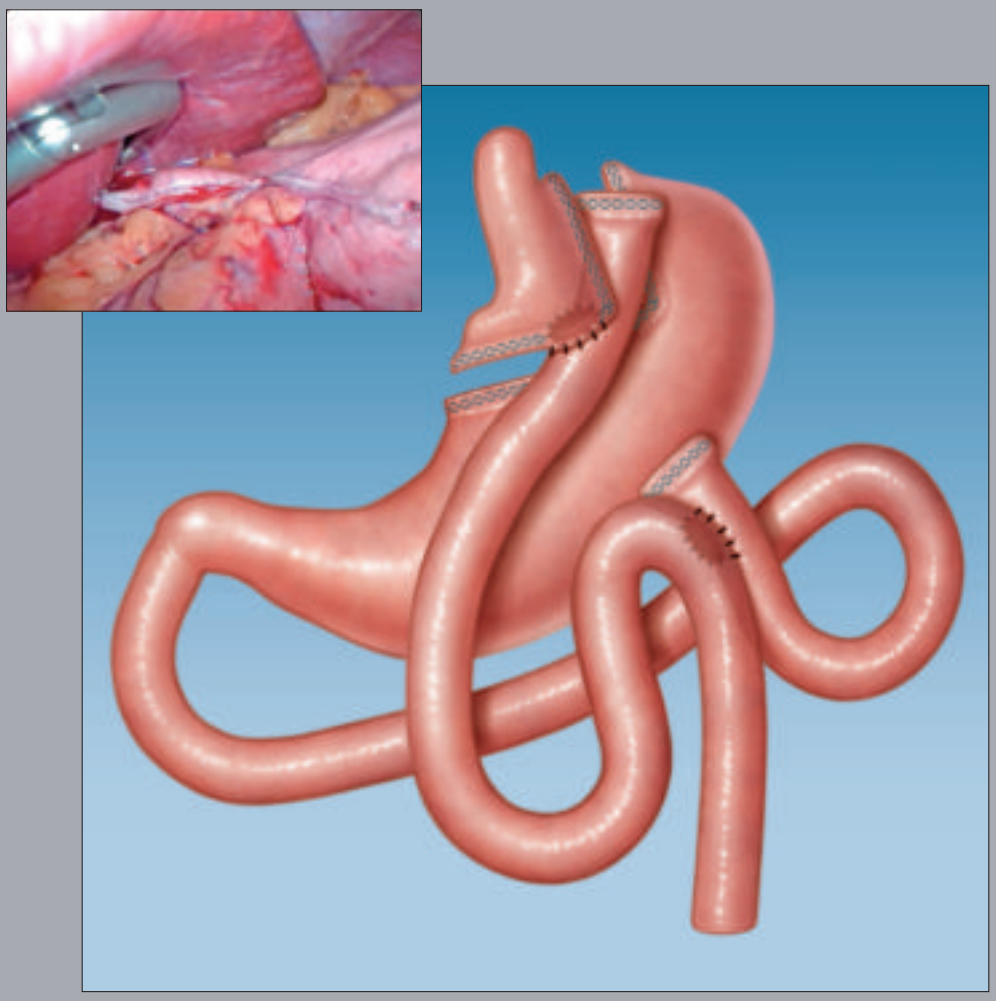
# LAPAROSCOPIC ROUX-EN-Y GASTRIC BYPASS FOR MORBID OBESITY

2nd Edition



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**2nd Edition**

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# Table of Contents

# 1.0 Introduction

Overweight is spreading throughout all countries so obesity is a worldwide problem: It is the heavy burden of affluent society. For the first time there are just as many fat people on earth as slim people: 1.1 billion people are starving every day – compared with 1.1 billion overweight individuals, and the trend is on the increase. The World Health Organization, WHO, describes obesity as the most serious chronic health problem at present. In some western industrial countries over 50% of the population is overweight. In Germany the figure has now reached 52.4%. 9 million Germans are suffering from obesity requiring treatment. Depending on the particular country, obesity and its sequelae account for 5%-10% of the total cost of the healthcare system. For women the mortality risk is doubled by morbid obesity with a BMI of > 40 kg/m$^2$ and for men it is tripled. The earlier obesity occurs, the sharper the rise in mortality risk.

Obesity and its sequelae account for approximately 280,000 deaths a year in the US. As a result, overweight is the second most common cause of death, after smoking.

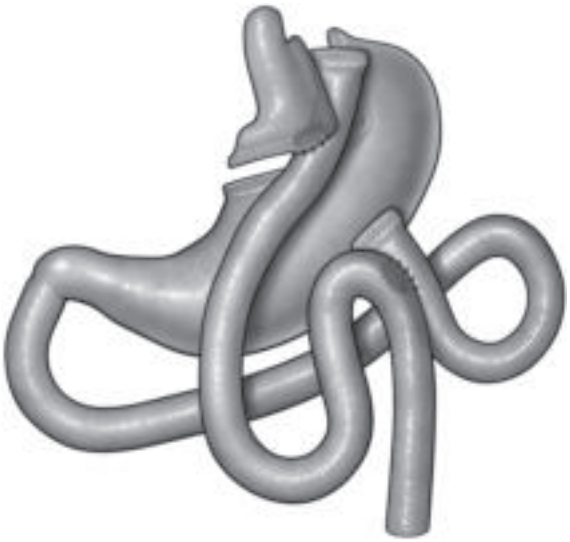
Historically, all attempts at treating morbid obesity (defined as a BMI of > 40 kg/m$^2$) by administration of medication and other conservative methods have produced only minor or transient effects. As a result, surgical treatment has gained widespread acceptance in recent decades due to its superior outcomes. About 2% of the German population is affected. With morbid obesity the interventions can be divided into two categories. A basic distinction is made between methods that cause food malabsorption or ones that cause food restriction. Recent gastric stimulation techniques are still undergoing trials. With regard to life expectancy long-term studies have now also produced evidence that has already been documented sufficiently for quality of life and co-morbidities: the positive impact of surgical weight reduction. When laparoscopic surgical techniques were introduced, bariatric surgery was given particular impetus because it is especially high-risk patients who profit from a minimally invasive approach. Nowadays all surgical procedures are performed using video endoscopy. However, bariatric surgery is high-risk surgery, and it will remain so because patients often suffer from sequelae. In the experienced hands of so-called “high-volume centers” perioperative mortality rates (depending on the type of intervention and the BMI) are achieved which are much higher than in other disciplines of visceral surgery. In the case of the gastric bypass the mean value is 0.5% and in the case of BPD (Biliopancreatic Diversion) and Duodenal Switch the figure rises to over 1%. Therefore, this type of intervention should not be performed at any hospital but only at centers by experienced bariatric surgeons. Surgery is not causal treatment of obesity and one day it will hopefully be superseded due to scientific advancement. For patients there is no other effective solution to their health problems at present. Since young obese patients benefit most from a weight reduction, surgical intervention should be implemented at an earlier stage if conservative therapy has failed. There are several reasons for the epidemic increase in obesity, including changing lifestyle habits (excessive intake of food rich in calories/fat and lack of physical activity) which interact with genetic predispositions and thus lead to an increase in the body’s fat content.

**The objectives of obesity therapy are as follows:**

- To reduce energy intake,
- to increase the patient’s energy consumption,
- and thus help the body to achieve a new energy balance.

Obesity is a chronic disease and should not be merely regarded as a biological variant.

According to an analysis for 1993 in the Federal Republic of Germany, commissioned by the German Federal Ministry of Health, over € 420,000,000 in healthcare costs were related to obesity, not including comorbidities.



The classical Roux-en-Y gastric bypass.

| What is the annual cost of obesity in the US? | | |
|---|---|---|
| **Total costs:** $ 99.2 billion per year in the US. | **Direct costs:** $ 51.6 billion per year (5.7% of the total US health-care costs per year). | **Indirect costs:** $ 47.6 billion (comparable to the total US healthcare costs per year related to cigarette smoking). |
| **Itemization of costs of concomitant and secondary disease due to overweight** | **Direct costs:** | **Indirect costs:** |
| Costs of **cardiovascular disease** due to overweight and obesity. | $ 6.99 billion (17% of $ 40.4 billion total cost of cardiovascular disease, excluding infarction) | |
| Costs of **type 2 diabetes mellitus** due to overweight and obesity. | $ 63.14 billion (more than 60% of the total costs due to type 2 diabetes mellitus) | |
| Costs of **osteoarthritis** due to overweight and obesity. Total costs: $ 17.2 billion | $ 4.3 billion | $ 12.9 billion |
| Cost of arterial **hypertension** due to overweight: | $ 3.23 billion (17% of the total costs related to hypertension) | |
| Costs of **carcinomas** due to overweight | | |
| **Post-menopausal breast cancer** Total costs due to overweight: $ 2.32 billion | $ 840 million | $ 1.48 billion |
| **Endometrial cancer** Total costs due to overweight: $ 790 billion | $ 286 billion | $ 504 billion |
| **Colon cancer** Total costs due to overweight: $ 2.78 billion | $ 1 billion | $ 1.78 billion |
| Annual costs related to **loss of productivity** due to overweight in the US population (17 – 64 years of age) | $ 3.93 billion annually | |

**Comorbidities:**

**Obesity is considered to be causative for the following sequelae:**

- Diabetes mellitus
- Cardiovascular disease
- Cerebrovascular stroke
- Hypertension
- Gall bladder disease
- Osteoarthritis (Degenerative bone disease)
- Sleep apnea
- Cancer (uterine, breast, colorectal, kidney and gall bladder)

**Obesity is a contributing factor for the following:**

- Hypercholesterolemia
- Pregnancy complications
- Menstrual disturbances
- Hirsutism
- Urinary stress incontinence
- Mental disease – dementia
- Increased surgical risk

This is a very low estimate of the true burden on the national economy since the comorbidities of obesity are unaccounted for and obesity is diagnosed only rarely in practice.

Obese people are much more likely to utilize outpatient and inpatient resources and need more medication, which results in higher costs than for individuals of normal weight.

On behalf of the German Federal Ministry of Health, the research institute Infratest ascertained the overall costs of obesity and its comorbidities in Germany. For the year 1995 the researchers found that obesity-related costs accounted for approximately 5.4% of the total healthcare costs in Germany, which was equivalent to more than € 10 billion. Similar calculations of obesity-related costs in other western countries are consistent with the findings of the German study and demonstrate that obesity accounts for 2% to 8% of the total healthcare costs in these countries. On account of the continued rise in the incidence of obesity there is bound to be a further cost increase.

In addition, new scientific findings are being published constantly. For example, study results were published in 2004 for the first time indicating that life expectancy can be shortened by morbid obesity and extended again by weight reduction after gastric bypass surgery. Findings in 2005 indicate that the probability of subsequent dementia is increased by overweight and obesity in middle age. That is the result of a US study conducted by researchers at the "*Kaiser Permanent Division of Research*" in 2005, at the baseline of which more than 10,000 men and women aged between 40 and 45 underwent a medical examination. 27 years later 7% had fallen ill with dementia. Compared to people of normal weight, obese individuals had a 74% higher risk of disease while in the case of overweight individuals the figure was 35%. Women were particularly affected. Due to obesity the risk of dementia rose by 200% but for men it only rose by 30%.

Historically, all attempts at treating morbid obesity (defined as a BMI > 40 kg/m$^2$) by administration of medication and other conservative methods have produced only minor or transient effects. As a result, surgical treatment has gained widespread acceptance in recent decades due to its superior outcomes. The criteria for any highly elective bariatric operation were established some 20 years ago: *effectiveness and safety of the method, long-term stability, and minimal adverse effects*. Numerous surgical procedures were initially attempted and later abandoned because they were either ineffective or produced too many complications; this was particularly the case with the various intestinal bypass procedures, such as the jejuno-colic and the jejuno-ileal bypass. The Roux-en-Y gastric bypass became established in the 1980s and 90s, mainly in the United States and southern Europe. In 1991, the *National Institutes of Health (NIH) Consensus Development Conference* recommended the method with vertical gastroplasty as the only available surgical procedure for obesity that has continued beyond the experimental phase.[9]

Gastric bypass procedures are currently considered to be the gold standard for bariatric surgery in the United States. At a consensus conference in 2004 the *European Association for Endoscopic Surgery* (EAES) summarized the current situation with regard to surgical treatment of obesity and published it in the journal *Surgical Endoscopy* in 2005.[37] This consensus founded on evidence-based studies can provide practical assistance when selecting surgical methods.

## 1.1 Operative Procedures in Bariatric Surgery

Current surgical procedures are based upon three different therapeutic approaches:

**1. Restrictive procedures**

**2. Mixed procedures: restrictive and malabsorptive**

**3. Malabsorption**

In our view the outcomes of the gastric bypass procedure are convincing in terms of weight reduction and improvement in the quality of life. However, one should always bear in mind that surgical treatment of obesity is non-causal and there is no ideal operative procedure, nor will there ever be one.

**Here is a list of the most important procedures** (detailed in WEINER, 2006)[51]:

- Jejuno-ileal bypass (obsolete)
- Roux-en-Y gastric bypass
- MASON's original retrocolic loop gastric bypass (obsolete)
- Biliopancreatic diversion (SCOPINARO)
- Biliopancreatic diversion with duodenal switch
- Vertical banded gastric bypass (FOBI/CAMPELLA)
- Gastric band, adjustable
- Gastric band (non-adjustable) (obsolete)
- Vertical gastroplasty – without disruption of continuity (MASON)
- Vertical gastroplasty – with disruption of continuity (McLEAN)
- Horizontal gastroplasty (obsolete)
- Sleeve gastrectomy) (as stage 1 of BPD-DS)
- Various types of gastric pacemaker (in studies only)

## 1.2 Indications for Surgery

According to internationally accepted criteria (**Tab. 1**), the indications for bariatric surgery are a BMI > 40 kg/m (in exceptional cases: BMI > 35 kg/m$^2$ with pronounced comorbidity). The *National Institutes of Health (NIH)* criteria[9] of 1991 also stipulate several failed non-surgical attempts at weight reduction under the guidance of a physician over a period of two or more years, the absence of surgical contraindications or concomitant disease, the approval of the health insurance company for covering the costs, and the patient's written informed consent. Nevertheless, limits to the indication for surgery continue to be the subject of active discussion. For example, diabetes specialists suggest a BMI level of 32 in patients with type 2 diabetes as an indication for surgery.

The general exclusion criteria involve organ-related causes of obesity (endocrine disease), severe mental disorders (schizophrenia, florid drug addiction or severe depression), severe concomitant disease (tumors), patients under 18 or over 65 years of age, and an increased surgical risk (relative contraindications).

| **Indications for surgery** *(according to I.F.S.O.)* |
|---|
| BMI > 40 for more than 3 years. Conservative therapy – preferably under the guidance of a physician or self-help group – has failed or showed only transient success. |
| Exclusion of endocrine causes, alcohol or drug abuse. (Endocrine disease) |
| Severe metabolic disease, such as metabolic syndrome or sleep apnea syndrome associated with an urgent need for weight reduction, thereby corroborating the suggested indication for surgery. |
| Under normal circumstances, endogenous depression should be considered a contraindication for the surgical approach, but not reactive depression. (Schizophrenia, florid drug addiction, severe depression) |
| As a matter of principle, surgical procedures for the purpose of weight reduction should not be undertaken in individuals under the age of 18 (exception: consent of a multidisciplinary team) |

**Tab. 1:**
Criteria for surgery for the purpose of weight reduction as defined by the *"International Federation for Surgery of Obesity (I.F.S.O.)"*

The overweight and obese classifications are defined by the BMI formula as follows (**Tab. 2**):

$$\text{BMI} = \frac{\text{Body weight kg}}{\text{Height (m)}^2}$$

| BMI kg/(m)$^2$ | |
|---|---|
| Underweight | < 18.5 |
| Normal weight | 18.5 — 24.9 |
| Overweight | 25.0 — 29.9 |
| Stage I obesity | 30.0 — 34.9 |
| Stage II obesity | 35.0 — 39.9 |
| Stage III extreme obesity | > 40 |

**Tab. 2:**
Classification of weight by body mass index (**BMI: B**ody **M**ass **I**ndex) according to *"WHO Expert Committee on Physical Status: The Use and Interpretation of Anthropometry"*.

## 2.0 Historical Background of the Roux-en-Y Gastric Bypass

In the mid-1960s, MASON observed that the Billroth II gastric resection and gastrectomy were often associated with a loss in body weight. This prompted Mason to develop the currently obsolete retrocolic loop gastric bypass. The technique created a small gastric pouch, which would quickly lead to the sensation of satiety and "dumping" symptoms after the intake of too many sweets.

ALDEN simplified the operation by stapling the stomach crosswise and anastomosing it with a jejunal limb in the antecolic position. Griffen later modified this procedure and created an anastomosis of the jejunum at a higher position by using a retrocolic Roux-en-Y limb.

Bariatric surgery always involves a high degree of uncertainty and risk regardless of the procedure applied. Multiple factors contribute to the high morbidity of extremely obese patients. It is mandatory that preoperative risk evaluation be undertaken prior to scheduling any surgery. Preoperative conditioning and, quite definitively, a minimally invasive surgical technique can minimize postoperative complications, especially pulmonary ones.

In general, the introduction of laparoscopic techniques has led to a broader implementation of bariatric surgery and improved patient compliance. The various operative techniques adopt different therapeutic approaches: Restrictive, malabsorptive and mixed procedures.

## 3.0 Laparoscopic Roux-en-Y Gastric Bypass

This is a combined procedure where restriction is complemented by a malabsorptive component to suit requirements. The size of the pouch and length of the intestinal limbs continue to be the subject of active discussion. Proper performance of a laparoscopic gastric bypass (**LGB, L**aparoscopic **G**astric **B**ypass) is a challenge for the surgeon. In the literature the procedure is also abbreviated to **LRYGBP** (**L**aparoscopic **Roux-en-Y G**astric **B**ypass). The procedure produces convincing results both in terms of reducing body weight and improving quality of life. Besides iron deficiency the most common side-effect is the dumping syndrome, which can have an adverse effect on the patient. It depends on the surgical technique. Circular anastomoses along the lesser curvature of the stomach are linked to postoperative dumping much more frequently than hand-sewn anastomoses along the greater curvature.

Since the gastric bypass is considered to be the gold standard for bariatric surgery in the United States, the number of laparoscopic gastric bypass operations can be expected to increase rapidly, in Europe as well. In 1994, WITTGROVE was the first to perform the procedure using a laparoscopic approach.[58] He has subsequently performed more than 1,000 procedures. The number of procedures continues to rise dramatically though at US centers. Numerous studies have been published involving more than 1,000 laparoscopic operations per center. In 2003 the number of interventions reached 140,000 a year in the US, a record figure. A further increase has now been stopped by the US insurance companies.

The results of weight reduction in the first postoperative years are convincing, although by comparison with laparoscopic gastric banding the mortality is five times as high according to a meta-analysis by BUCHWALD et al. (2004)[7] (0.1% vs. 0.5%). On the other hand, follow-up surgery is far more frequent after gastric banding. Laparoscopic conversion surgery after a gastric bypass is a rare occurrence. It usually involves conversions due to insufficient weight reduction, from a proximal bypass to a distal one. In our own patient group the incidence is < 0.5% relative to the number of primary p.a. bypass operations. In the case of gastric banding, on the other hand, re-operation rates can be up to 15%. More than half the cases are port and sleeve complications. They are minor complications and can often be corrected under local anesthesia.

# 4.0 Technique

The patient is placed in the reversed Trendelenburg position on an operating table approved for the patient's weight. Video monitors are positioned on the right and left side, above the patient's shoulders. Both arms are placed in a stretched-out position (**Fig. 3a**). A transurethral urinary catheter is placed, and the surgical site is disinfected repeatedly. Cephalosporin is given for antibiotic prophylaxis.

Using a threaded TERNAMIAN EndoTIP trocar cannula (KARL STORZ, **Fig. 2**), the pneumoperitoneum is established in the left hypogastric fossa until intraabdominal pressure is 15 mmHg.

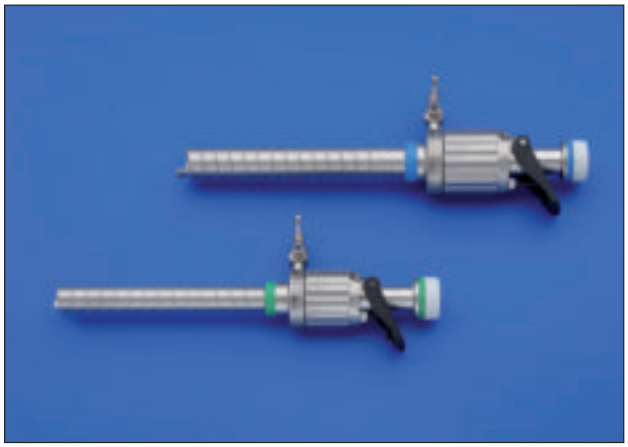


**Fig. 2**
A threaded TERNAMIAN EndoTIP trocar cannula (KARL STORZ) is used to establish the pneumoperitoneum safely.

**Fig. 3a**
Patient positioning and working positions of the surgery team in the laparoscopic gastric bypass operation.

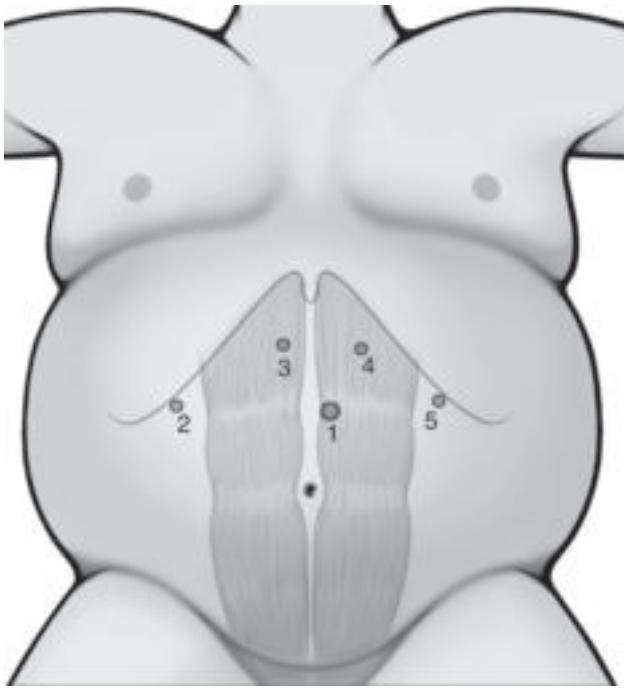



**Fig. 3b**

**1)** Umbilical optical port for rigid HOPKINS® rod-lens telescope, available in various directions of view, coupled to the endoscopic camera system.

**2)** Right upper quadrant port for retracting the left lobe of the liver with the liver retractor.

**3)** Epigastrium above the left hepatic lobe in the direction of the right costal arch (port for operating instruments).

**4)** Similar to position 3, except that it points toward the left costal arch and maintains a minimum distance of at least 10 cm (port for operating instruments).

**5)** Below the costal arch (port for operating instruments, e.g. a Babcock grasper for holding the stomach).

**Fig. 4**
The first trocar is placed in the upper abdomen about one forefinger-thumb length from the xyphoid.

It is essential that there be sufficient free space in the cranial position to permit unimpeded access to the gastrointestinal anastomosis. Accordingly, the initial port should be placed at an approximate distance from the xyphoid that corresponds to the distance between the index finger and the thumb (**Fig. 4**). The 15 cm (extra long) trocar is especially well suited for use in patients with a BMI > 50.

The other trocars (**Fig. 2b,** p. 11) are then placed successively. Once the camera trocar port is established, an 11 mm trocar for insertion of the liver retractor is placed below the right costal arch. The liver retractor is then securely attached to an instrument holder and can be used to elevate the greater omentum. Subsequently, a 13 mm trocar is placed at the lateral abdominal wall below the left costal arch. The two epigastric working trocars (13 mm) are inserted such that they provide an optimal working angle for surgical maneuvers in the area of the hiatus. The distance between the working trocars should be large enough to avoid any obstructions.

Usually, HOPKINS® rod-lens telescopes with 30° and 45° directions of view are inserted. The use of extra long telescopes (42 cm) and extra long instruments (43 cm) can be an advantage, particularly in obese men. That also applies to instrument length (43 cm).

Where the anastomosis between the gastric pouch and the jejunal limb is to be carried out with a circular stapler, the use of two gas insufflation units is recommended for adequate compensation of the gas loss often associated with this technique.



**Figs. 5a, b**
Use of the liver retractor in laparoscopic bariatric surgery.

In the event of gas loss, the heavy weight of the abdominal walls jeopardizes the continuation of the laparoscopic procedure. After insertion of the 11 mm trocar, the abdominal cavity is inspected with a 30° telescope. The other 13 mm trocars (for linear staplers) are inserted under constant endoscopic control.

The hiatal region is exposed using the liver retractor, which is securely attached to the instrument holder. Due to the frequent presence of hepatic steatosis, sturdy and extra long retractors must be used in this step. The authors prefer to use retractor 30623 UR (KARL STORZ) (**Figs. 5a and 5b**).

Once inspection of the abdomen has been completed, the hiatus and cardia are exposed. The anatomical landmarks, such as the caudate lobe on the left side of the liver, the right diaphragmatic crus, and the angle of His, are then identified. Preferably dissection should commence at the angle of His such that this structure is mobilized. That makes it much easier to visualize the subsequent target direction of the staple line because in many cases there are axial hiatal hernias. The cranial vasa brevia can be transected using an ultrasonic dissector if they are able to exert excessive strain on the spleen. The left diaphragmatic crus is then exposed, enabling subsequent completion of the pouch at the angle of His. Next, the lesser gastric curvature is dissected approx. 2 cm distal from the gastroesophageal junction and extended into the omental bursa using the ultrasonic dissector under constant endoscopic vision. Usually, the correct site is located proximal or distal to a large prominent vein running parallel to a side branch of the sinistral gastric artery across the anterior gastric wall. Dissection may involve some minor hemorrhage.

The stomach is completely transected using multiple cartridges of a 3.5 mm/45 mm linear stapler (**Figs. 6a, b**), creating a new gastric pouch. The latter should only have a small capacity. Consequently, the degree of restriction is determined and the risk of subsequent complications like ulcers and pouch dilation is minimized.

The preferred volumes nowadays range from 15 ml to 25 ml so they are much smaller than they were in the days of open surgery, where volumes of up to 90 ml were permitted. During the learning phase a nasogastric tube with a balloon tip can be useful during this step. There is often hemorrhage from the staple line.

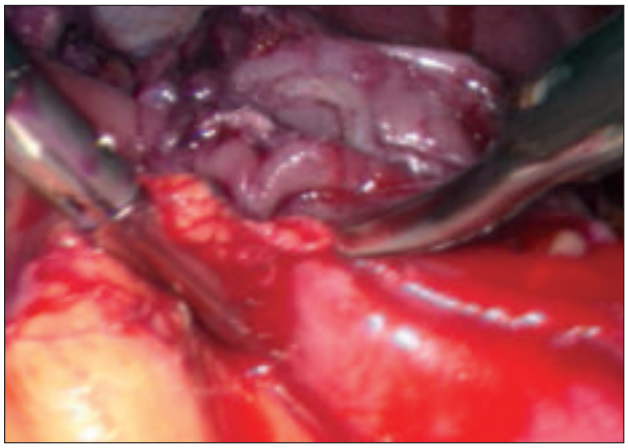


**Fig. 7**
Do not use electrocautery to stop intraoperative bleeding from the staple line. Oversewing of the staple line or clip application are more reliable methods.

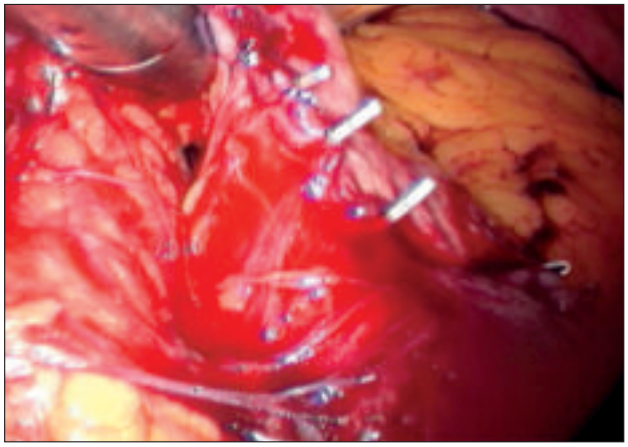


**Fig. 8**
Temporary clip application to stop spurting hemorrhage.

**Figs. 6a, b**
Creation of a gastric pouch (schematic drawing)

However, it must not be stopped with electrocautery (**Fig. 7**) since this may induce delayed necrosis. Clips can be applied for temporary management of spurting vessels (**Fig. 8**). To prevent hemorrhage from the staple line bioabsorbable membranes (e.g. Seamguard®, Gore) can be used. Smooth and neat resection margins are optimal for anastomosis (**Fig. 10,** p. 14).

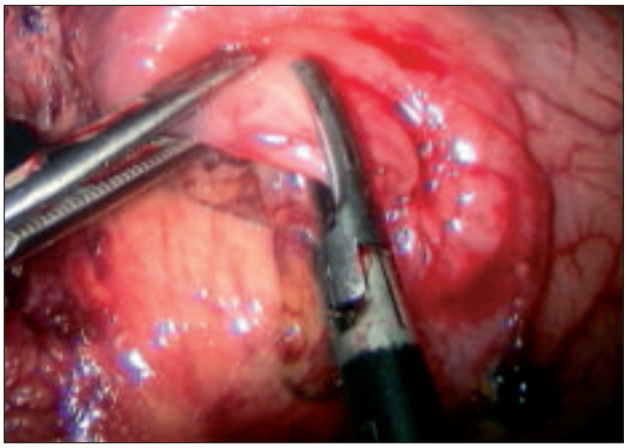


**Fig. 9**
Determination of the dissection plane in the area of the lesser curvature.

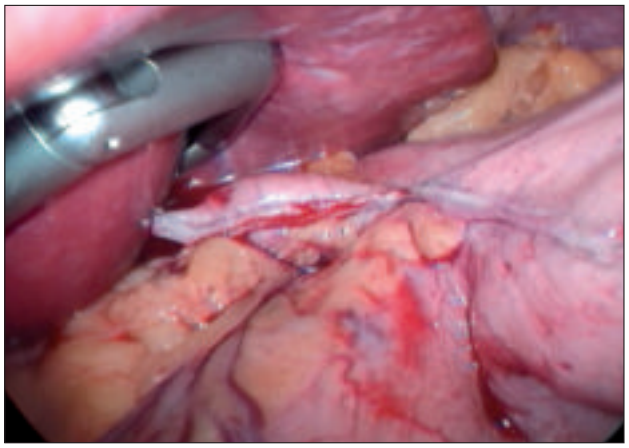


**Fig. 10**
Creation of the stomach pouch should be performed with a clearly defined resection line.

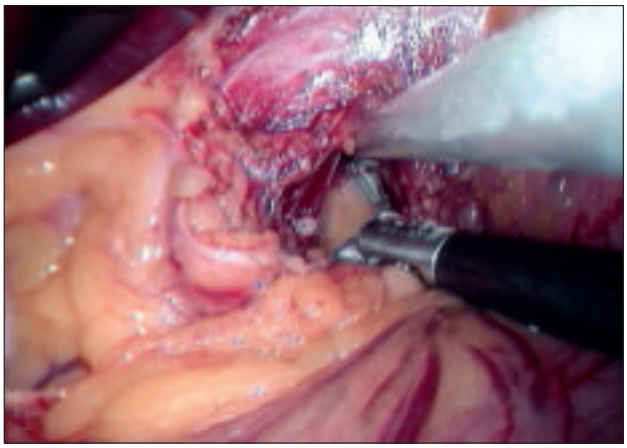


**Fig. 11**
Formation of a retrogastric tunnel for insertion of the linear stapler.

There is always a risk of the staple line opening partially and forming a suture dehiscence with restoration of pouch continuity to the remainder of the stomach. Generally speaking, the gastrogastric fistula is an surgical error that consists of incomplete disruption of stomach continuity. It therefore occurred more frequently in the days of open surgery because vision was limited and use of staplers was more difficult. Small bridges between the pouch and the remainder of the stomach were often overlooked near the spleen.

Continuous over-and-over suture of the resection lines can minimize the risk of staple line dehiscences, as can staple line reinforcement using bioabsorbable materials (e.g. Seamguard®, Gore).

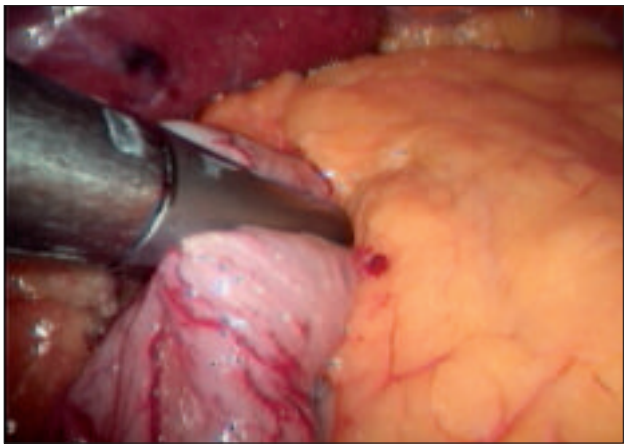


**Fig. 12**
Transverse resection of the stomach with a linear stapler.

## 4.1 Gastrojejunostomy

With the transverse colon in a turned-up position, the ligament is identified clearly and an oral jejunal limb is selected that reaches the upper abdomen without tension. For this purpose, the greater omentum should be transected to reduce tension if it contains a substantial amount of fat (**Figs. 13, 15 – 18b**). As a rule, the lowest point of this limb resides approx. 50 cm from the ligament of Treitz (**Fig. 19**). It is easiest to transect the jejunum now using a stapler (white cartridge) (**Fig. 20**). Prior to this step, the mesentery is skeletonized using the ultrasonic dissector. It is quite feasible to attach the limb to the pouch first and only transect the jejunal limb after anastomosis.

The oral and aboral limbs must remain identified unambiguously. The consequences of any confusion would be disastrous.

To minimize the incidence of bile reflux, which is rather unresponsive to conservative therapy, a minimum length of 50 cm should be maintained for the biliodigestive limb. This also facilitates any early or late revision surgery. Some variations of the bypass use a larger distance but are associated with a higher risk of malabsorption. The RUTLEDGE mini-bypass entails a higher risk of bile reflux because the biliodigestive limb takes the digestive juices into the alimentary limb via the anastomosis.

**There are three basic methods of limb routing for gastrojejunostomy:**

1. antecolic (author's preference) and antegastric
2. retrocolic and antegastric, and
3. retrocolic and retrogastric.

The antecolic approach is surgically easier but it is longer in terms of the distance between the upper jejunal limb and the gastric pouch, which has to be bridged. For this reason the lack of tension should be verified at the outset if the mesocolon contains a substantial amount of fat and/or the body is very long (> 190 cm). If there is tension, the retrocolic and retrogastric routes must be used.

**In terms of technique, the following types of anastomoses can be distinguished:**

1. Circular end-to-end anastomosis stapling
2. Linear end-to-end anastomosis stapling (as illustrated in **Fig. 14**).
3. "Hand-sewn" anastomosis.

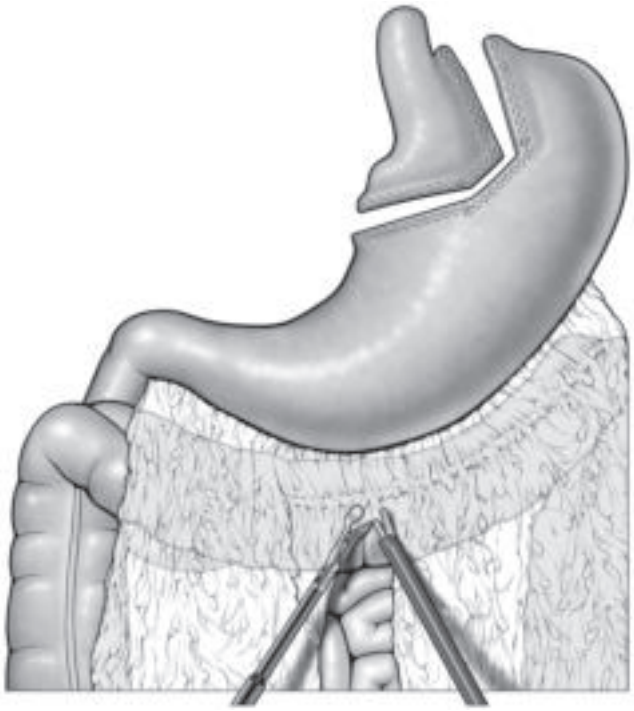


**Fig. 13**
Basic principle of omentum majus transection.

**Fig. 14**
Basic principle of the linear end-to-end anastomosis stapling technique (posterior wall).

**Fig. 15**
The greater omentum is passed to the upper abdomen and transected using an ultrasonic dissector.

**Fig. 16**
Identification of the oral jejunal limb at Treitz's ligament.

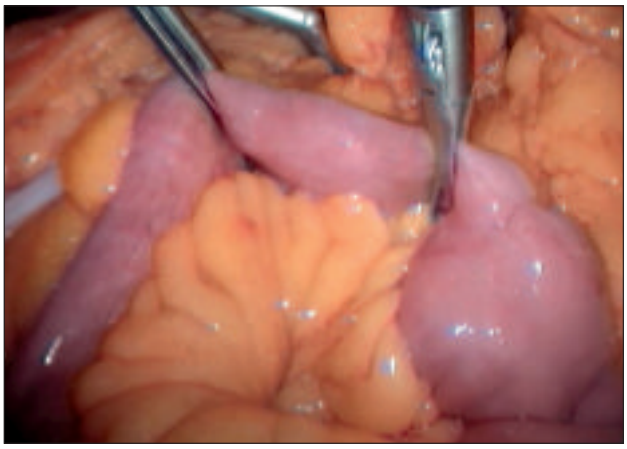


**Fig. 17**
Measuring the size of the jejunal limb is initiated at Treitz's ligament.

**Fig. 18a**
The distance markers on the forceps (in cm-steps) facilitate measurement of the correct length of the limb.

## 4.1.1 Circular End-to-End Anastomosis Stapling

The use of circular staplers can make it easier to perform gastrojejunostomy, although extremely thick abdominal walls make it difficult to guide the stapler properly. It is often difficult to pass the anvil abdominally through the small opening created in the gastric pouch (**Fig. 21**). The anvil can be introduced to the pouch through the opened remainder of the stomach before the last stomach bridge between the pouch and the fundus is transected.[44]

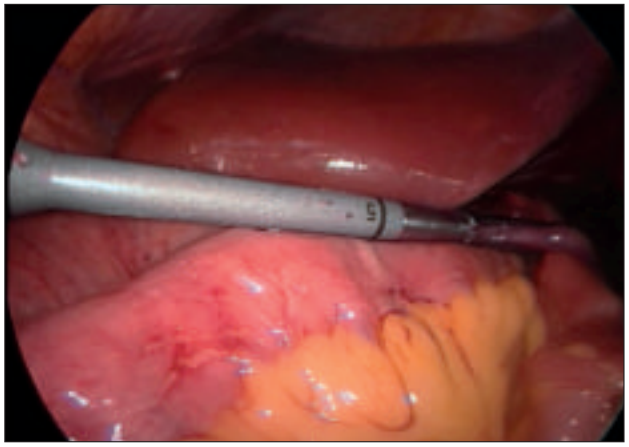


**Fig. 18b**
The distance markers on the forceps (in cm-steps) not only allow for measuring the length of the alimentary limb (starting at the gastrojejunostomy), but also add precision to this important step of the procedure.

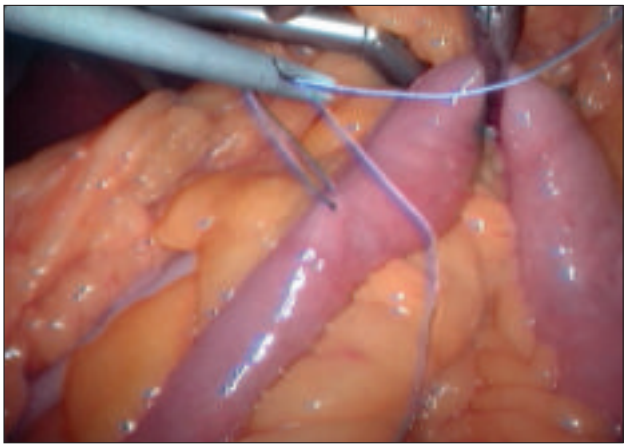


**Fig. 19**
The small intestinal limb is measured and marked with a suture (50 cm from Treitz's ligament).

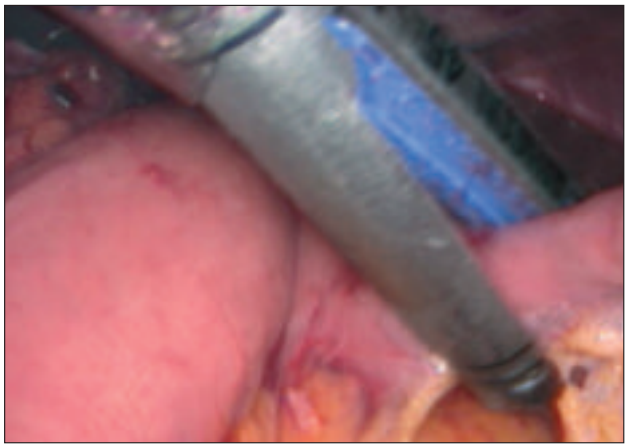


**Fig. 20**
Transection of the jejunal limb at a point distant enough so the pouch can be reached without tension.

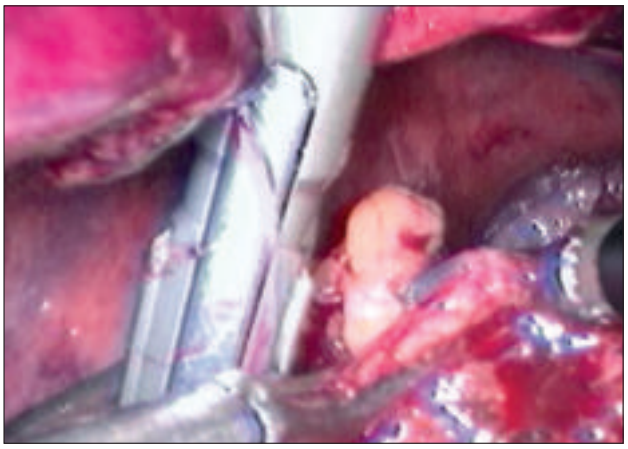


**Fig. 21**
The anvil is passed through the opening in the gastric pouch.

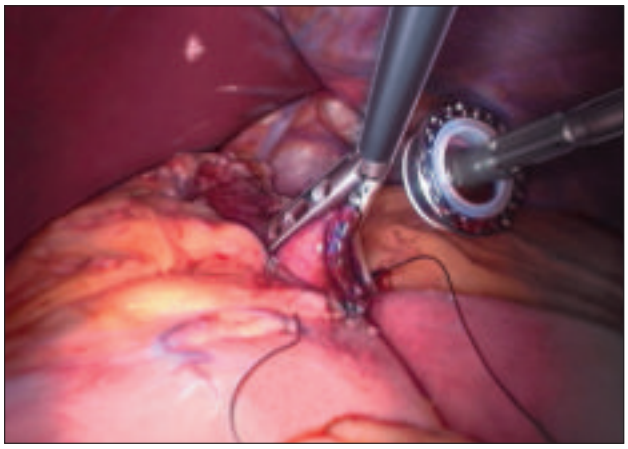


**Fig. 22**
The pouch is grasped and the stapler head advanced through the created opening; the jejunal limb is already fixed to the pouch.

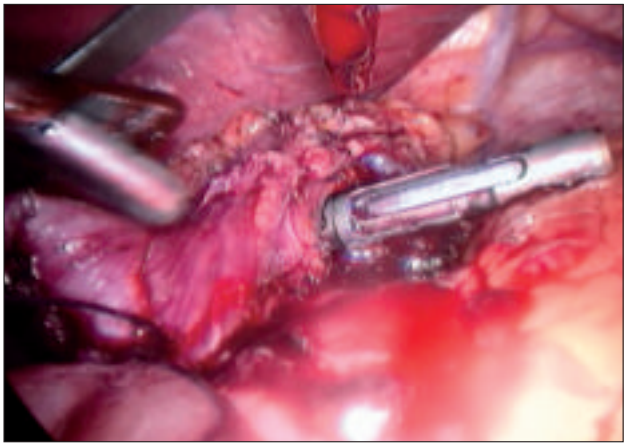


**Fig. 23**
The anvil is secured in the pouch by a purse-string suture.

Opening the pouch along the staple line causes defects that have to be closed again. The use of a specially designed "anvil grasper" simplifies this maneuver (**Fig. 22**). At all events, when the pouch has been opened the anvil should be secured with a purse-string suture (**Fig. 23**). If the anvil is being introduced transorally, there is no need for this maneuver but placement and transport problems can occur with the anvil.

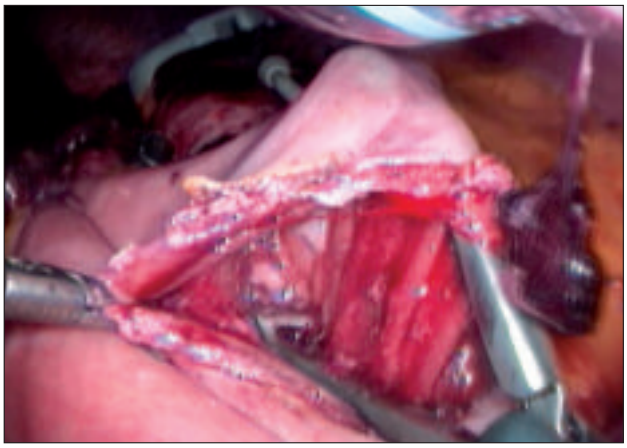


**Fig. 24**
Incision into the jejunal limb, which is spread open to insert the stapler.

The opening of the jejunal limb must be created antimesenterically enough for the selected stapler to be introduced easily (**Fig. 24**). The stapler must be inserted while the limb is secured in position with grasping forceps (**Fig. 25**). A gentle twisting motion may facilitate passage of the stapler. Preliminary placement of fixation sutures can be helpful, ensuring that no undue tension is produced while connecting the anvil to the stapler head (**Fig. 26**). After completion of the anastomosis, the stapler must be removed very carefully since tactile sensitivity may be attenuated at this point (**Fig. 27**). The major incisions for the circular stapler are at risk of getting infected. Therefore, the stapler should be removed through the abdominal wall only with plastic film protection (**Fig. 28**). We observed local infection only after the use of circular staplers. Commercially available trocars for circular staplers are too short for use in obese patients. As an alternative option, plastic film can be used to maintain the pneumoperitoneum and protect the abdominal wall.

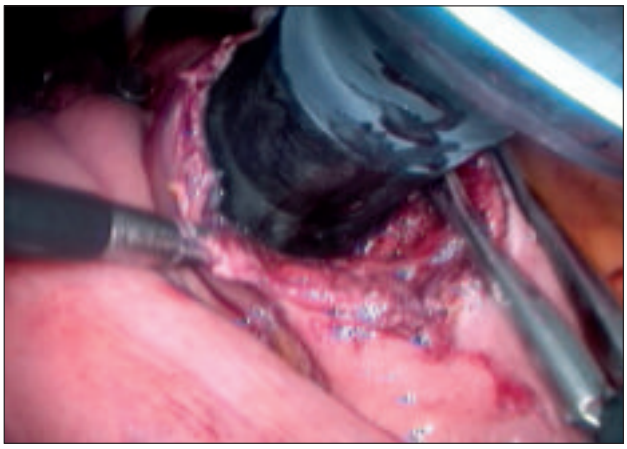


**Fig. 25**
Insertion of the circular stapler.

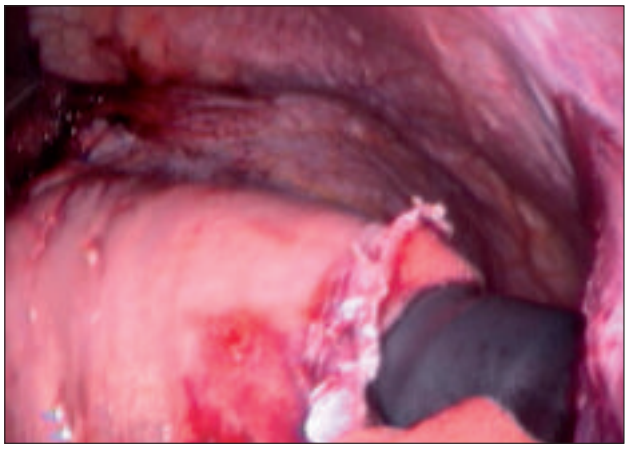


**Fig. 27**
Careful removal of the stapler after completion of the anastomosis.

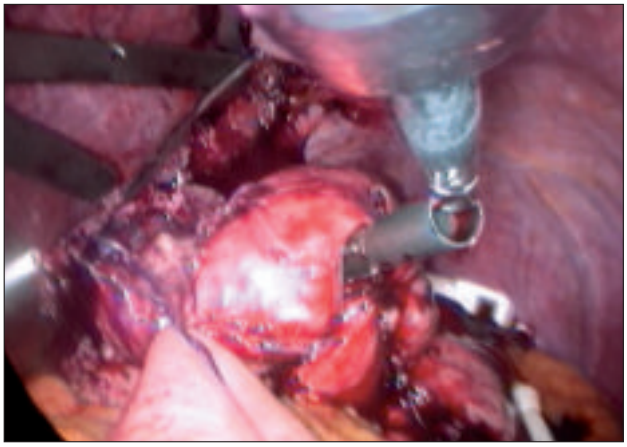


**Fig. 26**
Connection of the anvil to the stapler head.

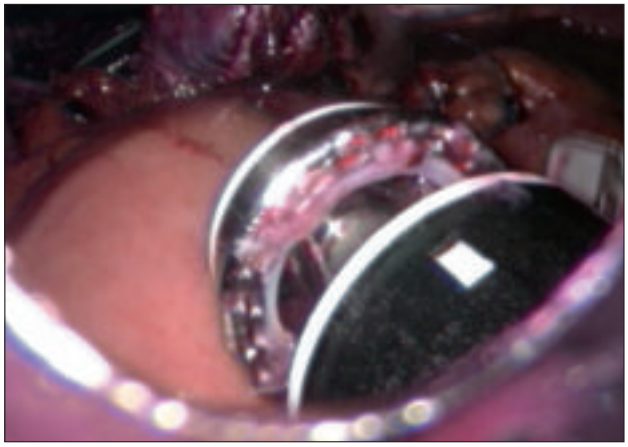


**Fig. 28**
After completion of the anastomosis, the circular stapler is a potential source of infection and must not come into contact with the abdominal wall.

### 4.1.2 Linear Stapler Anastomosis

After fixation of the alimentary limb to the gastric pouch two congruent openings are made in the pouch and the antimesenteric limb side using an ultrasonic dissector. The linear stapler is introduced and the anastomosis is "shot". Then the stapler is removed and the staple line is inspected for spurting hemorrhage. After that the nasogastric tube is placed and the opening is closed with a continuous suture.

### 4.1.3 "Hand-Sewn" Anastomosis

After fixation of the alimentary limb to the pouch and opening 1.5 cm of the intestine and stomach the latter can each be closed with a continuous suture in the region of the posterior and anterior walls. While the nasogastric tube is still in position, securing single button sutures are placed at both ends of the anastomotic suture in order to reduce the tension from the anastomosis.

If using linear staplers, as in the case of "hand-sewn" anastomoses, only 13 mm trocars are required. Wound infections are less likely under these circumstances since there is no need to punch any tissue and the stapler can be passed through the trocar without coming into contact with the abdominal wall.

In 585 anastomoses using linear stapler suture and "hand-sewn" suture (see **Figs. 29 a – c**) we have not seen a single wound infection. The diameter of the anastomosis should be at least 8 mm. After completion of the learning curve (the first 100 operations) we inserted an 8 mm nasogastric probe for determination of anastomotic size only. After completion of the anastomotic suture and laparoscopically controlled removal of the probe we dispensed with stabilization of the anastomosis by reinsertion of a postoperative indwelling probe. Since post-operative anastomotic insufficiencies are associated with high rates of morbidity and mortality, a leak test with methylene blue solution is performed during the operation. For this purpose, clips are applied to briefly exert pressure on the jejunum at the distal end of the nasogastric tube and methylene blue solution is injected under pressure through the NG tube. Any leakage detected requires immediate repair by manual seromuscular suture.

Alternately, intraoperative gastroscopy can be performed with gas insufflation. When doing so, gas bubbles should be observed after the instillation of liquid into the hiatal region. Superior mastery of suture skills and sturdy needle holders are fundamental to ensure that the suture is safely placed, even at extreme working angles. In the hands of the authors, the KOH Macro Needle Holder 26173 KC (KARL STORZ) produces outstandingly good results. In general, fixation sutures should be placed between the descending jejunal limb and the gastric pouch to ensure that traction on the anastomosis from the weight of the mesentery is reduced when the patient is mobilized early.

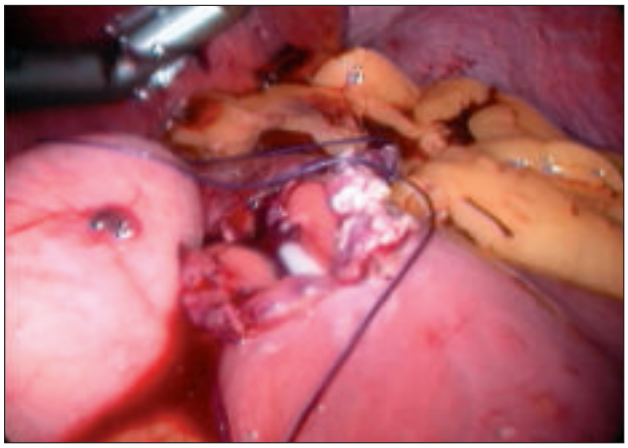


**Fig. 29a**
Gastrojejunostomy, "hand-sewn" anastomosis.

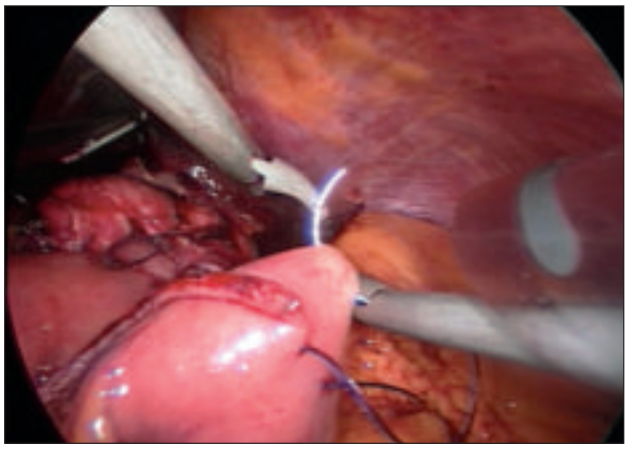


**Fig. 29b**
It is not absolutely necessary to oversew the end of the jejunal limbs or the entero-enteric anastomosis. Hemorrhage from the staple line can not be stopped reliably in this way though.

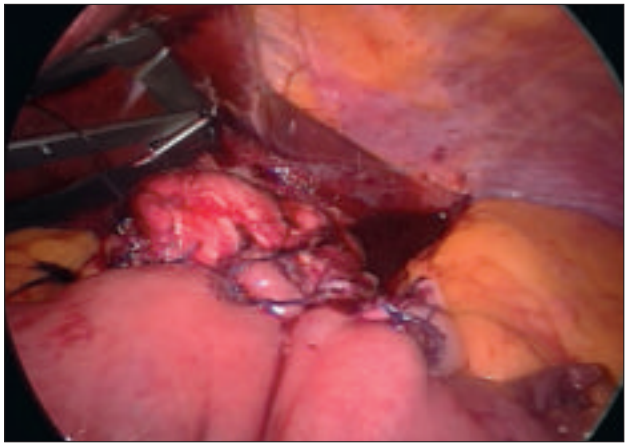


**Fig. 29c**
Gastrojejunostomy and oversewn end of the jejunal limbs after completion of the gastrojejunostomy.

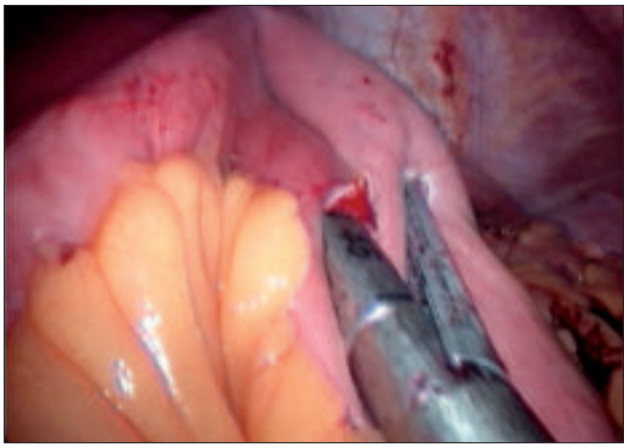


**Fig. 30**
Entero-enteric anastomosis (posterior wall by use of a stapler).

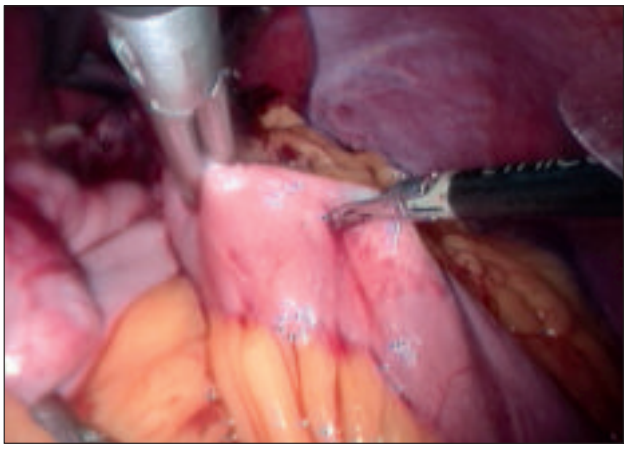


**Fig. 31**
Creation of a window in the antimesenteric aspect of the small intestine using an ultrasonic dissector.

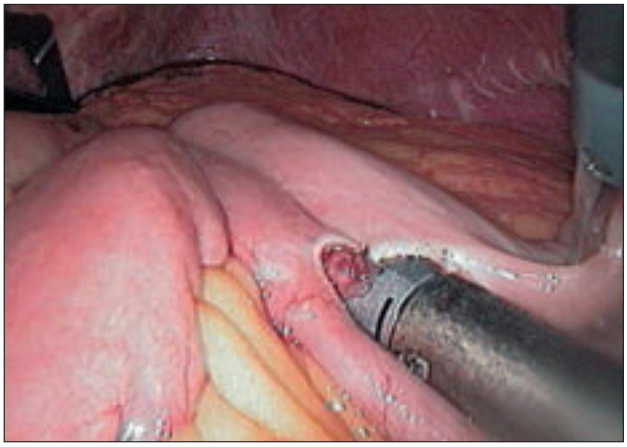


**Fig. 32**
Insertion of a linear stapler into the two limbs of the small intestine that are to be anastomosed.

## 4.2 Jejuno-Jejunal Anastomosis

The next step is to identify the Treitz ligament again and fix the biliodigestive limb with a retaining thread, followed by localization of the anastomosis. The jejuno-jejunal anastomosis is created at a distance of 120 – 150 cm from the site of gastrojejunostomy, depending on the patient's BMI. A general rule of thumb is: The higher the BMI, the longer the alimentary limb. It is not so much energy malabsorption as the hormonal diversion that leads to higher weight reduction. The differences in weight reduction are only minimal and in the main they are only found in patients with a high BMI so evidence has only been published in a few studies.

Measuring the length of the alimentary limb is conducted antimesenterically, as with the biliodigestive limb. For this purpose special atraumatic grasping forceps with length marks on the sheath (**Figs. 18a and 18b**) are used. These marks at intervals of 5 cm and 10 cm make it much easier to measure intestinal lengths accurately. The limbs are placed along the sheaths without stretching them too much. The intestinal lengths can be determined quickly and reliably with two grasping forceps using both hands.

The entero-enteric anastomosis is created by applying the side-to-side technique using a 45 mm linear stapler (**Fig. 30**). For this purpose, an incision must be placed first in the antimesenteric aspect of the jejunum (**Fig. 31**). The linear stapler is then inserted into the jejunal limbs, once they are aligned parallel to each other (**Fig. 32**). This can be conducted either orally or aborally. In order to avoid stenoses the staplers can be used in both directions.

A continuous suture is applied to close the remaining enterotomy employing absorbable suture material (**Fig. 33**). When closing the openings with a linear stapler, stenoses often occur so two cartridges should be used here for the anastomosis, one orally and one aborally. At this site it is difficult to perform a leak test using methylene blue solution. As such, profound proficiency in laparoscopic technique is mandatory. It is important to check for any hemorrhage from the staple line prior to closure of the enterostomy (**Fig. 34**). Any hemorrhage must be stopped by placement of a suture. With staple line reinforcement (e.g. Seamguard®, Gore) it is possible to reduce the risk of hemorrhage drastically.

It is also important not to generate a dead end to avoid manifestation of symptoms of blind limb syndrome (**Fig. 35**). The completed anastomosis should be free of any signs of leakage when pressure is exerted on it (**Fig. 36**).

Normally, two drains are placed, one near the gastro-jejunal anastomosis and the other near the jejuno-jejunal anastomosis. An easy-flow drain can reach both anastomoses.

**Fig. 33**
Continuous hand-sewn suture of the anterior wall.

**Fig. 34**
The staple line must be thoroughly inspected for signs of hemorrhage. Any hemorrhage must be stopped by a purse-string ligature.

**Fig. 36**
Completed entero-enteric anastomosis (suture of the anterior wall by use of absorbable suture material).

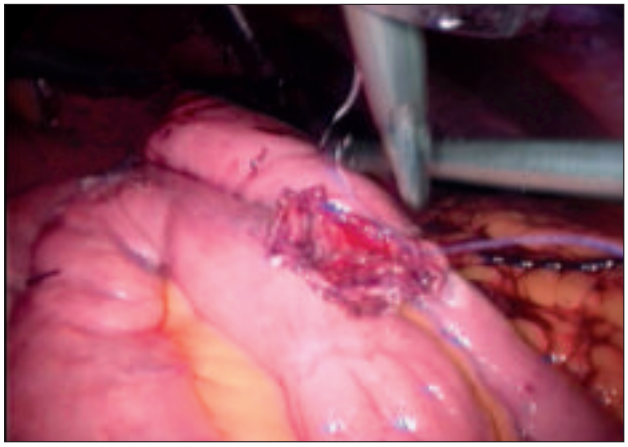


**Fig. 35**
The anastomosis should not create a dead end.

### 4.3 Postoperative Phase

Since tachycardia occasionally is the only sign of significant problems, postoperative monitoring in the ICU is of particular importance. In the case of persistent tachycardia (HR >120 bpm) an early re-laparoscopy should be considered because other diagnostic procedures only supply a limited amount of information. The patient should be mobilized on the evening of the day of surgery. A high incidence of atelectasis and low oxygen saturation often makes breathing exercises (e.g. Triflow) necessary for this group of patients.

All patients should be given thrombosis prophylaxis and low molecular weight heparin (at a dose adjusted to body weight).

If the patient has a history of deep vein thrombosis, we begin with intermittent mechanical compression by machine as soon as the anesthesia is induced and it is continued in the ICU.

If the nasogastric tube was placed intraoperatively, it is removed 24 hours after at the latest. In the learning phase a postoperative anastomosis check should be conducted between the first and second day after the operation in the case of a primary gastric bypass. After performing 264 problem-free operations we dispensed with this diagnostic procedure. As from the second day after the operation liquid alimentation can be commenced. The drain is removed 36 hours after the operation. Postoperative alimentation must first be restricted to fluids (soups).

After a 3-week diet of fluids, a bland diet can be initiated (white meat, cooked fish, easily digestible, low-fiber, and no raw vegetables or fruit). Supplementation is also commenced at this point in time. While serious disturbances of the wound healing processes tend to be rare, hematomas and seromas occur occasionally at the trocar sites.

## 5.0 Results

Bypass operation outcomes with respect to weight loss and improvement in the quality of life are convincing, provided the operation is performed at centers with a sufficiently large patient population. *WITTGROVE* had already performed 1,500 operations by the year 2001.[56] The general rate of complications (thrombosis, embolism, postoperative hernia, etc.) of the laparoscopic procedure is clearly lower as compared to the patient population subjected to laparotomy. The laparoscopic approach requires the surgeon to have special expertise and practical skills, and the learning phase is quite long. Weight loss outcomes for the Roux-en-Y bypass are impressive. Laparoscopic conversion surgery after gastric bypass is a rare occurrence.

In our group of patients conversions from the proximal bypass to the distal bypass after a therapy failure are rare, accounting for 2–3 interventions a year. The extremely long duration of the surgery with the patient in the reversed Trendelenburg position accounts for the relatively high rate of complications and mortality, aside from the challenging nature of the procedure. If the duration of surgery is allowed to extend for a very long period, deep vein thrombosis and other thromboembolic complications must be anticipated.

The complication rate of the laparoscopic approach is in the range of 6.7 – 15%. The rate of 6.7% for minor and major complications as reported by *SCHAUER et al.* [38–40] and the rate of 12.6% reported by *WITTGROVE* seem very low.[57,59,60] The mean follow-up in these cases was only 12.5 months, which may be too short an interval to allow for a conclusive statement. 15% major complications in the documentation by GAGNER et al. [13] appear to be more realistic on the other hand.

## 5.1 Mortality

The comprehensive meta-analysis by BUCHWALD (2004) reported a mortality rate of 0.5% for the gastric bypass.[7] The rate is therefore 5 times higher than after a gastric banding operation (0.1%) but only half the figure for BPD and duodenal switch (1.1%). Extremely long operating times in the reverse Trendelenburg position would suggest a relatively high complication density and hence mortality, no matter how sophisticated the procedure is. Deep vein thrombosis and other thromboembolic complications are to be expected relatively frequently.

Operating times fluctuate substantially (**Tab. 3**).

**Data published by various authors on laparoscopic gastric bypass operations**

| Authors | Year | Operations | BMI | Operating time (min.) | Mortality |
|---|---|---|---|---|---|
| *Lönroth et al.*[26] | 1996 O | 8 | 38 | 250 | 0% |
| *Gustavsson & Westling*[16] | 1998 A | 32 | n.m. | n.m. | 0% |
| *Wittgrove & Clark*[59] | 1998 A | 300 | n.m. | 240** | 0% |
| *Wittgrove & Clark*[60] | 1999 A | 500 | n.m. | 135 | 0% |
| *Gagner et al.*[13] | 1999 A | 52 | 55 | 241 | 0% |
| *Schauer et al.*[39] | 1999 A | 15 | 56 | 280 | 0.8% |
| *Schauer P* | 1999 O | 1 | 53 | 408 | 0% |
| *Westling et al.* | 1999 A | 51 | 55 | n.m. | 0% |
| *Schweitzer et al.** [42] | 1999 O | 8 | n.m. | 145 – 270 | 0% |
| *Lönroth et al.* | 2000 A | 76 | 43*** | n.m. | 1.3% |
| *Schauer et al.*[40] | 2000 O | 275 | n.m. | n.m. | 0.4% |
| *Wittgrove & Clark*[57] | 2000 O | 500 | n.m. | n.m. | 0% |
| *Huerta et al.*[22] | 2001 O | 364 | 46 | n.m. | 0% |
| *Higa et al.*[21] | 2001 O | 1500 | n.m. | up to 60 | 0% |
| *Nguyen et al.*[31] | 2001 O | 51 | 45 | 232 ± 43 | 0% |
| *Westling et al.*[56] | 2001 O | 30 | 42 | n.m. | 0% |
| *Gould et al.* | 2002 O | 223 | 49 | n.m. | 0% |
| *Korenkov et al.* | 2002 A | 5 | 56.7 | 270 – 450 | 0% |
| *DeMaria et al.*[10] | 2002 O | 281 | 48.1 | 162 – 234 | 0% |
| *Papsavas et al.*[34] | 2002 A | 107 | 48.5 | n.m. | 0% |
| *Biertho et al.* | 2003 O | 456 | 49 | n.m. | 0.4% |
| *Schwartz et al.* | 2003 O | 600 | n.m. | 170 | 0% |
| *Tieu et al.*[****] [49] | 2012 | 1100 | 39.8 | 155 | 0% |
| *Brolin & Lin*[6] | 2012 | 1069 | 42.2 | n.m | 0% |
| *Results of the authors* | 2012 | 2347 | 32 – 83 | 59 | 0.04% |

* Hand-assisted (pneumo-sleeve)
** In the last 20 cases: 120 min
*** BMI 22 – 66
(the indication criteria applied were more than questionable!)
**** Robot operatins

A: Abstract
O: Original paper

**Tab. 3:**
Data of primary laparoscopic gastric bypass operations.

## 5.2 Morbidity

16% surgery-related health disorders (332/ 2073) were calculated by GENTISCHELI *et al.* (2002)[14] based on the published data of a literature review with an evidence level of more than II.

A broad range of variation (6.7 –75%) was observed in laparoscopic "hand-assisted" operations.[42]

**For comparison:** The incidence of complications in the days of "open" surgery (involving abdominal incision) was as high as 16%. The study by SEE et al. [43] reported the following **complication rates:**

- 13% Revision surgeries
- 4.9% Anastomotic insufficiency
- 2.4% Intestinal obstructions (ileus)
- 1.2% Splenectomy
- 1.2% Pulmonary embolism
- 0.8% Ulcers at the site of anastomosis
- 1.8% Ulceration

| **Number of Operations:** | **69** | **69** | **69** |
|---|---|---|---|
| Age (years) | 39 | 39.7 | 39 |
| Body weight (kg) | 130 | 124.8 | 124.8 |
| BMI (kg/m²) | 45.7 | 44.7 | 45.9 |
| Duration of surgery (min.) | 193 | 163+ | 151++ |
| Overall morbidity (%) | 20.3 | 21.7 | 20.3 |
| Major complications (%) | 10.1 | 7.2 | 1.4+++ |

**Tab. 4:**
Outcomes of laparoscopic bypass surgery and learning curve effect (SUTER et al., 2003).[48]

In a series of patients treated at *Sahlgrenska University Clinic in Gothenburg, Sweden,* three "leaks" (anastomotic dehiscences) and six cases of hemorrhage were observed among the first 76 patients. One patient died from hemorrhage that blocked the lumen in the region of the gastroenteroanastomosis and led to dilation and perforation of the stomach. In addition, after the operation many patients suffer from vomiting and a dumping syndrome if they have failed to adhere to the nutritional rules strictly. Morbidity, especially the incidence of major complications, is dependent on the operating surgeon's experience. SUTER et al. (2003)[48] divided their patient population into three groups. The duration of surgery and the incidence of major complications showed a significant decrease with increasing number of operations performed, providing a clear correlation with the experience of the surgeon (**Tab. 4**). Generally speaking, the hospital stay is becoming shorter in the US and it is being shortened further by laparoscopic procedure and increasing experience (**Tab. 5**).

## 5.3 Conversion Rate

GENTISCHELI et al. (2002)[14] calculated a mean conversion rate of 2.4% for evidence-based LGB series published up to and including 2002 (50/2,073). The complexity of the intervention means that an initially high conversion rate and a long learning phase are to be anticipated. A conversion rate of 33% (7/21) was reported by WESTLING (1999 A) in his initial series. LÖNROTH et al. (1996)[26] reported a conversion rate of 25%, mainly due to technical difficulties and complications. Note that these are initial results only. Once a surgeon has performed several hundred procedures, the conversion rate tends to approach zero.

## 5.4 Reasons for Conversion

The most common reasons for conversion are related to technical difficulties in completing the operation within a reasonable and justifiable period of time. BALTASAR et al. (1998)[3] converted because of hemorrhage, inability to insert the stapler into the esophagus, technical failure of the stapler and difficulties in creating the retrogastric tunnel.

Organ perforation was another common reason (LÖNROTH et al., 1996).[26] A short, fat-rich mesentery is another reason for conversion, provided it is found impossible to sufficiently mobilize the mesentery (LÖNROTH et al., 1998).[25] Generally speaking, previous abdominal surgery causes both the conversion rate and the operating time to rise. This applies not only to upper abdomen interventions but also to previous surgery in the true pelvis, where the omentum and jejunal limbs can be fixed in place. Cesarean section deliveries also rank among the previous events that can complicate a laparoscopic gastric bypass.

## Gastric Bypass Studies Reporting Operating Times and Duration of Hospital Stay

| Study | Open surgery (open) or laparoscopy (lap.) | Number of patients | Operating time (min.) | Hospital stay (days) | Comment |
|---|---|---|---|---|---|
| *DeMaria EJ et al.*[10] Results of 281 Consecutive Total Laparoscopic Roux-en-Y Gastric Bypasses to Treat Morbid Obesity, Ann Surg 2002 May; 640-7 | lap. | 281 | 234 ±77 reduced to 162 ±42 | Stay: 4; Range: 2–91; Median: 2; 75% of patients are discharged within 3 days | 69% follow-up after 1 year |
| *Higa KD et al.*[19] Laparoscopic Roux-en-Y gastric bypass for morbid obesity: technique and preliminary results of our first 400 patients Arch Surg 2000 Sep 1029–33 | lap. | 400 | 60 – 90 | 1.6 days lap. surgery<br>2.7 days after conversion to open surgery | |
| *Huerta S et al.*[22] Reduced length of stay by implementation of a clinical pathway for bariatric surgery in an academic health care center, Am Surg 2001 Dec; 1128–35 | open | 182 in '98/99 (Group I)<br>182 in '99/00 (Group II) | | Group I – 4.05<br>Group II – 3.17 | |
| *Nguyen NT et al.*[31] Laparoscopic versus open gastric bypass: a randomized study of outcomes, quality of life, and costs, Ann Surg 2002 Sep 279–89 | lap.<br>open | 79<br>76 | | lap. – 3<br>open – 4 | |
| *Schauer PR et al.*[40] Outcomes after laparoscopic Roux-en-Y gastric bypass for morbid obesity, Ann Surg 2000 Oct 515–29 | lap. | 275 | | Median: 2 | Median return to work: 21 days |
| *Smith SC et al.*[45] Roux-en-Y gastric bypass: A 7-year retrospective review of 3,855 patients, Obes Surg 1995 Aug 314–18 | open | 3855 | Mean: 78 | Mean: 3.6 | |
| *Deylgat B et al.*[11] Indications, safety, and feasibility of conversion of failed bariatric surgery to Roux-en-Y gastric bypass: a retrospective comparative study with primary laparoscopic Roux-en-Y gastric bypass Surg Endosc. 2012 Jan 19. | lap.<br>open (16) or lap. (56) | 652 primary<br>72 secondary | | 4.95<br>5.38 | No statistically significant difference |
| *Tieu K et al.*[49] Robotic-assisted Roux-en-Y gastric bypass: update from 2 high-volume centers Surg Obes Relat Dis. 2012 Jan 16. | Robotic-assisted | 1100 | Mean duration of operation: 155 Min. (longer than RYGB) | | – No mortality<br>– Complications:<br>▷ 2 pulmonary embolism<br>▷ 3 deep vein thrombosis<br>▷ 1 leakage<br>▷ 9 bleeding |
| *Brolin RE et al.*[6] Treatment of gastric leaks after Roux-en-Y gastric bypass: a paradigm shift. Surg Obes Relat Dis. 2012 Jan 16. | Prim. lap<br>Prim. open<br>Revisional procedures | 836 (no leakage)<br>114 (8 leakages)<br>119 (5 leakages)<br>8 + 5=13 (7 at gastro-jejunustomy and 6 at staple line of upper pouch)<br>5 patients required reoperation | | Operative group: 36 ±34 days<br>EIFS (endoscopic injection of fibrin sealant) 33 ±7 days | EIFS (endoscopic injection of fibrin sealant). Provides safe and successful treatment of patients who develop gastric leaks after bariatric operations |
| *Boza C et al.*[4] Laparoscopic Roux-en-Y gastric bypass versus laparoscopic sleeve gastrectomy: a case-control study and 3 years of follow-up. Surg Obes Relat Dis. 2011 Sep 21 | lap.<br>Complic. rate, mortality, % of estimated weight loss (EWL) are compared 1, 2 and 3 years after surger | LSG (lap. sleeve gastrectomy): 811<br>LRYGB (Lap. Roux-en-Y gastric bypass): 786 | 76.6 ±28.0<br>106.2 ±33.2 | 2.8 ±0.8<br>3.4 ±4.4 | **LRYGB:**<br>– compl. rate 7.1%<br>– suture leak 0.7%<br>– % EWL<br>**1 Y:** 97.2% ±24.3%<br>**2 Y:** 94.6% ±30.2%<br>**3 Y:** 93.1% ±25%<br>– cholesterol level at 1 Y: 169 ±32.9 mg/dl<br>– rate of diabetes remission 86.6%<br>**LSG:**<br>– compl. rate 2.9%<br>– suture leak 0.5%<br>– % EWL<br>**1 Y:** 86.4% ± 26.4%<br>**2 Y:** 84.1% ± 28.3%<br>**3 Y:** 86.8% ± 27.1%<br>– cholesterol level at 1 Y: 193.6 ±38.7 mg/dl<br>– rate of diabetes remission 90.9% |

**Tab. 5:**

## Gastric Bypass Studies Reporting Operating Times and Duration of Hospital Stay

| Study | **Open surgery** (open) **or laparoscopy** (lap.) | **Number of patients** | **Operating time** (min.) | **Hospital stay** (days) | **Comment** |
|---|---|---|---|---|---|
| *Romy S et al.* [36] Roux-en-Y Gastric Bypass (RYGBP) vs Gastric Banding (GB) for Morbid Obesity: A Case-Matched Study of 442 Patients. Arch Surg. 2012 Jan 16. | lap. | 442 (92.3% of patients were followed 6 y postop) | no information available | no information available | **Early morbidity:** after RYGBP 17.2% after GB 5.4%<br>**after Gastic Banding**:<br>– weight loss was quicker<br>– maximal weight loss was higher<br>– weight loss after RYGBP was maintained significantly better during the 6-year follow-up period<br>**At 6 years:**<br>– more failures after GB (48.3% vs 12.3%).<br>– more long-term complications after GB (41.6% vs 19%)<br>– more reoperations after GB(26.7% vs 12.7%)<br>**Comorbidities:** More improvements after RYGBP |
| *Spivak H et al.* [46] Long-term outcomes of laparoscopic adjustable gastric banding (LAGB)and laparoscopic Roux-en-Y gastric bypass (LRYGB) in the United States. Surg Endosc. 2012 Jul;26(7):1909–19. | lap. | Lap. adjustable gastric banding (LAGB): 148<br>Lap. Roux-en-Y gastric bypass (LRYGB): 175 | no information available | no information available | – BMI loss levelled off from 5–7 y at 15 kg/m$^2$ for LRYGB and at 9 kg/m$^2$ for the LAGB.<br>– At 7 y, (EWL) was 58.6% for LRYGB and 46.3% for LAGB<br>– By 7 y, 19 LAGB patients (15%) had their bands removed.<br>– By 10 y, 29 (22.8%) of bands had been removed<br>– LRYGB group had 9 (8.6%) serious life-threatening complications, whereas the LAGB group had none<br>– 1death in LRYGB group. |

**Tab. 5:**

## 5.5 Excess Weight Loss

Weight reduction outcomes are basically no different than the "open" gastric bypass. Excess weight loss (*excess weight: current weight minus ideal weight*) is between 72% and 82% within the first year after a Roux-en-Y bypass operation (**Diagram 1**).

However, there is also a slight increase in weight again after a few years. This is chiefly dependent on the compliance of patients, who ought to retain their nutritional habits of the first few years after surgery. Ultimately all the chiefly restrictive methods result in a gradual rise in weight after some years, as was demonstrated by the S.O.S. study recently. In the long term, only biliopancreatic diversion (Scopinaro) guarantees weight stability after a previous weight reduction.

M. SUTER et al. (2003)[48] evaluated their results on the basis of success criteria and found the results to be very good (**Diagram 2**).

The BMI drops in parallel to the loss in excess weight (**Diagram 3**). This diagram shows the change in body mass index in patients with a BMI of less or more than 50 kg/m$^2$.

## 5.6 Improvement of Comorbidities

The meta-analysis by H. BUCHWALD et al. (2004)[7] demonstrated that weight loss after all the surgical procedures, including bypass operations, leads to a sustained improvement in a large number of comorbidities. Diabetes mellitus disappeared completely in 76.8% of patients and was eradicated or improved in 86.0%. Hyperlipidemia improved in at least 70% of patients. Hypertension disappeared in 61.7% of patients and was at least influenced significantly in 78.5%. Obstructive sleep apnea was eradicated in 85.7% of patients and was improved significantly in 83.6% of patients. Sleep apnea syndrome often subsides after an excess weight loss of only approx. 20 kg. In the series described by MacDONALD (2001)[27] the incidence of hypertension was effectively reduced from 59% before surgery to 21% after 5 years and 29% after 16 years following a gastric bypass operation. The specific effects of bypass surgery on diabetes mellitus are most significant. They are of a hormonal nature and cannot be explained solely by the weight reduction. Consequently, the effect of the gastric bypass operation is very different than the purely restrictive methods like gastric banding and gastroplasty.

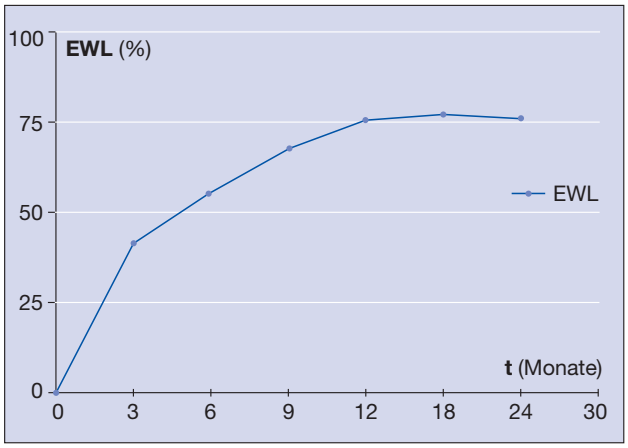



**Diagram 1**
Excess weight loss (EWL) after laparoscopic gastric bypass surgery. More than 90% of morbid obesity patients (BMI 40 – 50) report a definite success after 18 months.

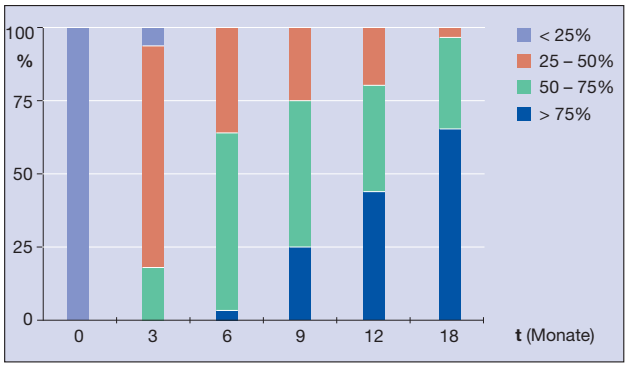



**Diagram 2**
Success rate after laparoscopic gastric bypass surgery according to the criteria specified by REINHOLD.
(Excess weight loss <25%, 25 – 30%, 50 – 75% and > 75%).

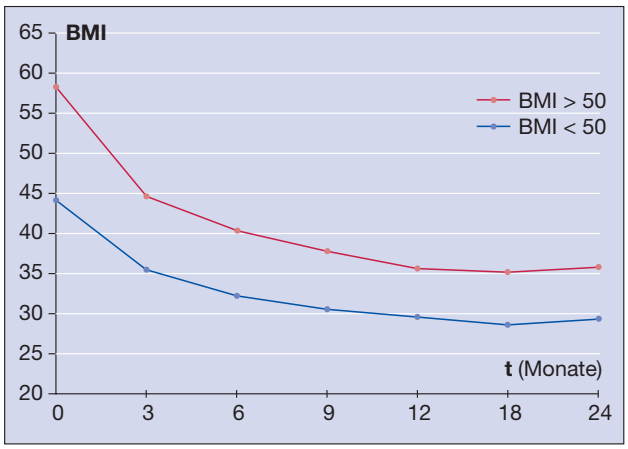



**Diagram 3**
Body mass index after laparoscopic gastric bypass surgery. Different curves are obtained for the populations of *super-obese* (BMI > 50) and *morbidly obese* (BMI 40 – 50) patients.

In the study conducted by MacDONALD (2001)[27] the prevalence of diabetes mellitus fell from 26% before the operation to 4% 5 years after the intervention and 7% 16 years after.

Generally speaking, complaints about the locomotor system can be influenced positively by weight reduction. In the MacDONALD study these were reduced from 29% to 4% after only 5 years. 16 years after gastric bypass surgery the rate of complaint increased again (15%), which may be explained as a normal result of aging. The scores from psychological tests showed a continuous improvement over the first 2 years. However, by the 5th year after the operation all the parameters had reached the preoperative baseline levels. This observation is a reflection of the fact that patients are slow in realizing that weight reduction does not solve all of their problems. Moreover, the initial success, consisting of rapid weight reduction, is soon over. Patients gradually begin to understand that a continuous diet and physical activity are essential for achieving optimal body weight.

The therapeutic effects of weight reduction by gastric bypass surgery on the cardiovascular risk are particularly impressive because here the metabolic syndrome is influenced positively as far as long-term therapy is concerned. MacDONALD (2001)[27] reported a retrospective comparative analysis of morbidly obese diabetic patients with no weight-reducing surgical procedure versus a comparable group after gastric bypass surgery and found the rate of fatalities in the control group to be 4.5 times higher than in the group subjected to bypass surgery. Whereas 28% of the obese patients with diabetes in the control group died within the first 6.2 years of the follow-up period, only 9% of the bypass surgery patients died within a period of 9 years. The stated rate of fatalities includes perioperative mortality. The effect was particularly pronounced for cardiovascular morbidity, which accounted for 54.5% of the fatalities in the control group, but only 14.3% among patients subjected to gastric bypass surgery. These data are the best results published so far and indicate that gastric bypass surgery possesses the potential to drastically reduce the mortality and morbidity of obese patients.

A long-term study by FLUM and DELLINGER (2004)[12] revealed that life expectancy shows a significant increase after successful gastric bypass surgery compared to obese patients not subjected to surgery. Of 66,109 obese patients subjected to follow-up 3,328 had been given a gastric bypass. The incidence of operations increased from 0.7 per 100,000 in 1987 to 10.6 per 100,000 in 2001. After 15 years 16.3% of non-surgery patients had died while only 11.8% of bypass patients had died.

It is not possible to deal with all the positive effects of weight reduction here. The therapeutic effect of gastric bypass surgery on an existing gastroesophageal reflux disorder is particularly significant. In many cases it is associated with an axial hiatus hernia. A diaphragmatic hernia can be caused by many factors. Chronic pressure rises in the abdominal space, and especially with obesity, often have to be linked to a diaphragmatic hernia.

20% of the population of western countries are suffering from a more or less pronounced diaphragmatic hernia. Women are more often affected than men, the ratio being 2:1. In the case of morbid obesity we succeeded in detecting a hiatus hernia in over 40% of cases during preoperative diagnosis. After gastric bypass surgery all the reflux symptoms disappear. The reason for this is not only the elimination of acid reflux by separating the stomach. Virtually all the symptoms of a reflux disorder disappear due to operative mobilization of the hernia followed by traction on the gastric pouch by the connected jejunal limb.

## 5.7 Quality of Life

The results of surgery in regard to improving the quality of life (QoL), brought about by weight reduction, are apparent in all QoL tests (**Diagram 4**). The results of the author's prospective randomized study clearly demonstrate the improvement in the patient's quality of life after bypass surgery.[52–54]

**Diagram 4** illustrates the sustained improvement in quality of life after bypass surgery. Since the SF-12 index contains no commanding parameters related to weight loss and comorbidities, it is not possible to describe the outcome of surgery by this means. Bariatric surgery-specific indices reflect the positive effects of successful gastric bypass surgery more clearly.

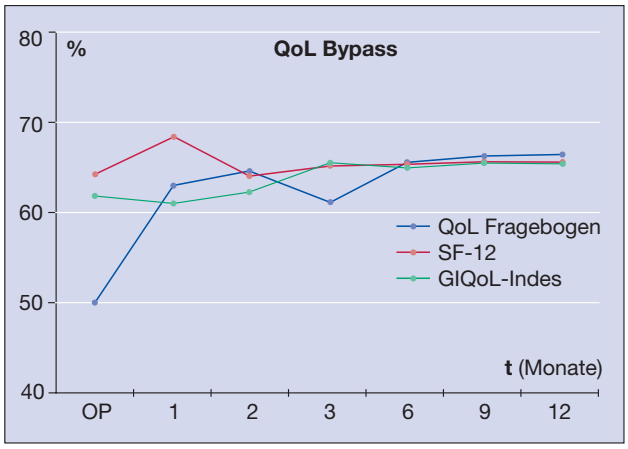



**Diagram 4**
Indices of quality of life tests after laparoscopic gastric bypass surgery.

## 5.8 Simultaneous Cholecystectomy?

To what extent simultaneous cholecystectomy should always be performed if a gall bladder is present was discussed controversially on many occasions in the past. After a gastric bypass it is no longer possible to conduct subsequent ERCP (***E**ndoscopic **R**etrograde **C**holangio-**p**ancreatography*) in the normal manner for bile duct stones. Case reports have now become available where ERCP was performed with extra-long instruments or by means of gastrostomy with laparoscopic assistance (dilation technique). Based on our own experience we have increasingly dispensed with simultaneous cholecystectomy in cases where no stones have been detected. About 1/3 of all patients attend bypass surgery after cholecystectomy. If there are symptomatic gall stones, the aim should be to perform cholecystectomy. However, it extends the duration of surgery considerably because the trocars for the main intervention are introduced in the left upper abdomen working toward the hiatal region. If the abdominal wall is rich in fat, its use for cholecystectomy in the right upper abdomen is impaired considerably, or even rendered impossible. A concomitant steatosis makes the intervention more difficult in addition, resulting in a much higher complication risk, which is automatically reduced substantially by weight reduction after a second intervention. HAMAD et al. (2003)[17] performed simultaneous cholecystectomy in 16% of their patients, thus extending the duration of surgery by a median of 49 min. and doubling the length of hospital stay. By administering Ursofalk® and ensuring an adequate supply of fluid the formation of gall stones can be reduced considerably by bringing about a weight reduction. VALLEGAS et al. (2004)[50]detected gall stones in their patient group (n = 289) by means of intraoperative ultrasound in 14% of cases (n = 60) and removed the gall bladder at the same time. For a total of 80% of patients (n = 151) where the gall bladder was left alone systematic follow-up was conducted after 6 months. 22% of patients (n = 33) developed gall stones and 8% sludge (n = 12). Only 7% of patients (n = 11) manifested symptoms and underwent cholecystectomy.

Two of the patients developed acute cholecystitis and had to be subjected to laparoscopic cholecystectomy in an emergency operation. One patient developed acute cholangitis accompanied by septic shock, underwent open cholecystectomy in an emergency operation and was given a T-drain after open bile duct exploration. That patient's life was at risk and it was only possible to dismiss him after one month.

106 patients (70%) were free of gall stones at the time of the ultrasound follow-up. This low incidence with strict ursodeoxycholic acid prophylaxis (600 mg/day) certainly justifies leaving the gall bladder alone during a gastric bypass. Discovered gall stones should, however, prompt surgeons to perform cholecystectomy as early as possible in order to avoid possible complications where therapy options are restricted.

# 6.0 Complications

The technical aspects of the laparoscopic gastric bypass (**LGB**, **L**aparoscopic **G**astric **B**ypass) are a true challenge for any surgeon. Initial operating times of 8 hours and more are not rare, especially as far as the retrocolic approach is concerned, and not only pose problems for the surgeon but also increase the surgical risk for the patient. In the meantime, operating times and hospital stays have been reduced considerably after a learning curve. Series of studies from the US demonstrate how far "fast-track" surgery can also be enhanced in laparoscopic bariatric surgery. However, they still differ from European clinics (**Tab. 4,** p. 24). In the author's own practice the mean operating time in antecolic technique has settled at less than 60 min. It was already shorter but it was extended again by systematic closure of mesenteric gaps. The length of hospital stay after the operation is 5 days on average so it is longer than in the US. The results of the laparoscopic gastric bypass procedure with respect to weight loss and improvement in quality of life are convincing as long as the operation is performed at centers with a sufficiently large population of patients. *Wittgrov*e had already performed 1,500 operations by the year 2000. The operation figures at centers in the US jumped again between 2000 and 2003. At the figure of 140,000 gastric bypass operations it became the most frequent laparoscopic intervention in the US. The increase in the cost of surgical treatment for obesity has now prompted some insurance companies to put a stop to the unhindered rise. In the meantime, operation figures for LRYGB are also rising in Europe. Initial experiences with 625 LRNYGBs (525 primary, 88 secondary) in Germany was taken into consideration in this brochure.[52] The surgeon's personal learning curve is much longer than with gastric banding. The level of complexity is much higher, which is reflected in a conversion rate that is higher at the beginning. Our own "error curve" can only be minimized by adequate training and preparation within the scope of guest attendances at operations and exercises on animal models.[41]

## 6.1 Hemorrhage

With this highly complex operation there are many different risks of hemorrhage. This applies not only to formation of the mesocolic slit, retrogastric preparation, and transection of the stomach and small intestine, but also to formation of the anastomosis.

According to the literature, hemorrhage-related complication rates range between 0% and 13%. Hemorrhage from the staple line is a particularly common occurrence and requires suturing. Hemorrhage complications rarely lead to conversions though.

Sophisticated preparation technique in the obese environment, especially when opening the fat-rich mesocolon during a retrocolic gastric bypass with the ultrasonic dissector, is vital.

Hemorrhage from the staple line can be avoided almost completely by using bioabsorbable staple line reinforcement (e.g. Seamguard®, Gore). These materials are expensive though. If hemorrhage occurs at the staple line, it can be controlled well and does not represent a reason to convert. Hemorrhage from the mesocolon can be managed with an ultrasonic dissector. Hemorrhage from the staple line can be stopped by compression using atraumatic forceps, suturing or clip application.

## 6.2 Anastomotic Insufficiency

Creation of the gastrojejunal anastomosis is a very complex and difficult step in the operation. There is no reason to suspect that the causes of postoperative anastomotic insufficiency might be correlated with causal mechanisms different than those in open gastrojejunostomy. In many cases, these causes remain unclear.

Disturbed circulation (compression by use of a stapler, skeletonization of the small intestinal limb) seems to play a central role in this context.

Although there are a large variety of anastomotic insufficiencies (0 – 25%), the experience of the surgeon may be of particular significance. GAGNER et al. (1999 A)[13] reported a rate of 5.7% after a total of 52 interventions. While 2 cases of leakage after "hand-sewn" anastomoses were observed within the first 8 interventions (25%), the third insufficiency was reported in the last 44 operations after a stapler anastomosis. In the largest patient group of WITTGROVE and CLARK[59] (n = 300) only 9 cases of anastomosis leakage were reported (3%). Two of them had to be re-operated on with open surgery and 7 with laparoscopy. In 1999, the same authors reported only two cases of leakage after 200 procedures (1%), such that the total incidence of leakage was only 2.3% (500 procedures).[57,60] LÖNROTH (2000 A) reports 4% early leakages, whereby 2 involved gastroenteroanastomosis and one enteroanastomosis.

Careful creation of the anastomosis and testing for leakage and adequate blood circulation are the main prophylactic measures for the prevention of anastomotic insufficiencies.

Insufficiency of the gastrointestinal anastomosis is a life-threatening event in all patients. However, this complication poses a particularly high risk to morbidly obese patients and is associated with a high rate of fatality.

**Caution: Any sign of tachycardia (heart rate > 120 bpm) is sufficient reason to consider re-laparoscopy.**

ALI et al. (2002)[1] managed leakage secondary to LRYGB as follows:

| | | |
|---|---|---|
| • By **re-laparoscopy** | 7 | (50%) |
| • **Successful closure** | 1 | (7%) |
| • **Persistent leakage** | 3 | (21%) |
| • **Conversion** | 3 | (21%) |
| • By **laparotomy** as the initial treatment | 3 | (21%) |

## 6.3 Wound Infection

The extremely thick abdominal walls represent a potential infection risk. This particularly applies to operations where the gastrointestinal tract has to be opened.

Intestinal pathogens find ideal growth conditions and thrive in the poorly vascularized fatty tissue. Pathogenic contamination occurs at the trocar ports, especially where miniature laparotomy ("hand-assisted" operations) are performed.

Wound infection rates of up to 25% have been reported (SCHWEITZER et al., 1999).[42] GAGNER reported 3 infectious complications in 52 interventions (5.8%).[13] One case, however, involved an infected intraabdominal hematoma. This patient had to undergo revision surgery. The other 2 cases were regular wound infections. SCHWEITZER et al. (1999)[42] had to treat no less than 2 out of 8 patients (25%) suffering from wound infections. Working with the largest patient population (300 patients), WITTGROVE and CLARK[59] reported only 15 minor (5%) and two major (0.7%) infections. The foremost concern in all procedures involving exposure of hollow organs is the prevention of infections at the site of the trocar port. Consequently, perioperative antibiotic prophylaxis is mandatory under these circumstances. The antibiotic dose must be adjusted to body weight and administered every 2 – 3 hours during long operations to keep the concentration of active agents at an adequately high level. It remains unclear whether postoperative administration of antiseptic agents to the trocar incisions is capable of preventing infection.

Amply sized incisions must be made and broad-range antibiotics administered under these circumstances. Because of the range of germs involved in necrotizing fasciitis, radical surgical debridement is required to prevent the pathogens from spreading.

## 6.4 Postoperative Hemorrhage

Hemorrhage usually results from the anastomosis, especially from the staple line. Apart from that there is a wide range of possible hemorrhage in this intervention. This especially applies to the slit made in the mesocolon, since the extreme accumulation of fat in this area can make the timely identification of vascular structures quite difficult. In the largest study, WITTGROVE and CLARK (1998 A)[59] found only a 1.3% rate of relevant postoperative hemorrhage requiring revision. Only one revision called for laparotomy, while 3 others were managed by a laparoscopic approach.

LÖNROTH (2000 A) reported a 7.9% rate of postoperative hemorrhage requiring transfusion. Postoperative hemorrhage can be prevented only by sophisticated surgical technique. It is mandatory that the operating field be closely inspected for any hemorrhage at the end of surgery. The indication for relaparoscopy or relaparotomy is based on the general principles of surgery. The decision should be taken without delay to spare the patient secondary complications, eliminate the need for transfusions and help prevent life-threatening situations.

## 6.5 Anastomotic Stenosis (Gastrojejunostomy)

Creation of the anastomosis under laparoscopic vision may pose technical difficulties, and the sutures placed under such conditions may leave behind an anastomosis that is too narrow.

Delayed stenosis is most often caused by local infection along the circular staple line. Stenoses after circular staple line anastomoses are always much more frequent than after hand-sewn anastomoses. Pouch size also has an influence on the development of ulcers and therefore on stenoses as well. Excessive pouch volume is associated with an increased ulcer risk. Since laparoscopic procedures do not involve miniature laparotomy, a patency test by digital palpation is not performed. It is usually not the case of anastomoses being primarily made too small but a case of secondary inflammatory shrinkage. Anastomotic stenosis rates ranging between 1% and 38% have been reported.[42,59]

The principles guiding the correct placement of the anastomosis are no different from those applied in conventional and laparoscopic technique. By contrast, secondary bypass operations, i.e. after previous surgery such as Mason or gastric band migration, exhibit a higher stenosis rate than after primary interventions. In our own patient group we failed to see any stenoses after 585 primary LRNYGBs but after 88 secondary LRYGBs we observed 3 stenoses, which were dilated successfully in all cases.

Clinically relevant anastomotic stenoses can be treated by dilation with endoscopy. In some cases several sessions may be necessary.

## 6.6 Anastomotic Stenosis (Entero-Enteric Anastomosis)

Creation of the anastomosis under laparoscopic vision may pose technical difficulties, and the sutures placed under such conditions may leave behind an anastomosis that is too narrow.

Complete stenosis is hazardous because due to a lack of digestive juice discharge it can lead to early postoperative dilation of the remainder of the stomach (within 24 – 28 hours). This can trigger reflex cardiac arrest. Delayed stenosis is usually caused by local infection along the staple line. Since laparoscopic procedures do not involve miniature laparotomy, a patency test by digital palpation is not performed.

TAMOFF et al. (2002) report anastomotic stenosis at a rate of 0.4% (4/939). The majority of surgeons have had to contend with this complication and report on it in their personal communications.

The principles guiding the correct placement of the anastomosis are no different from those applied in conventional and laparoscopic technique.

As with gastrojejunostomy, creation of the anastomosis by laparoscopic suture technique is difficult here too, especially because the trocar positions were aligned after gastrojejunostomy.

Clinically relevant anastomotic stenosis must be treated by revision surgery. The problem can also be solved laparoscopically by creating an additional anastomosis between the biliodigestive and alimentary limbs.

## 6.7 Deep Vein Thrombosis

The rate of thromboembolic complications in surgery has dropped since perioperative thromboembolism prophylaxis has become standard. This is of special importance for laparoscopic surgery because of attendant circumstances that contribute to pathophysiological processes promoting deep vein thromboses in the legs and pelvis. These factors include: reduced venous reflux owing to compression of the caval vein, long duration of surgery, and, especially, extreme patient positioning. In the case of laparoscopic gastric bypass operations extreme patient positioning and long duration of surgery are combined.

Moreover, up to 40% of morbid obese patients have a history of deep vein thrombosis. The pulmonary embolism is still the most frequent non-surgical cause of death in bariatric surgery. With an incidence of up to 5% thromboembolisms (1/21 WESTLING 1999 A[56]; 2/52 GAGNER et al., 1999 A[13]) occur much more frequently than after other standard laparoscopic operations. The clearly higher rate of thromboembolic complications in LGB procedures, which is due to a combination of prolonged operating times and the extreme position patients are placed in, requires prophylactic measures to be taken.

Laparoscopic gastric bypass surgery is associated with the highest incidence of thrombosis. However, laparoscopy is not the only contributing factor.

SCOTT et al. (1992) report less than 0.01% thromboembolic complications after 12,000 laparoscopic procedures (1992). Despite a number of individual case reports, it is not yet conclusive whether these observations can be attributed to an increased rate of complications following laparoscopic surgery. Low dose heparinization has been the standard from the very beginning. Before the days of heparin prophylaxis, the rate of deep vein thrombosis of the leg following conventional cholecystectomy was 5%, a considerable rate (BERQUIST et al., 1990).

Limitation of the duration of gastric bypass operations is the critical factor in the prevention of postoperative thromboembolic complications. Early mobilization is another important prophylactic measure which has a very positive impact in the prevention of deep vein thrombosis of the leg. It may even compensate potential deficiencies. Intraabdominal pressure is an essential factor in determining the degree of venous reflux. Pressure values above 15 mmHg must be strictly avoided, since they may cause stasis in the area of the venous reflux. Venous stasis can promote the development of thrombosis and thromboembolism and is a particularly important pathogenic mechanism in patients with a history of previous vascular disease. Low dose heparinization is part of the standard protocol for all surgical procedures and reduces the risk of thromboembolic complications.

High-risk patients must be identified preoperatively and must receive physical treatment, such as intermittent pneumatic compression of the lower extremities. In severe high-risk cases, physical measures must be complemented by heparinization.

The therapeutic management of thromboses and thromboembolic complications follows generally accepted guidelines and does not differ from those commonly applied in minimally invasive surgical procedures. Heparinization in minimally invasive surgical procedures does not expose patients to the same high degree of risk found with major laparotomies or thoracotomies.

## 6.8 Anastomotic Ulcer

Only recently explored, the pathogenesis of ulcers has nullified many surgical therapy concepts. An improved understanding of the bacterial colonization of the stomach and duodenum and its impact on ulcer pathogenesis has led to a major revision of the indications for surgical management of this complication. Anastomotic ulcers have been reported at a rate of up to 10% (WESTLING, 1999 A). Preoperative records of the patient's ulcer case history must be collected in detail (Helicobacter pylori, gastrin) to prevent formation of postoperative anastomotic ulcers.

As a matter of policy all patients should be subjected to gastroscopy prior to a gastric bypass operation. Analysis for Heliobacter pylori followed by eradication is obligate.

## 6.9 Internal Hernias and Small Intestine Environment

The eliminated Roux-en-Y limb may give rise to a number of potential complications. Most commonly, kinks and stenosis at the mesocolic opening lead to postoperative complications after a rectocolic bypass. Another common factor is the so-called Petersen hernia defect (**Fig. 36**) between the jejunal mesentery and the mesocolon.[39]

This herniation after an antecolic bypass was observed more and more frequently in recent years whenever Petersen's space was not primarily closed with intraoperative non-absorbable suture.

Ileus rates of up to 38% after gastric bypass surgery have been reported in the literature. The large-scale analysis was presented by HIGA and BOONE (2003).[20] Data from 2,000 patients who had undergone a gastric bypass operation from 1998 – 2001 was analyzed retrospectively. There were a total of 66 internal hernias, resulting in an incidence rate of 3.1%. The distribution of internal herniations was as follows: Mesocolon (44); jejunal mesentery (14); Petersen's space (5). Virtually all the patients were symptomatic but 5% were discovered by chance during other interventions. 5 patients had to be subjected to laparotomy. 6 patients exhibited small intestinal perforation. One patient died as a result of complications after internal herniation. The negative exploration rate was 2% and in my view it is always justifiable.

The more frequent incidence of internal herniations after laparoscopic bypass surgery vs. open surgery is due to the reduced adhesion in the abdominal space. Mesenteric gap closure with non-absorbable suture has now become the standard procedure generally after antecolic LRYGBs as well. Not only do the mesenteric gaps between the biliodigestive and alimentary limbs have to be closed reliably, so too does Petersen's space. For this purpose the mesocolon must be grasped with suture without harming the mesenteric vessels. Omentum fixation or an "omental seal" is not sufficient on its own because it shrinks in the course of weight reduction.

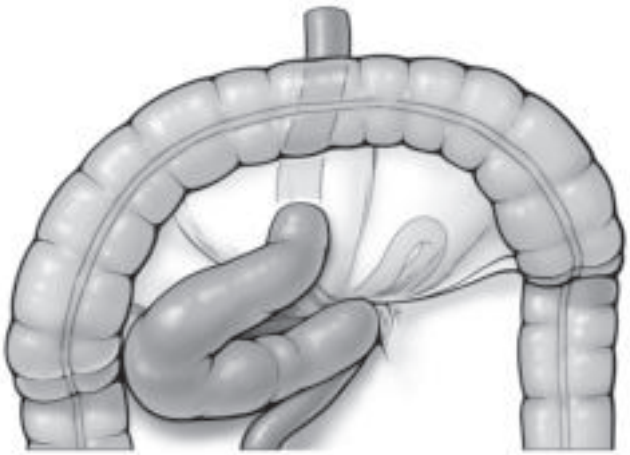


**Fig. 36**
Herniation of a jejunal limb at the mesocolic opening created during retrocolic bypass surgery.

Accurate fixation of the jejunal limb in a mesocolic slit fashioned with an optimal anatomic fit is the best prophylaxis against this serious complication in the case of the retrocolic LRNYGB. Nevertheless, even after fixation such internal herniations can occur due to enormous fat loss. Ileus soon occurs and, if no treatment is given, intestinal gangrene.

Early symptoms are pains in the left upper abdomen and typical signs of ileus. In radiology, dilated jejunal limbs (with mirror imaging) in the left upper abdomen are signs. A CT or MRI scan is also more informative than an intestinal x-ray series with contrast medium, which often fails to produce a clear diagnosis due to the distal location of the disorder. From our experience early relaparoscopy is the best method of ruling out such complications and remedying them if the result turns out to be positive.

Clinical manifestation of mechanical ileus following a gastric bypass operation requires open revision surgery. Clinically, the complication may become apparent as unspecific abdominal spasm and vomiting, whereby in the case of obese patients this is firstly associated with "overeating". SCHWEITZER et al. *(1999)* successfully avoided intestinal infarction in 2 cases by performing early revision surgery.[42]

Conservative attempts at treatment are time-consuming and can waste valuable time. Intestinal infarction can only be prevented by taking a quick decision. SERRA et al. (1999) report a rare form of internal herniation of the small intestine through the mesocolic slit, which was manifested clinically by subsequent perforation of the overextended stomach.

## 6.10 Fistulas and Abscesses

Suture dehiscences, especially after the use of staplers, lead to the formation of fistulas. Abscesses are often found in association with anastomotic insufficiencies and are a late sequela. Infected hematomas are another frequent cause of postoperative abscesses.

Since only isolated case reports are available, it may be conjectured that the incidence of abscess formation following gastric bypass surgery is lower than 1%.[39] However, the incidence may well be higher.

The decision on how to manage the patient – either by means of conservative or surgical treatment – depends on the manifest clinical symptoms.

Fistulas without septic complications can be managed with fibrin adhesive under endoscopic control. The important point is that they are not gastrogastric fistulas. With these there is a connection between the gastric pouch and the remainder of the stomach. They are usually due to incomplete transections of the stomach, necessitating repeat operative transection. Attempts using fibrin adhesives do not turn out to be successful.

## 6.11 Postoperative Incisional Hernia

The abdominal walls of extremely obese patients do not always allow individual layers of the abdominal wall to be exposed without extended incisions. There is an elevated rate of wound infections in the poorly vascularized fatty tissue, which constitutes another risk factor for post-operative herniation.

According to SUTER et al. (1999 A), the incidence of postoperative incisional hernias ranges between 0% and 13% in laparascopically assisted procedures (miniature laparotomies). Most publications make no mention of hernias, which does not mean they did not occur.

13% incisional hernias related to hand-assisted procedures may be compared with the results obtained in primary "open" gastric bypass surgery. GAGNER et al. (1999 A) observed only 2 incisional hernias in their follow-up of 52 patients (3.9%).[13]

Accurate closure of the abdominal wall in obese patients is a difficult task and requires the surgeon to exercise a great deal of diligence. In particular, the abdominal walls of obese women are rich in fat, making it quite difficult to accomplish wound closure at the site of the trocar port with the commonly practiced method. The instrument for fascial closure used by BERCI is very useful in this step of the procedure. Wound infections must be prevented, since they may induce formation of postoperative incisional hernias.

Clinical symptoms are critical in the decision when to initiate incisional hernia repair. The longer ago gastric bypass surgery was performed, the greater the degree of shrinking in subcutaneous fatty tissue, simplifying surgical management.

If the intestine is at imminent risk of getting entrapped in the hernia, the surgical procedure must be initiated at the earliest point in time to obviate the development of a potentially life-threatening situation.

After wound infection, one should wait as long as possible to prevent secondary wound-related infection.

## 6.12 Wernicke's Syndrome

Chronic vomiting and large-scale cessation of the stomach's function lead to vitamin B deficiency, which may in turn lead to the development of neurological disorders. There are various clinical manifestations. Rarity: GUSPI et al. (2000 A)[15] described the case of a 23 year-old female patient who had a gastric bypass placed due to non-compliance following the removal of an adjustable gastric band. Due to recurrent vomiting over a period of weeks and termination of the gastric passage, the patient manifested vitamin B deficiency with ensuing neurological symptoms. These were reversible within 24 hours after parenteral administration of vitamin B. Recurrent vomiting is an indication for immediate intervention. Patients must be informed in detail about the symptoms and advised to present at the clinic without delay if they experience persistent vomiting.

All patients must be given sufficient parenteral vitamin supplements. Elimination of the cause of persistent vomiting and substitution of water, electrolytes, vitamins, and trace elements should be initiated immediately.

**Caution: If neurological symptoms manifest after bariatric procedures with concomitant persistent vomiting, vitamin B deficiency must be taken into consideration. The diagnosis may be made ex juvantibus, i.e. based on the result of therapy.**

In the described case of Wernicke's syndrome with ophthalmopathological symptoms, parenteral vitamin B supplements must be administered in the ICU. In particular, adequate doses of vitamins $B_1$ and $B_6$ must be administered.

**Emergency therapy: 100 mg thiamine per day** (compound containing vitamin B1 100 mg, vitamin B6 100 mg, and vitamin B12 1000 mg) **for 1–2 weeks. Depending on the preparation used, the parenteral administration may be given I.M. or I.V.**

## 6.13 Iron Deficiency

Elimination of the principal iron absorption site (duodenum) often leads to iron deficiency. This is particularly the case with fertile women, who tend to lose blood regularly on account of menstruation. Oral iron substitution is ineffective so in many cases compensation can only be provided by iron infusions.

## 6.14 Hyperparathyroidism

Secondary hyperparathyroidism is more frequent in the case of morbid obesity (up to 8%). After gastric bypass surgery there are not as many disturbances of the calcium metabolism as after biliopancreatic diversions and duodenal switch surgery. Nevertheless, systematic follow-up is necessary and therapy may have to be provided by administering hormones and calcium.

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Note: Abstracts of conference papers are indicated by the letter 'A' after the year (e.g., 1999 A).


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# Instrument Set for Laparoscopic Roux-en-Y Gastric Bypass for Morbid Obesity

## Telescopes, Operating Instruments and Accessories

## Recommended Set for Laparoscopic Roux-en-Y Gastric-Bypass

**Recommended Instrument Set, Units and Accessories**

26003BA 1 **HOPKINS® Forward-Oblique Telescope 30°,** enlarged view, diameter 10 mm, length 31 cm, **autoclavable,** fiber optic light transmission incorporated, color code: red

26003AA 1 **HOPKINS® Straight Forward Telescope 0°,** diameter 10 mm, length 31 cm, **autoclavable,** fiber optic light transmission incorporated, color code: green, for use with TERNAMIAN **EndoTIP** Cannula 31103 MTR

495NCS 1 **Fiber Optic Light Cable,** with straight connector, extremely heat-resistant, diameter 4.8 mm, length 250 cm

30103CS 1 **Telescope Stopper,** sterile, disposable, package of 12 pieces, for use with telescope 26003 AAK and 26003 AA

30103MTR 1 TERNAMIAN **EndoTIP Cannula,** with thread and rotatable insufflation stopcock, size 11 mm, working length 10.5 cm, color code: green

30108MTR 6 TERNAMIAN **EndoTIP Cannula,** with thread and rotating stopcock, size 13.5 mm, working length 11.5 cm color code: blue

30140HB 1 **Reduction Sleeve,** reusable, instrument diameter 5 mm, trocar cannula outer diameter 13 mm, color code: black

30142HB 6 **Double Reducer,** 13/10 mm, 13.5/10 mm, 13/5 mm and 13.5/5 mm

30623URL 1 CUSCHIERI **Retractor,** large contact surface, size 10 mm, length 36 cm

28272KKB 1 **Holding System, autoclavable,** with quick release coupling KSLOCK

30173RAO 1 KOH **Macro Needle Holder,** dismantling, with LUER-Lock irrigation connector for cleaning, single action jaws, jaws curved to right, with tungsten carbide inserts, with axial handle, disengageable ratchet, ratchet position top, size 5 mm, length 33 cm

30173LAO 1 KOH **Macro Needle Holder,** dismantling, with LUER-Lock irrigation connector for cleaning, single action jaws, jaws curved to left, with tungsten carbide inserts, with axial handle, disengageable ratchet, ratchet position top, size 5 mm, length 33 cm

33563BLS 2 **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

33500CM 1 **CLICKLINE Metal Outer Sheath,** with LUER-Lock connector for cleaning, size 10 mm, length 36 cm

33325KW 1 **CLICKLINE** MATKOWITZ **Grasping Forceps,** rotating, dismantling, insulated, with connector pin for unipolar coagulation, LUER-Lock connector for cleaning, double action jaws, diameter 5 mm, length 36 cm

33300CM 1 **CLICKLINE Metal Outer Sheath,** insulated, with cm-marking, with LUER-Lock connector for cleaning, size 5 mm, length 36 cm, for use with Forceps Insert 33310KW

33333ON 2 **CLICKLINE Grasping Forceps,** rotating, dismantling, without connector pin for unipolar coagulation, with LUER-Lock irrigation connector for cleaning, single action jaws, with fine atraumatic serration, fenestrated, size 5 mm, length 36 cm

33325ML 1 **CLICKLINE** KELLY **Dissecting and Grasping Forceps,** rotating, dismantling, insulated, with connector pin for unipolar coagulation, LUER-Lock connector for cleaning, double action jaws, long, size 5 mm, length 36 cm

33361AV 1 **CLICKLINE Anvil Grasper,** rotating, size 5 mm, length 36 cm, double action jaws

34351MA 1 **CLICKLINE Scissors,** rotating, dismantling, with connector pin for unipolar coagulation, with LUER-Lock irrigation connector for cleaning, double action jaws, spoon-shaped blades, serrated, curved, length of jaws 20 mm, size 5 mm, length 36 cm, for use with trocars size 6 mm

30775UF 1 **Coagulation and Dissection Electrode,** L-shaped, size 5 mm, length 36 cm, with connector pin for unipolar coagulation

30775UFE 1 **Exchangeable Electrode Tip,** L-shaped, **autoclavable,** package of 6

30444LR 1 **Clip Applicator,** dismantling, rotating, size 10 mm, length 36 cm, for PILLING-WECK Titanium Clips 30460AL (medium-large), with ratchet to lock the jaw holding the clip

30460AL 1 PILLING-WECK **Titanium Clip,** medium-large, box with 16 sterile cartridges, 10 clips each, for use with Clip Applicator 30444LR

37360LH 1 **Suction and Irrigation Tube,** with lateral holes, size 5 mm, length 36 cm, for use with suction and irrigation handles

30805 1 **Handle with Two-Way Stopcock,** for suction and irrigation, **autoclavable,** for use with suction and irrigation tubes sizes 3 and 5 mm

26173AM 1 BERCI **Fascial Closure Instrument,** for subcutaneous ligature of trocar incisions, size 2.8 mm, length 17 cm, for closure of trocar incision wounds

**Please note:** **HOPKINS® Telescopes, Trocars, Forceps, Scissors and Needle Holders** are also available in **extended length** versions.

## HOPKINS® Laparoscopes Telescopes

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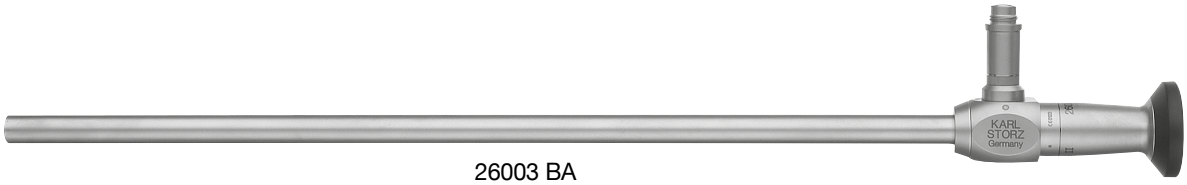
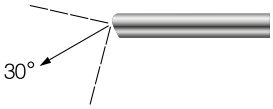
**Trocar, size 11 mm**

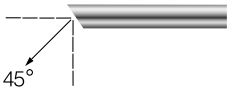



26003 BA



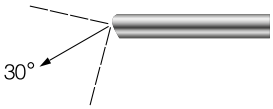

26003BA **HOPKINS® Forward-Oblique Telescope 30°,**
enlarged view, diameter 10 mm, length 31 cm,
**autoclavable,**
fiber optic light transmission incorporated,
color code: red

**or:**

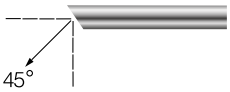



26003FA **HOPKINS® Forward-Oblique Telescope 45°,**
enlarged view, diameter 10 mm, length 31 cm,
**autoclavable,**
fiber optic light transmission incorporated,
color code: black

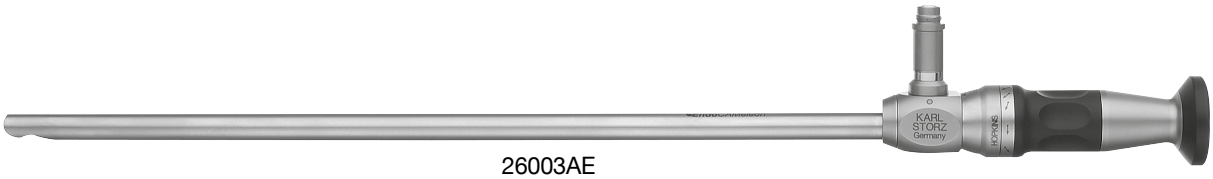
**Optional excess length HOPKINS® telescopes:**



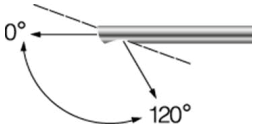

26003BEA **HOPKINS® Forward-Oblique Telescope 30°,**
enlarged view, diameter 10 mm, length 42 cm,
**autoclavable,**
fiber optic light transmission incorporated,
color code: red




26003FEA **HOPKINS® Forward-Oblique Telescope 45°,**
enlarged view, diameter 10 mm, length 42 cm,
**autoclavable,**
fiber optic light transmission incorporated,
color code: black




26003AE



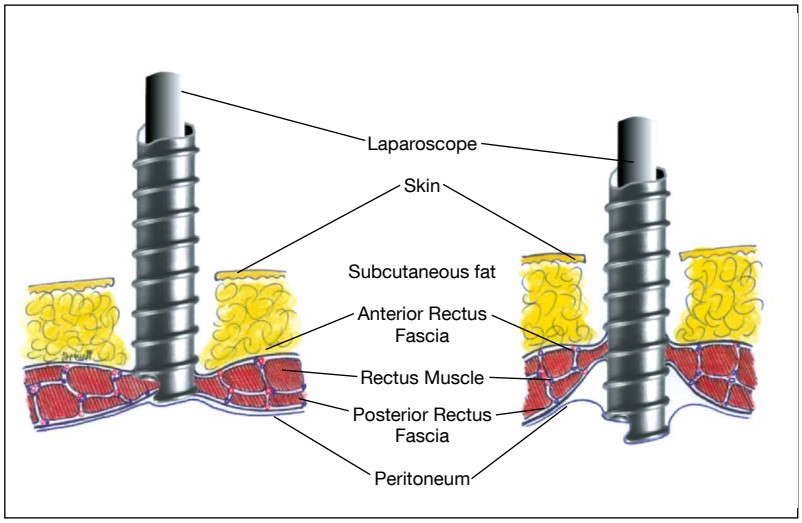

26003AE **ENDOCAMELEON® HOPKINS® Telescope,**
diameter 10 mm, length 32 cm,
variable direction of view from 0°–120°,
twisting controller to select the desired direction of view,
fiber optic light transmission incorporated,
color code: gold

**It is recommended to check the suitability of the product for the intended procedure prior to use.**

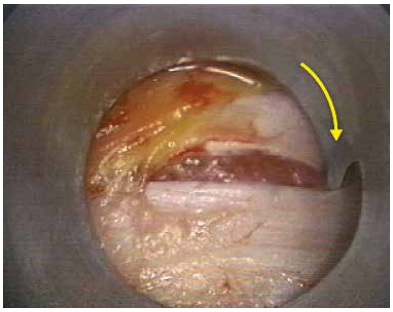
## **KARL STORZ** TERNAMIAN **EndoTIP System**

**for optically controlled access to the abdominal cavity**

The TERNAMIAN **EndoTIP** System (**Endo**scopic **T**hreaded **I**maging **P**ort) is a new KARL STORZ instrument for optically controlled access to the abdominal cavity. It replaces conventional trocars and, due to its unique design, offers a range of notable advantages for both surgeon and patient.




- The tissue is not cut through as it is when punctured with a conventional trocar, but is merely displaced. The integrity of the fasciae **is preserved**, and, therefore as well that of the **fascial closure mechanism**.
- The TERNAMIAN **EndoTIP** System contains **neither sharp points nor a cutting trocar** which reduces the risk of unintentional injuries to the patient. Since the TERNAMIAN **EndoTIP** System is not pushed into the peritoneum by applying pressure, but is introduced by controlled rotation, **injuries to organs caused by uncontrolled penetration of the abdominal wall are nearly impossible.**
- **In conjunction with a HOPKINS® Telescope, the surgeon has an excellent, enlarged image of the point of penetration and is, therefore, able to carefully monitor the penetration under optical control**. The various tissue layers can be identified precisely.
- The special design of the TERNAMIAN **EndoTIP** System ensures a **secure hold** in the abdominal wall and **prevents gas loss** at the point of penetration.

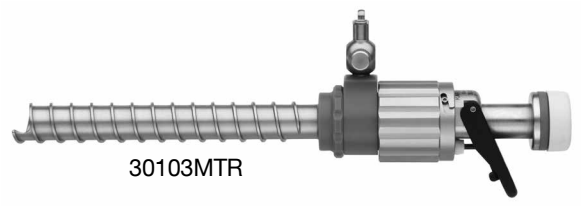
*The cannula is engaged in the anterior rectus fascial window and rotated clockwise.*

26003AA **HOPKINS® Straight Forward Telescope 0°,**
diameter 10 mm, length 31 cm,
**autoclavable,**
fiber optic light transmission incorporated,
color code: green,
for use with TERNAMIAN **EndoTIP** Cannula 31103MTR

30103CS **Telescope Stopper,** sterile, disposable,
package of 12 pieces,
for use with telescope 26003AAK and 26003AA

## TERNAMIAN **EndoTIP Cannulas**

**size 11 mm and 13.5 mm**

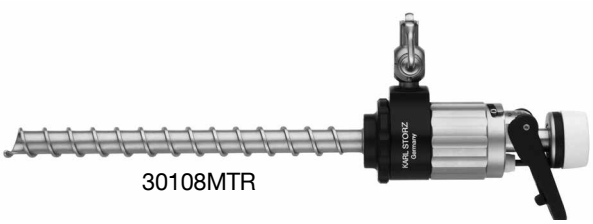


30103MTR

30103MTR TERNAMIAN **EndoTIP Cannula,**
with thread and rotatable insufflation stopcock,
size 11 mm, working length 10.5 cm,
color code: green,

including:
**Cannula**
**Multifunctional Valve**

31103MTR **Same, length 15 cm**




30108MTR

30108MTR TERNAMIAN **EndoTIP Cannula,**
with thread and rotating stopcock,
size 13.5 mm, working length 11.5 cm,
color code: blue,

including:
**Cannula**
**Multifunctional Valve**

31108MTR **Same,** length 15 cm


30140HB

30142HB

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

30140HE **Reduction Sleeve,** reusable, instrument diameter 10 mm, trocar cannula outer diameter 13 mm, color code: black

30142HB **Double Reducer,** 13/10 mm, 13.5/10 mm, 13/5 mm and 13.5/5 mm

## Dissecting and Grasping Forceps

**CLICKLINE – rotational, can be dismantled,**
**with and without connector pin for unipolar coagulation**
**size 5 mm, trocar size 6 mm**

| Working Length | Handle | | | | |
|---|---|---|---|---|---|
| | 33151 | 33125 | 33153 | 33161 | 33163 |
| 36 cm |  |  |  |  |  |
| 43 cm | | | | | |

**Double-action jaws:**

| Insert No. | Catalog number for the complete instrument | | | | |
|---|---|---|---|---|---|
| 33310KW | 33351KW | 33325KW | 33353KW | 33361KW | 33363KW |
| 33410KW | 33451KW | 33425KW | 33453KW | 33461KW | 33463KW |
|  18 | **CLICKLINE** MATKOWITZ* **Grasping Forceps** | | | | |
| 33310ML | 33351ML | 33325ML | 33353ML | 33361ML | 33363ML |
| 33410ML | 33451ML | 33425ML | 33453ML | 33461ML | 33463ML |
|  22 | **CLICKLINE** KELLY **Dissecting and Grasping Forceps,** long | | | | |
| 33310AF | 33351AF | 33325AF | 33353AF | 33361AF | 33363AF |
| 33410AF | 33451AF | 33425AF | 33453AF | 33461AF | 33463AF |
|  24 | **CLICKLINE Grasping Forceps,** atraumatic, fenestrated | | | | |

**Single-action jaw:**

| | | | | | |
|---|---|---|---|---|---|
| 33310ON | 33351ON | 33325ON | 33353ON | 33361ON | 33363ON |
| 33410ON | 33451ON | 33425ON | 33453ON | 33461ON | 33463ON |
|  26 | **CLICKLINE Grasping Forceps,** with fine atraumatic serration, fenestrated | | | | |

*) Outer tubes with a working length of 36 cm are also available with cm-markings. Outer tube 33300 CM needs to be specified separately in your order. Measurement of the length of the alimentary limb during Laparoscopic Roux-en-Y Gastric Bypass Surgery is considerably facilitated by cm-markings on the outer tube.

**Please note:**
**For CLICKLINE** instruments only the **individual component parts** are numbered. The catalog number for the **complete instrument** is **not** on the instrument. Instruments with **insulated handles** with connector pin for unipolar coagulation, are shown against the **red background,** instruments with **handles without connector pin for unipolar coagulation** are shown against the **blue background.** The colour **green** indicates the **inserts.**

## Scissors

**CLICKLINE – rotational, can be dismantled,**
**with and without connector pin for unipolar coagulation**
**size 5 mm, trocar size 6 mm**

| Working Length | Handle | | |
|---|---|---|---|
| | 33151 | 33125 | 33161 |
| 36 cm |  |  |  |
| 43 cm | | | |

**Double-action jaws:**

| Insert No. | Catalog number for the complete instrument | | |
|---|---|---|---|
| 34310MS | 34351MS | 34325MS | 34361MS |
| 34410MS | 34451MS | 34425MS | 34461MS |
|  15 | **CLICKLINE** METZENBAUM **Scissors,** curved, length of blades 12 mm | | |

| | | | |
|---|---|---|---|
| 34310MA | 34351MA | 34325MA | 34361MA |
| 34410MA | 34451MA | 34425MA | 34461MA |
|  20 | **CLICKLINE Scissors,** with serrated jaws, curved, spoon blades, length of blades 17 mm | | |

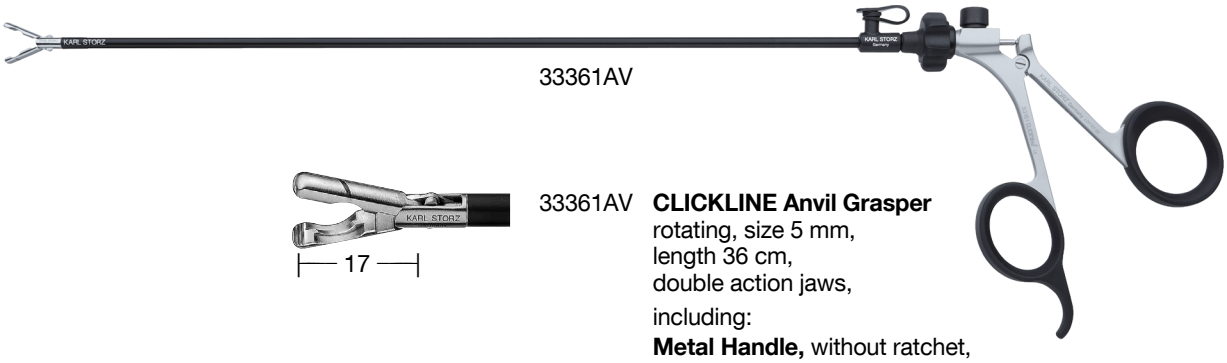
**Single-action jaw:**

| | | | |
|---|---|---|---|
| 34310EH | 34351EH | 34325EH | 34361EH |
| 34410EH | 34451EH | 34425EH | 34461EH |
|  10 | **CLICKLINE Hook Scissors** | | |

**Please note:**
**For CLICKLINE** instruments only the **individual component parts** are numbered. The catalog number for the **complete instrument** is **not** on the instrument. Instruments with **insulated handles** with connector pin for unipolar coagulation, are shown against the **red background,** instruments with **handles without connector pin for unipolar coagulation** are shown against the **blue background.** The colour **green** indicates the **inserts.**

## Anvil Grasper

**CLICKLINE – rotational, can be dismantled,**
**with and without connector pin for unipolar coagulation**
**size 5 mm, trocar size 6 mm**




33361AV



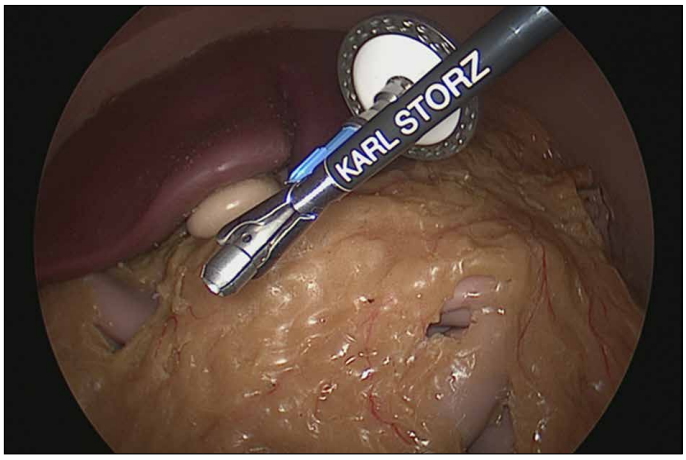

33361AV **CLICKLINE Anvil Grasper**
rotating, size 5 mm,
length 36 cm,
double action jaws,

including:

**Metal Handle,** without ratchet,
with larger contact area

**Outer Tube,** insulated

**Forceps Insert**



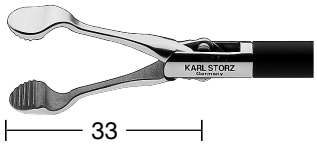
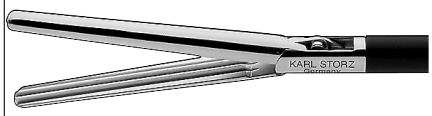

Grasping of the anvil

## Dissecting and Grasping Forceps

**CLICKLINE – rotational, can be dismantled, size 10 mm, trocar size 11 mm**

| Working Length | Handle | | |
|---|---|---|---|
| | 33161 | 33162 | 33163 |
| 36 cm |  |  |  |

**Double-action jaws:**

| Insert No. | Catalog number for the complete instrument | | |
|---|---|---|---|
| 33510BLS | 33561BLS | 33562BLS | 33563BLS |
|  33 | **CLICKLINE** BABCOCK **Grasping Forceps,** rounded | | |
| 33510DU | 33561DU | 33562DU | 33563DU |
|  44 | **CLICKLINE** DUVAL **Grasping Forceps** | | |
| 33510CB | 33561CB | 33562CB | 33563CB |
|  53 | **CLICKLINE Bowel Grasping Forceps** | | |
| 33510MLL | 33561MLL | 33562MLL | 33563MLL |
|  44 | **CLICKLINE** KELLY **Dissecting and Grasping Forceps,** long | | |

*) Outer tubes with a working length of 36 cm are also available with cm-markings. Outer tube 33500 CM needs to be specified separately in your order. Measurement of the length of the alimentary limb during Laparoscopic Roux-en-Y Gastric Bypass Surgery is considerably facilitated by cm-markings on the outer tube.

**Please note:**
**For CLICKLINE** instruments only the **individual component parts** are numbered. The catalog number for the **complete instrument** is **not** on the instrument. Instruments with **handles without connector pin for unipolar coagulation** are shown against the **blue background.** The colour **green** indicates the **inserts.**

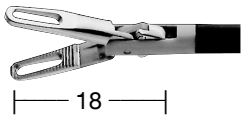
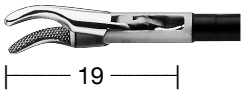
## ROBI® Bipolar Grasping Forceps and Scissors

**ROBI® – rotational, can be dismantle**
with connector pin for **bipolar** coagulation, CLERMONT-FERRAND Model,
**size 5 mm, trocar size 6 mm**

bipolar

| Working Length | Handle 38151 |
|---|---|
| 36 cm |  |
| 43 cm | |

**Double-action jaws:**

| Insert No. | Catalog number for the complete instrument |
|---|---|
| 38610ON | 38651ON |
| 38710ON | 38751ON |
|  18 | **ROBI® Grasping Forceps,** CLERMONT-FERRAND Model, fenestrated, with fine atraumatic serration |
| 38610MD | 38651MD |
| 38710MD | 38751MD |
|  19 | KELLY **ROBI® Grasping Forceps,** CLERMONT-FERRAND Model, suitable for dissection |
| 38610MM | 38651MM |
|  16 | **ROBI® Grasping Forceps,** CLERMONT-FERRAND Model, suitable for tying intracorporeal knots |
| 38610MW | 38651MW |
| 38710MW | 38751MW |
|  20 | METZENBAUM, **ROBI® Scissors,** CLERMONT-FERRAND Model, curved jaws, double-action jaws, thinner scissor blades |

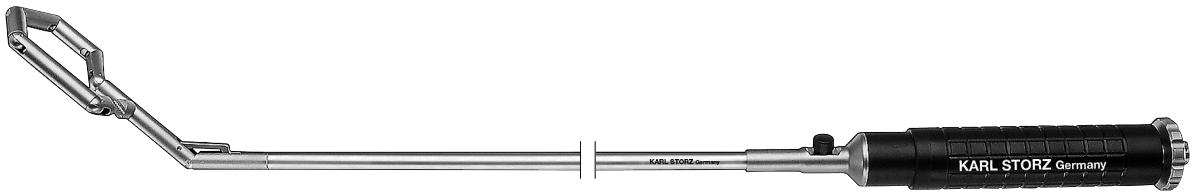
**Please note:**
**For ROBI® Bipolar Grasping Forceps** instruments only the **individual component parts** are numbered. The catalog number for the **complete instrument,** as shown above against the **red background** is **not** on the instrument. The colour **green** indicates the **inserts.**

## CUSCHIERI **Retractor**

**size 10 mm**
**trocar size 11 mm**

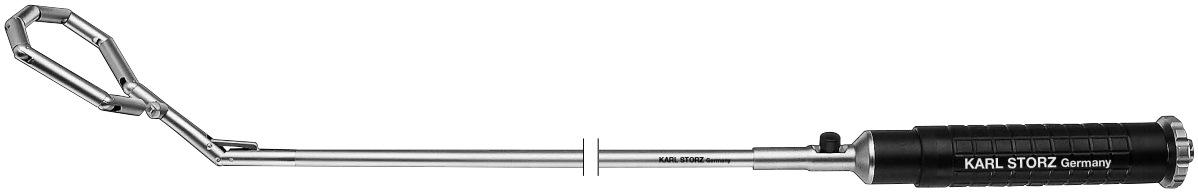
CUSCHIERI retractors 30623UR and 30623URL can be deflected by rotation of the proximal part of the handle.

During Roux-en-Y Gastric Bypass Surgery the retractor is introduced through the 11 mm-port and placed below the right costal arch. Once securely attached to an instrument holder and firmly fixed in position, the retractor can be used to elevate the greater omentum. In this way, it is also possible to use the retractor for exposure of the hiatal region.




30623UR

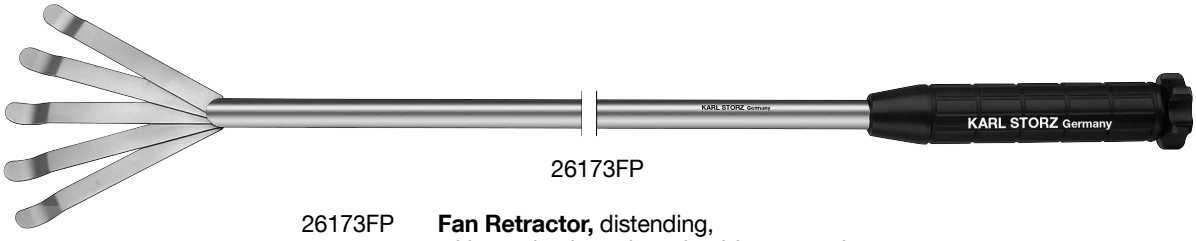
30623UR CUSCHIERI **Retractor,**
size 10 mm, length 36 cm




30623URL

30623URL CUSCHIERI **Retractor,**
large contact surface,
size 10 mm, length 36 cm

**size 12 mm,**
**trocar size 13 mm**

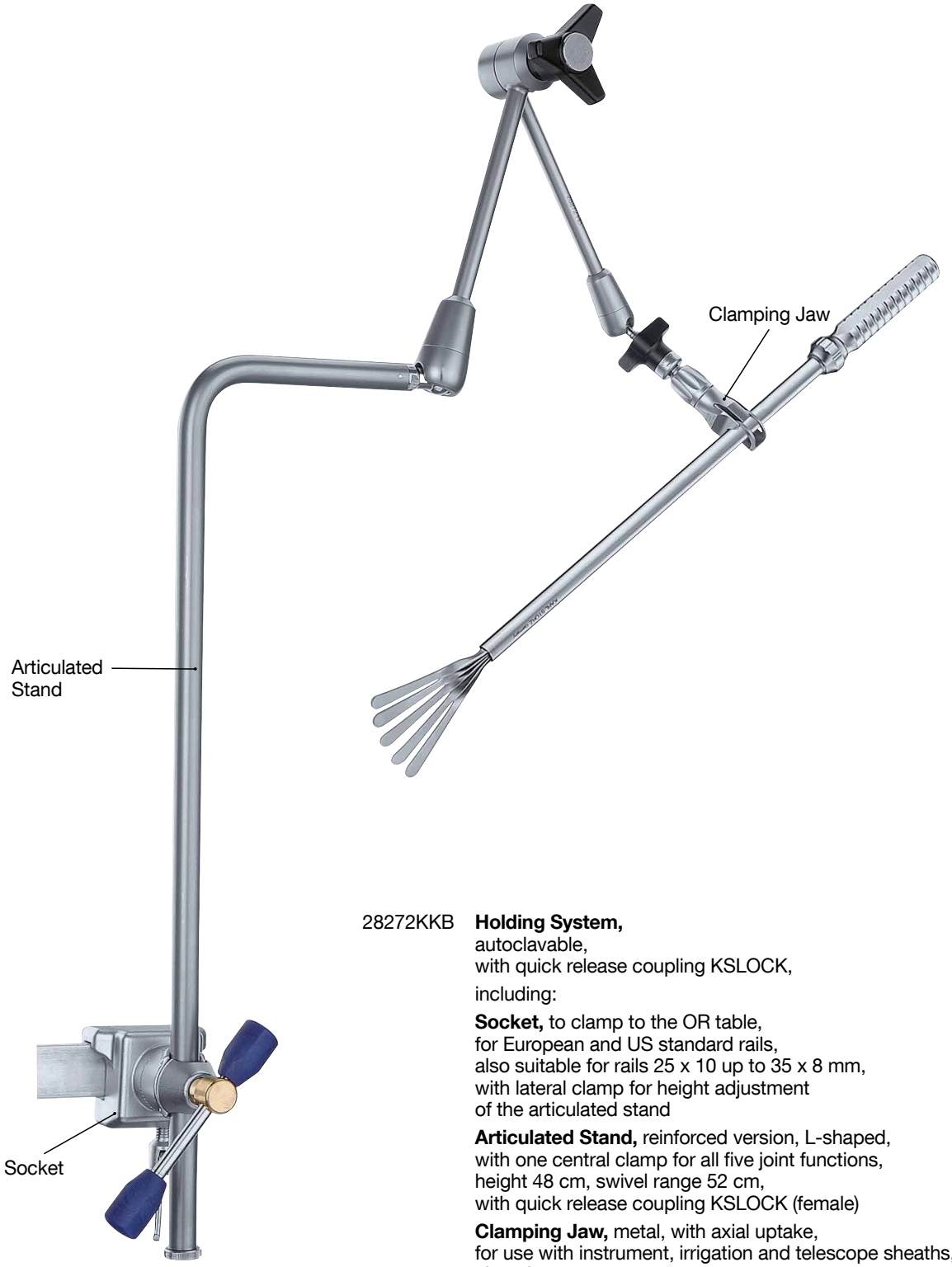



26173FP

26173FP **Fan Retractor,** distending,
with proximal rotating wheel for expansion,
size 12 mm, length 36 cm

## Holding System

**for fixation of a retractor**




28272KKB **Holding System,**
autoclavable,
with quick release coupling KSLOCK,

including:

**Socket,** to clamp to the OR table,
for European and US standard rails,
also suitable for rails 25 x 10 up to 35 x 8 mm,
with lateral clamp for height adjustment
of the articulated stand

**Articulated Stand,** reinforced version, L-shaped,
with one central clamp for all five joint functions,
height 48 cm, swivel range 52 cm,
with quick release coupling KSLOCK (female)

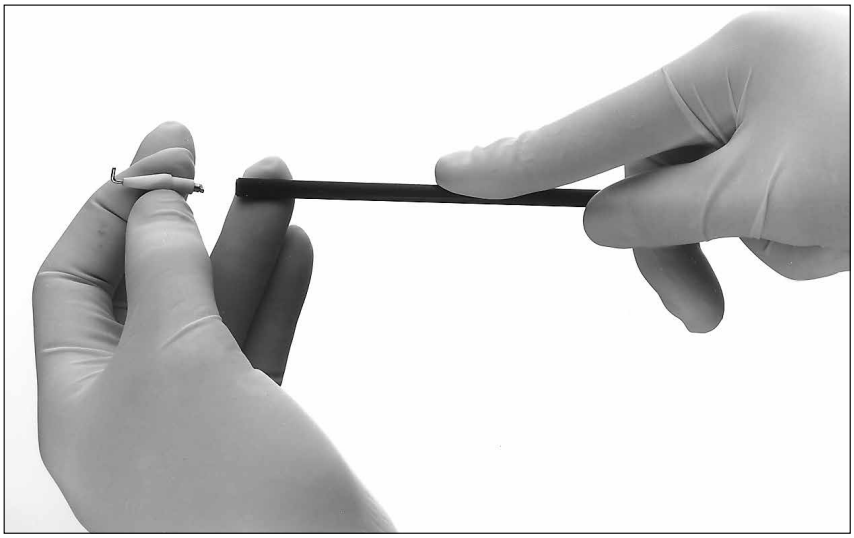
**Clamping Jaw,** metal, with axial uptake,
for use with instrument, irrigation and telescope sheaths,
clamping range 4.8 up to 12.5 mm,
with quick release coupling KSLOCK (male)

## Coagulating and Dissecting Electrodes

**with Connector Pin for Unipolar Coagulation**
**size 5 mm**
**trocar size 6 mm**

**Special Features:**

- **Exchangeable electrode tip**



| Working Length | Instrument |
|---|---|
| 36 cm |  |

| Distal End | Instrument | |
|---|---|---|
|  | 30775UF | **Dissecting Electrode,** including one L-shaped tip |

30775UFE **Exchangeable Electrode Tip,**
L-shaped, package of 6, autoclavable

## Coagulating and Dissecting Electrodes with Channel

**with Connector Pin for Unipolar Coagulation**
**size 5 mm**
**trocar size 6 mm**

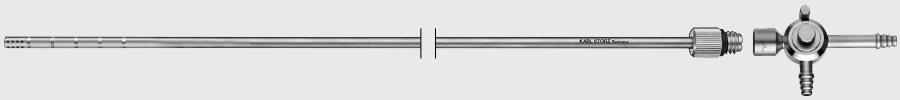
| Working Length | Instrument |
|---|---|
| 36 cm |  |
| 43 cm | |

| Distal End | Instrument | |
|---|---|---|
|  | 37370DL<br>37470DL | **Coagulating and Dissecting Electrode,** with suction channel, L-shaped |
|  | 37370DU<br>37470DU | **Coagulating and Dissecting Electrode,** with suction channel, U-shaped |

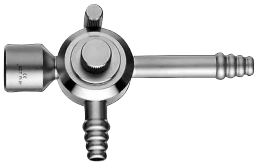
30804 **Handle with Trumpet Valve,**
for suction or irrigation, **autoclavable,**
for use with 5 mm coagulating suction tubes
and 5 mm suction and irrigation tubes

## Irrigation and Suction Tubes

**size 5 mm**
**trocar size 6 mm**

| Working Length | Instrument |
|---|---|
| 36 cm |  |
| 43 cm | |

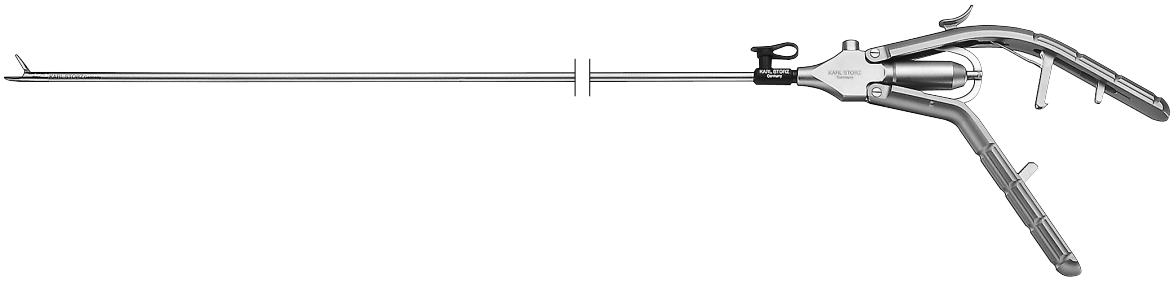
| Distal End | Instrument | |
|---|---|---|
|  | 37360LH<br>37460LH | **Suction and Irrigation Tube,** with lateral holes |
|  | 37360SC<br>37460SC | **Suction and Irrigation Tube** |



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

## KOH **Macro Needle Holder**

**dismantable**



KOH **Macro Needle Holder, size 5 mm, dismantling,**
including:

- **Handle**
- **Outer Sheath**
- **Working Insert**

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.

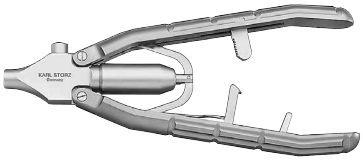
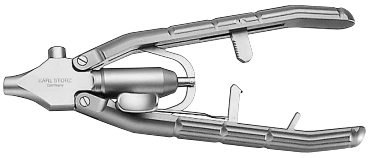
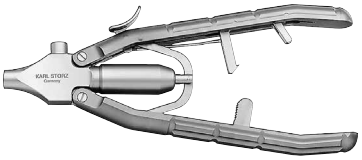
**This unique reusable three-piece design offers the user the following benefits:**

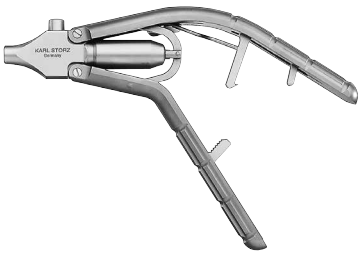
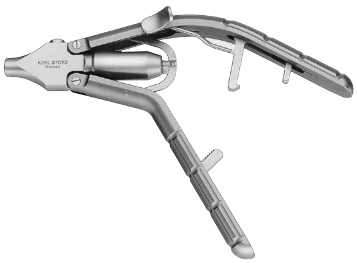
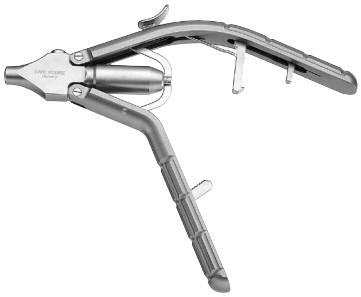
- **Can be disassembled into three separate components**
- **Autoclavable**
- **Cleaning adaptor**
- **Choice of six different handles and three different working inserts**
- **With tungsten carbide inserts**
- **In the event of damage, only the component with the defect needs to be replaced**

## Handles and Outer Tubes

KOH **Macro Needle Holders, dismantable**

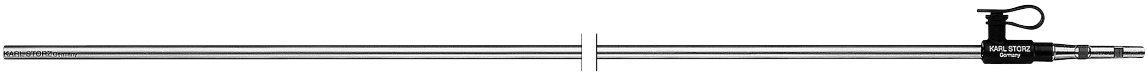
**Handles axial and pistol grip with disengageable ratchet**

| | | |
|---|---|---|
|  |  |  |
| 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**



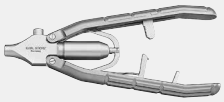
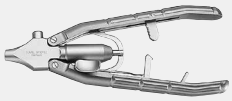
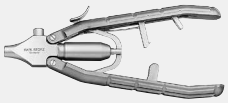
30173A

| **with** LUER-Lock connector for cleaning | Length |
|---|---|
| 30173A | 33 cm |
| 30178A | 43 cm |

# KOH **Macro Needle Holder**

**dismantable**

**Size 5 mm**

| Working Length | Handle | | |
|---|---|---|---|
| | 30173 AR | 30173AL | 30173AO |
| 33 cm |  |  |  |
| 43 cm | | | |

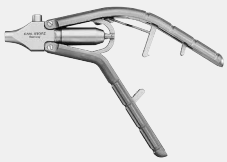
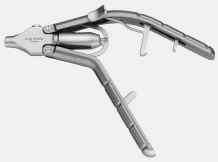
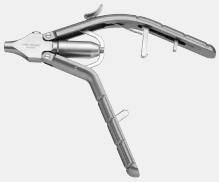
**Single-action jaws**

| Insert No. | Complete Instrument | | |
|---|---|---|---|
| 30173R | 30173RAR | 30173RAL | 30173RAO |
| 30178R | 30178RAR | 30178RAL | 30178RAO |
|  | KOH **Macro Needle Holder,** dismantling, jaws curved to right, with tungsten carbide inserts | | |
| 30173 L | 30173LAR | 30173LAL | 30173LAO |
| 30178L | 30178LAR | 30178LAL | 30178LAO |
|  | KOH **Macro Needle Holder,** dismantling, jaws curved to left, with tungsten carbide inserts | | |
| 30173F | 30173FAR | 30173FAL | 30173FAO |
| 30178F | 30178FAR | 30178FAL | 30178FAO |
|  | KOH **Macro Needle Holder,** dismantling, straight jaws, with tungsten carbide inserts | | |

# KOH **Macro Needle Holder**

**dismantable**

**Size 5 mm**

| Working Length | Handle | | |
|---|---|---|---|
| | 30173PR | 30173PL | 30173PO |
| 33 cm |  |  |  |
| 43 cm | | | |

**Single-action jaws**

| Insert No. | Complete Instrument | | |
|---|---|---|---|
| 30173R | 30173RPR | 30173RPL | 30173RPO |
| 30178R | 30178RPR | 30178RPL | 30178RPO |
|  | KOH **Macro Needle Holder,** dismantling, jaws curved to right, with tungsten carbide inserts | | |
| 30173L | 30173LPR | 30173LPL | 30173LPO |
| 30178L | 30178LPR | 30178LPL | 30178LPO |
|  | KOH **Macro Needle Holder,** dismantling, jaws curved to left, with tungsten carbide inserts | | |
| 30173F | 30173FPR | 30173FPL | 30173FPO |
| 30178F | 30178FPR | 30178FPL | 30178FPO |
|  | KOH **Macro Needle Holder,** dismantling, straight jaws, with tungsten carbide inserts | | |

## Clip Applicator

**size 10 mm**
**trocar size 11 mm**



30444LR **Clip Applicator,** dismantling, rotating, size 10 mm, length 36 cm, for PILLING-WECK Titanium Clips 30460 AL (medium-large), with ratchet to lock the jaw holding the clip,

including:
**Metal Handle,** with ratchet
**Metal Outer Sheath**
**Forceps Insert**

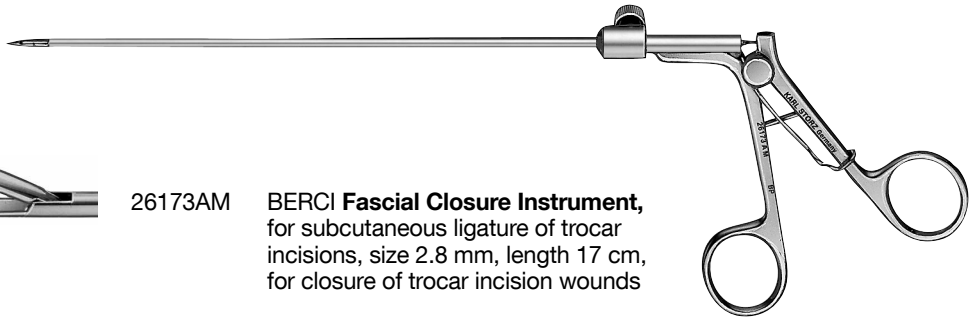
Natural Size

30460AL PILLING-WECK **Titanium Clip,** medium-large, box with 16 sterile cartridges, 10 clips each, for use with Clip Applicator 30444LR

**Please note:**
The use of other clips than indicated above can lead to damage of the mouthpiece.

## BERCI **Fascial Closure Instrument**

**for subcutaneous ligature of trocar incisions**



26173AM BERCI **Fascial Closure Instrument,** for subcutaneous ligature of trocar incisions, size 2.8 mm, length 17 cm, for closure of trocar incision wounds

## Mobile Equipment Cart


**Monitor:**

| | |
|---|---|
| 9627NB | **27" FULL HD Monitor** |

**Camera System:**

| | |
|---|---|
| TC200DE | **IMAGE1 S CONNECT**, connect module |
| TC300 | **IMAGE1 S H3-LINK**, link module |
| TH100 | **IMAGE1 S H3-Z**<br>**Three-Chip FULL HD Camera Head** |

**Light Source:**

| | |
|---|---|
| 20133101-1 | **XENON 300 SCB Cold Light Fountain** |
| 495NCSC | **Fiber Optic Light Cable** |

**HF-Device:**

| | |
|---|---|
| 20535201-125 | **AUTOCON® II 400** |
| 20017830 | **Two-Pedal Footswitch** |

**Insufflation:**

| | |
|---|---|
| UI400S1 | **ENDOFLATOR® 40** |
| UP501S3 | **S-PILOT™** |

**Pump System:**

| | |
|---|---|
| 26331101-1 | HAMOU® **ENDOMAT®** |

**Equipment Cart:**

| | |
|---|---|
| UG120 | **COR™ Equpiment Cart,** narrow, high |
| UG500 | **Monitor Holder** |
| UG609 | **Bottle Holder,** for $CO_2$-Bottles |
| 29005DFH | **Foot-Pedal Holder,**<br>for Two- and Three-Pedal Footswitches |
| UG310 | **Isolation Transformer,** 200V–240V |
| UG410 | **Earth Leakage Monitor,** 200V–240V |

## IMAGE1 S Camera System

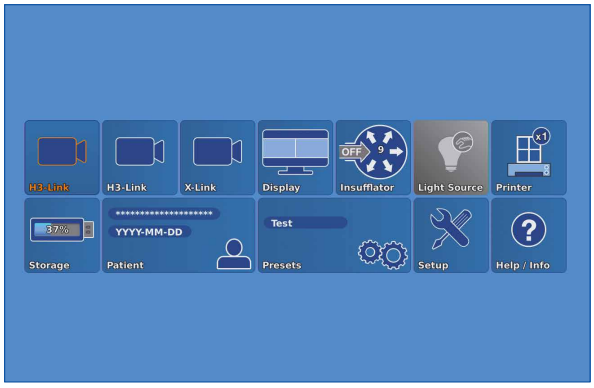
IMAGE1 S

### Economical and future-proof

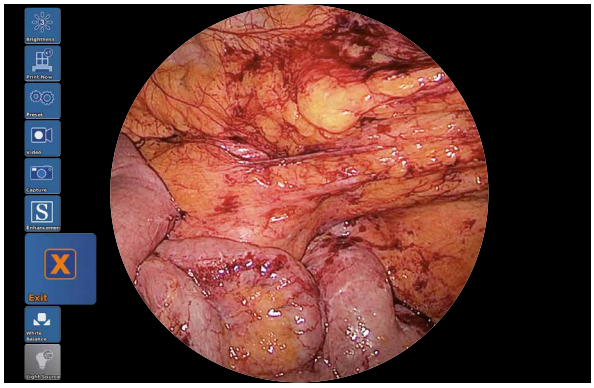
- Modular concept for flexible, rigid and 3D endoscopy as well as new technologies
- Forward and backward compatibility with video endoscopes and FULL HD camera heads
- Sustainable investment
- Compatible with all light sources


### Innovative Design

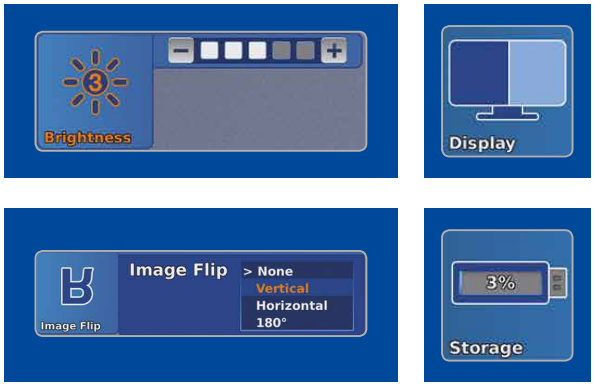
- Dashboard: Complete overview with intuitive menu guidance
- Live menu: User-friendly and customizable
- Intelligent icons: Graphic representation changes when settings of connected devices or the entire system are adjusted
- Automatic light source control
- Side-by-side view: Parallel display of standard 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



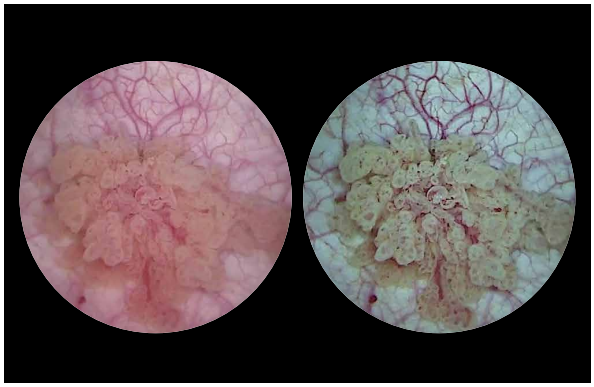

*Dashboard*




*Live menu*




*Intelligent icons*



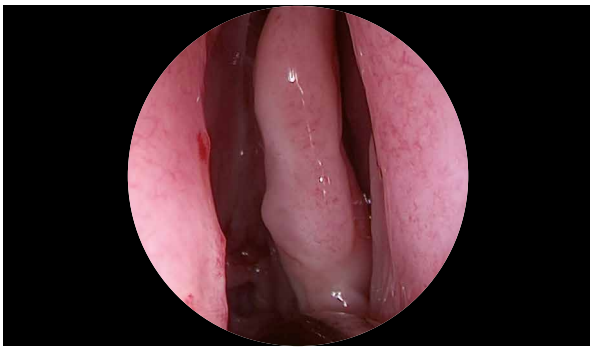
*Side-by-side view: Parallel display of standard image and Visualization mode*

## IMAGE1 S Camera System

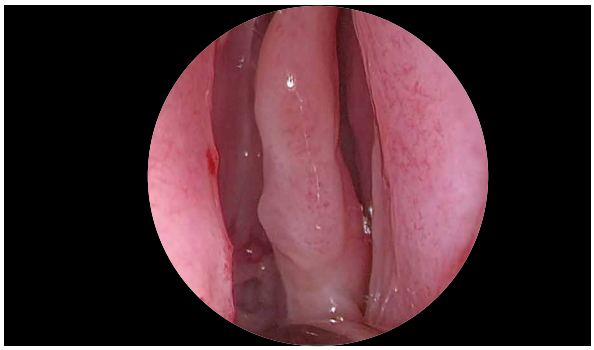
IMAGE1 S

**Videoendoscopic Imaging**

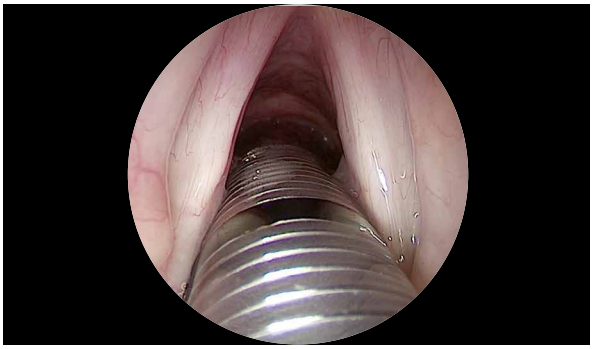
- **Very high quality of endoscopic images in FULL HD**
- **Natural color rendition**
- **Multiple IMAGE1 S technologies for homogeneous illumination, contrast enhancement and color shifting**



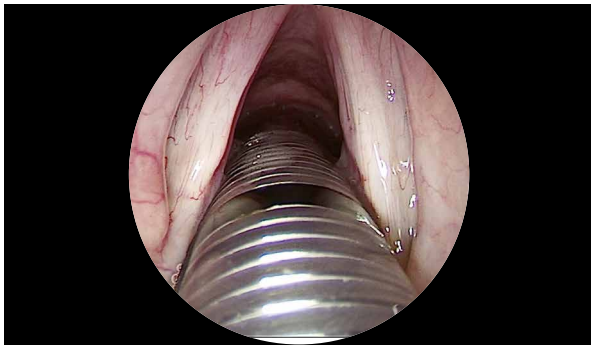
*FULL HD image*



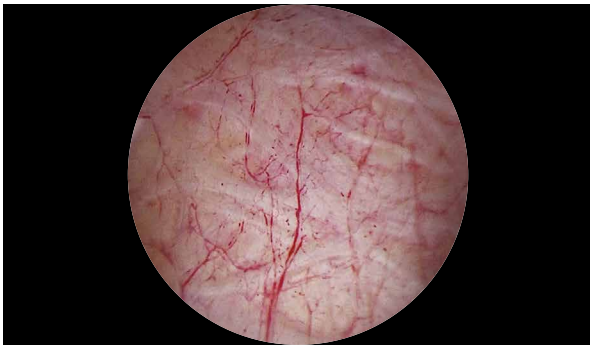
*CLARA*



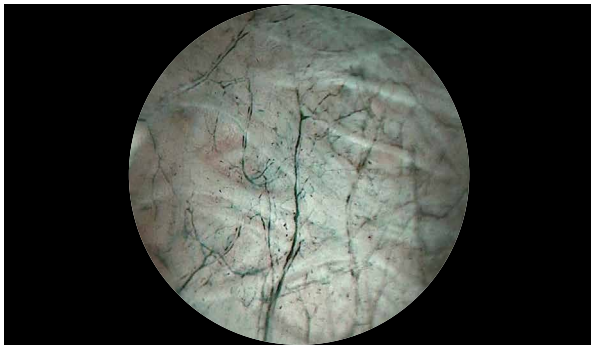
*FULL HD image*



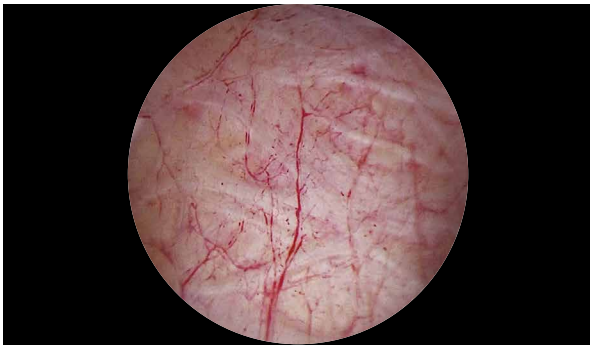
*CHROMA*



*FULL HD image*



*SPECTRA A**



*FULL HD image*

*SPECTRA B***

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

## IMAGE1 S Camera System


TC200EN

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:**

| | |
|---|---|
| HD video outputs | - 2x DVI-D<br>- 1x 3G-SDI |
| Format signal outputs | 1920 x 1080p, 50/60 Hz |
| LINK video inputs | 3x |
| USB interface<br>SCB interface | 4x USB, (2x front, 2x rear)<br>2x 6-pin mini-DIN |

| | |
|---|---|
| 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

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:**

| **Camera System** | **TC 300 (H3-Link)** |
|---|---|
| Supported camera heads/video endoscopes | TH100, TH101, TH102, TH103, TH104, TH106<br>(fully compatible with IMAGE1 S)<br>22220055-3, 22220056-3, 22220053-3, 22220060-3, 22220061-3, 22220054-3, 22220085-3<br>(compatible without IMAGE1 S technologies CLARA, CHROMA, SPECTRA*) |
| LINK video outputs | 1x |
| 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 | 1.86 kg |

* *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

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

**Specifications:**

| IMAGE1 FULL HD Camera Heads | IMAGE1 S H3-Z |
|---|---|
| Product no. | TH100 |
| Image sensor | 3x ⅓" CCD chip |
| Dimensions w x h x d | 39 x 49 x 114 mm |
| Weight | 270 g |
| Optical interface | integrated Parfocal Zoom Lens, f = 15–31 mm (2x) |
| Min. sensitivity | F 1.4/1.17 Lux |
| Grip mechanism | standard eyepiece adaptor |
| Cable | non-detachable |
| Cable length | 300 cm |

TH104

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

**Specifications:**

| IMAGE1 FULL HD Camera Heads | IMAGE1 S H3-ZA |
|---|---|
| Product no. | TH104 |
| Image sensor | 3x ⅓" CCD chip |
| Dimensions w x h x d | 39 x 49 x 100 mm |
| Weight | 299 g |
| Optical interface | integrated Parfocal Zoom Lens, f = 15–31 mm (2x) |
| Min. sensitivity | F 1.4/1.17 Lux |
| Grip mechanism | standard eyepiece adaptor |
| Cable | non-detachable |
| Cable length | 300 cm |

## Monitors


9619NB

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

9826NB **26" FULL HD Monitor,**
wall-mounted with VESA 100 adaption, color systems **PAL/NTSC,**
max. screen resolution 1920 x 1080, image fomat 16:9,
power supply 100–240 VAC, 50/60 Hz including:
**External 24 VDC Power Supply**
**Mains Cord**

## Monitors

| KARL STORZ HD and FULL HD Monitors | 19" | 26" |
|---|---|---|
| **Wall-mounted with VESA 100 adaption** | 9619NB | 9826NB |
| **Inputs:** | | |
| DVI-D | ● | ● |
| Fibre Optic | – | – |
| 3G-SDI | – | ● |
| RGBS (VGA) | ● | ● |
| S-Video | ● | ● |
| Composite/FBAS | ● | ● |
| **Outputs:** | | |
| DVI-D | ● | ● |
| S-Video | ● | – |
| Composite/FBAS | ● | ● |
| RGBS (VGA) | ● | – |
| 3G-SDI | – | ● |
| **Signal Format Display:** | | |
| 4:3 | ● | ● |
| 5:4 | ● | ● |
| 16:9 | ● | ● |
| Picture-in-Picture | ● | ● |
| PAL/NTSC compatible | ● | ● |

**Optional accessories:**

9826SF **Pedestal,** for monitor 9826NB

9626SF **Pedestal,** for monitor 9619NB

**Specifications:**

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

## Fiber Optic Light Cables

**For use with telescopes, size 10 mm:**

495NCS **Fiber Optic Light Cable,**
with straight connector,
extremely heat-resistant,
diameter 4.8 mm, length 250 cm

**For use with telescopes, size 5 mm:**

495NA **Fiber Optic Light Cable,**
with straight connector,
diameter 3.5 mm, length 230 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**
**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

## 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.**

*

## Notizen

## Notizen

with the compliments of

KARL STORZ — ENDOSKOPE