NEEDLESCOPIC FOREGUT SURGERY

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NEEDLESOCOPIC
FOREGUT SURGERY

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1.0 Needlescopic Surgery

1.1 Introduction

Since the advent of laparoscopy, there has been a growing interest in reducing the size of the instrumentation used for surgical procedures. This has lead to the development of needlescopic surgery (laparoscopic surgery with instruments ≤ 3 mm of outer diameter). The possible benefits of those smaller instruments include: better cosmetic results with 66% of incisions not being visible in one study, a reduced risk of trocar site herniation, a potential shorter length of stay and a reduced need for postoperative analgesia. The potential risks of needlescopic surgery are related to the loss of tactile feedback and the increased risk of trauma to adjacent structures due to the smaller diameter of the instruments.

1 Relative trocar size. From right to left: 3.5 mm, 5 mm, 10 mm.

2 Relative size of instruments: 5 mm Maryland dissector vs. 3 mm needledriver.

3 Relative size of 3 mm needledriver and needle.
1.2 Comparison with Other Approaches

Needlescopic surgery has been used for many procedures with satisfying results (appendectomy, Heller myotomy, cholecystectomy, adrenalectomy, etc). It is generally associated with increased operative time which is probably related to the technical challenge of the needlescopic approach and the frequent optic change necessary to complete the surgery.1,3,4,5,24,30,37

When needlescopic instruments are used, it is always possible to convert the needlescopic approach to a laparoscopic one. This explains the higher rate of conversion in many studies. Conversion could be necessary to control bleeding or to obtain a better view of the operative field. However a 5 or 10 mm safety port at the umbilicus will minimize this need.

A systematic review grouping 14 randomized controlled trials and 6 prospective studies was performed by the Minimally Invasive Research Group of the Ottawa hospital. This study includes trials reporting on cholecystectomy, appendectomy, adrenalectomy, splenectomy, ventral hernia repair, gastric surgeries, splenic epithelial cyst, colon resection and choledochal cyst. The goal of this study was to evaluate the evidence to support the use of needlescopic instruments.

Table 1: Result of a Systematic Review on Needlescopic Surgery

<table>
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<th>Studies</th>
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<th>Operative time</th>
<th>Length of hospital stay</th>
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Legend  
- Favors laparoscopic  
- Favors needlescopic  
- No significant difference  
- No information available
The conclusion of this review was that the current quality of evidence is poor to moderate and the studies likely underpowered to detect difference in complications and conversion rate. However, with the available data, needlescopic surgery seems to be a safe approach. It is possibly associated with better pain control and better cosmetic results.

One trial compared needlescopic surgery and single-incision laparoscopic cholecystectomy (SILS). This trial involving 70 patients showed a significant longer operative time for the SILS surgery. Rate of complications, postoperative pain and analgesic requirement were equivalent for both type of procedure. There was an advantage in cosmetic results for patient with SILS surgery associated with a shorter total wound length. The main advantage of needlescopic approach over single incision is that needlescopic does not require major change in the usual basic principles of laparoscopic surgery.

Nissen fundoplication and Heller myotomy are ideal procedures for needlescopic instruments. There is no specimen to extract, there is no heavy organ to manipulate with small instruments and there is no anastomosis to create with 12 mm endoscopic stapler.

2.0 Needlescopic Nissen Fundoplication

2.1 Introduction

Gastro-esophageal reflux disease (GERD) is a frequent cause of complaints in developed countries. It is estimated that 20% of Western population experiences heartburn weekly. Many of these patients can be treated with simple intermittent medication but others may require lifelong medical therapy or may be only partially relieved by the medication. For these patients and for those who develop complications of GERD, surgery is a real and viable alternative. Since the first description of a laparoscopic Nissen fundoplication in 1991, it has become procedure of choice for GERD worldwide.

In this booklet we will review the indications of Nissen fundoplication and the outcomes from this surgery and we will explain the technical steps to perform a needlescopic fundoplication.

2.2 Indications for Anti-reflux Surgery

- Patients with symptoms related to GERD not completely eliminated by optimized medical treatment.
- Patients with symptoms controlled by medical treatment who do not desire lifelong medication.
- Patients with complication of reflux: stricture, Barrett esophagus, vocal cord injury.
2.3 Preoperative Evaluation for Nissen Fundoplication

Because the symptoms of GERD are often non-specific, it is necessary to confirm the diagnosis with more objective testing before discussing the potential benefits of surgery with the patient. The evaluation should be used to assess the severity of GERD, to identify GERD as the cause of the symptoms and to select the appropriate procedure for a particular patient.

**24h pH Monitoring**

pH monitoring is the most reliable test to diagnosis GERD with sensitivity and a specificity of 96%. An esophageal pH < 4 reflects an episode of reflux of gastric juice into the esophagus. This test will also link the symptoms of the patient to the episodes of reflux. The DeMeester score has been developed to offer a global evaluation of the severity of the reflux by combining six components of reflux disease: the total time of pH < 4, the upright time with pH < 4, the supine time with pH < 4, the number of episodes of reflux, the number of episode ≥ 5 min and the longest episode. A score > 14.7 is considered as abnormal.

**Endoscopy**

Patients should be evaluated by endoscopy to search for esophagitis and other potential complications. The absence of esophagitis does not exclude the diagnosis of GERD since 40–50% of patient with confirmed GERD don’t present with esophagitis. There is also 10% of esophagitis that are not related to GERD. The esophagogastroduodenoscopy also permits to search for alternate diagnoses like gastritis, peptic ulcer disease and carcinoma that can present with non-specific symptoms similar to GERD. Endoscopy also affords a possibility to look for complications of reflux such as stricture and Barrett’s oesophagus. Finally, endoscopy allows the evaluation of the gastro-esophageal junction and the search for a paraesophageal hernia.

**Manometry**

Manometry is classically routinely performed before anti-reflux surgery. It has been used as a tool to select the appropriate procedure for patients with reflux. However, many trials have demonstrated that tailoring the surgery by using manometry does not offer any advantage in terms of surgical outcomes and patient satisfaction. A recent review on the role of manometry in GERD concludes that tailoring the surgery according to the results of manometry is not indicated and that the type of fundoplication used by surgeon is based more on the personal preference of the surgeon than evidence-base data. However, manometry remains a useful tool to exclude primary or secondary motility disorders. In a study from Akyuz et al, 11% of patients evaluated for reflux had a primary esophageal motility disorder (achalasia, uncoordinated contractions, nutcracker esophagus) and 2% had secondary motility disorder due to scleroderma.
2.4 Principles of Nissen Fundoplication

To offer the best results to patients some general principles must be applied to the procedure:¹⁰

- There must be 3 cm of intra-abdominal esophagus.
- The fundus should be used for the fundoplication.
- The wrap should be anchored on the esophagus.
- The vagal nerves should be protected during the surgery.
- The wrap should not be longer than 2–3 cm.
- The crura should be closed with non-absorbable suture.
- The fundoplication should be constructed over a large caliber bougie.

Needlescopic instruments allow the surgeon to perform these same critical steps as do regular laparoscopic instruments. Needlescopic surgery does not require changes in accepted laparoscopic surgical standards and preserves the laparoscopic paradigm unlike single port surgery.

2.5 Instrumentation for Needlescopic Nissen Fundoplication

1. 5 mm and 3 mm scope
2. Four 3.8 mm trocars and one 5 mm trocar
3. One 3 mm curved scissor
4. One 3 mm Maryland dissector
5. One 3 mm L-hook cautery
6. Three 3 mm atraumatic graspers
7. One toothed 3 mm grasper with ratchet
8. One 3 mm suction
9. Two 3 mm needle drivers
2.6 Technique of Needlescopic Nissen Fundoplication

- The patient is placed in semi-lithotomy position on a bean bag.
- A small incision on the skin of the umbilicus allows the insertion on a Veress needle. After the creation of a 15 mmHg pneumoperitoneum, a 5 mm trocar is inserted at the base of the umbilicus. The abdominal cavity is explored with the 5 mm scope. A 3 mm scope is used as a bridge to allow the insertion of hemostatic device such as hemoclip or harmonic scalpel and for the insertion of the needles via the 5 mm port. The surgery is mainly performed with the 5 mm scope which offers better visualization of the operative field (Figs. 5a, b).
- Four 3.8 mm trocars are inserted. One in the subxiphoid region, one in the right upper quadrant and two in the left upper quadrant (Fig. 6).
- A grasper with teeth is inserted in the subxiphoid trocar and tacked to the diaphragm to lift the left lobe of the liver. Alternatively a liver retractor may be used (Fig. 7).
Opening of pars flaccida.

Hemostasis with cautery and Maryland dissector.

- The pars flaccida is then dissected and the lesser sac is entered using cautery. Vessels are controlled with a pinch burn technique (Figs. 8, 9).
- The medial border of the right crus is identified and dissected, taking care not to damage the peritoneal lining of the crus. Traction on the esophagus helps this dissection (Figs. 10a, b).

Dissection of right crus.
The retroesophageal space is dissected to the left crus. The posterior vagal trunk should be protected during this dissection (Figs. 11a, b).

The anterior dissection is completed by taking down the phrenoesophageal ligament anteriorly from right to left (Fig. 12).

The short gastric vessels are then controlled using a pinch burn cautery technique, or hemostatic clips or ultrasonic dissector inserted in the umbilical trocar. The mobilization of the fundus is completed to allow a floppy wrap (Figs. 13, 14).
The exposure of the left crus is completed from the left side (Fig. 15).

By the end of the dissection, there is at least 3 cm of intra-abdominal oesophagus and the hiatal structures are all well delineated (Fig. 16).

The hiatal reconstruction is done using non-absorbable braided suture on a straight needle. The straight needle is easily inserted via the 5 mm umbilical trocar. A figure of 8 stitch is placed using the 3 mm needledrivers (Figs. 17–19).
The 360° wrap is then completed. The fundus is grasped and passed behind the esophagus and progressively brought on the right side using the great curvature as traction point (Figs. 20–22).

The wrap is anchored with one stitch between the stomach and the esophagus. Care is taken when tying this stitch not to pull anteriorly to avoid injury to the esophagus (Figs. 23, 24).
Two other stitches are then placed to complete the wrap. A 50F bougie should be inserted in the esophagus without resistance at the end of the fundoplication (Fig. 25).

Finally the wrap is fixed to the right crus using another non-absorbable braided suture (Figs. 26–28).

The skin of the 5 mm umbilical trocar is closed with one subcuticular suture (Fig. 29).

- Two last stitches on the wrap.
- Fixation of the wrap to the crus.
- Fixation completed.
- Completed fundoplication.
- Appearance of the incisions at the end of the procedure.
2.7 Cosmetic Results

30 Cosmetic results at 2–3 weeks.

31 Cosmetic results at 3 months.

2.8 Results of Nissen Fundoplication

Cost-effectiveness

Many studies were done to evaluate the benefits of Nissen fundoplication over medical therapy. The REFLUX trial concluded that the surgery was cost effective if the patient was not taking medication 5 years after the surgery. A Cochrane systematic review of 4 studies including 1232 patients demonstrated that GERD related quality of life is improved at 3 months and one year but that the cost of surgery was higher for the first year.

Use of anti-reflux medication

The use of medication after the fundoplication has been inconsistent among the studies. In the Cochrane systematic review, 12.5% of patients were taking over the counter medication one year after the fundoplication. With a follow-up of 5 years another group found that 15–21% of patients were on acid suppressing drugs after surgery versus 81–82% in the non-surgical group.

Complications

The most frequent complications reported with Nissen fundoplication is dysphagia and bloating. 1–19% of dysphagia is reported in different studies. The post-operative dysphagia can usually be treated by dilatation of the fundoplication. Bloating is increased after anti-reflux surgery by 3%–5% and incapacity to belch affects 25% of the patients. 0–15% of patient undergoing a Nissen fundoplication will need another surgery during the follow-up. The most frequent indications for those surgeries include: dysphagia, recurrent reflux and intrathoracic herniation of the wrap.
2.9 Results of Needlescopic Nissen Fundoplication

One study compared needlescopic and laparoscopic Nissen fundoplication. There was no significant difference in estimated blood loss, operative time and intraoperative complications. The postoperative period was also similar between the groups in term of narcotics requirements, hospital stay and complications. At follow-up (average 61 days) there was no difference in dysphagia or bloating. There was a significant reduction in operative time after the first 4 cases 166 versus 120 min p: 0.03. The relatively short learning curve in this study was probably related to the previous experience of the participating surgeons in laparoscopy.

2.10 Conclusion

As with other procedures, needlescopic Nissen fundoplication is safe in the properly selected patient. It should be used by surgeons with experience in advanced laparoscopy and in patients with adequate body habitus. The benefits in terms of cosmetic results with the needlescopic approach are not obtained at the cost of a major change in the well established surgical paradigm of Nissen fundoplication. This advantage will probably allow a better acceptance by the surgical community.

3.0 Needlescopic Heller Myotomy

3.1 Introduction

Minimally invasive surgery was initially used to treat achalasia in 1991. First, the myotomy was performed through a left thoracoscopic approach. However, this procedure was associated with a cumbersome anesthesia setting, a sub-optimal view of the gastro-esophageal junction and a high risk of post-operative reflux. Laparoscopic Heller myotomy was developed to allow a safe and effective treatment of achalasia avoiding the thoracic approach and providing a better exposure of the gastro-esophageal junction. Myotomy combined with a fundoplication is now considered to be the treatment of choice of achalasia.

In this booklet we will briefly review the clinical features of achalasia and the result of Heller myotomy. We will then explain the operative steps necessary to perform a needlescopic Heller myotomy with a Dor anterior fundoplication.

3.2 Epidemiology of Achalasia

Achalasia is affecting 10 patients per 100,000 in United States. There is no gender preponderance. The incidence is increasing with advanced aged. There is a peak incidence between 25 and 60 years old.
3.3 Etiology

**Primary achalasia:**
- Degeneration of ganglion cells in the myenteric plexus

**Secondary achalasia:**
- Cancer (Most common cause of secondary achalasia)
  - Mechanisms:
    - Direct invasion
    - Paraneoplastic symptoms (secretion of antineuronal antibodies)
- Anti-reflux surgery
- Laparoscopic gastric banding
- Post-vagotomy
- Amyloidosis
- Sarcoidosis
- Sjögren's Syndrome
- Chagas disease
  - Trypanosoma cruzi infection, associated with megacolon, heart disease and neurologic disorders
- Allgrove's disease
  - Achalasia
  - Alacrima
  - Autonomic disturbance
  - ACTH insensitivity

3.4 Clinical Presentation

The cardinal symptom of achalasia is dysphagia, present in > 90% of patients. Dysphagia is generally associated with both solid and liquid, a feature that differentiates achalasia from mechanical abnormalities.\(^{18,38}\)

Regurgitation is present in 60–80% of patients. This can lead to aspiration and respiratory symptoms. Chest pain, heartburn and difficulty belching are also commonly found in those patients.

Heartburn can be caused by many factors: retention and fermentation of undigested food by bacteria, neuropathic pain, secondary and tertiary contraction of the esophagus, gastro-esophageal reflux. In a 2008 study looking at the presentation of achalasia, 45% of patients with achalasia had been treated for GERD before the diagnosis of achalasia was made.\(^{20}\)

Weight loss rarely exceeds 5–10 kg. Elderly patients with a weight loss of more than 10 kg and symptoms for less than 6 months should raise the suspicion of a secondary achalasia related to esophageal cancer.\(^{18,19,38}\)
3.5 Diagnosis

**Barium study**
Barium swallow is the recommended first test in patient with dysphagia. It defines the anatomy and allows for a safer endoscopy. The classic features of achalasia are: dilated esophagus with bird’s beak gastro-esophageal junction and absence of peristalsis. There is no frank correlation between the severity of the symptoms of the patient and the radiologic appearance. 64% of esophagogram suggest the diagnostic of achalasia.18, 38

**Endoscopy**
Upper endoscopy is recommended for all patients presenting with dysphagia. This exam is useful to rule out malignancy. Typically, esophagus may be dilated with retained food and an increased resistance at the gastro-esophageal junction. However, 40% of patients will have a normal upper endoscopy.18

**Manometry**
This test is the gold standard for the diagnosis of achalasia. Classic criteria include: absence of esophageal peristalsis in the body of esophagus, hypertensive lower esophageal sphincter (LES) (pressure > 45 mmHg), non-relaxing LES (residual pressure > 8 mmHg). LES is not hypertensive in up to 50% of patients.38

3.6 Non-Surgical Treatment

**Medications**
Many medications have been used to improve the symptoms of achalasia: nitrates, calcium channel blockers, nitric oxide donor. The efficacy of those is generally poor and no medical treatment is widely used for this disease.

**Endoscopic Pneumatic Balloon Dilatation**
Standard balloon dilatation and bougie dilatation are generally ineffective for treatment of achalasia. Pneumatic balloon dilatation has been used with good result in terms of initial symptoms improvement, relieving dysphagia in 55–70% of patients after one treatment and up to 90% of patients after multiple attempts. However it is associated with a higher rate of recurrence then surgery, with 25% of patients needing repeated dilatation.23 The main downside of this therapy is the risk of perforation that is estimated to be around 1–2% but can be as high as 12% in some series.21 Other complications associated with this treatment include GERD in up to 33% of patients and gastroesophageal bleeding from mucosal tear.23

**Endoscopic Botulinum Toxin Injection**
This strategy is associated with good short term results but repeated injections are generally necessary. With repeated injections there is a potential 85% of relief of dysphagia at 2 years.22 In a randomized controlled trial, 66% of patients in the endoscopic botulinum injection group were symptomatic compared to 13.5% in the surgical group at 2 years follow-up.23 There is concerning evidence that myotomies performed after injections are more difficult. There is an initial resistance to this treatment in 26% of patients related to antibody formation.23 Endoscopic botulinum toxin injection is generally reserved for patients presenting with co-morbidities precluding a surgical treatment or endoscopic pneumatic dilatation (Ex: sigmoid esophagus). It can also be used as a test to confirm the diagnosis. A good response to botulinum toxin injection is predictive of a good clinical result after a myotomy.21
3.7 Surgical Treatment

**Role of Surgical Myotomy**

The surgical approach to achalasia has evolved since the introduction of Heller myotomy in 1913. The advent of laparoscopy has changed the role of the surgical myotomy in the treatment of achalasia. Before minimally invasive surgery, the left thoracotomy used for the myotomy and the complications related to this approach precluded widespread use of the surgery as a primary treatment. Since the introduction of laparoscopic Heller myotomy, surgical treatment is associated with low morbidity and a short hospital stay that render this approach more attractive. In a meta-regression analysis, the laparoscopic approach offered a better rate of symptoms improvements then the thoracoscopic approach (89 vs 78%) with a lower risk of post-operative reflux (28 vs 15%).

The use of needlescopic instruments to perform this surgery may allow for possible improvements of these results in terms of pain control, length of stay and cosmetic results. A retrospective study including 29 patients was published in 2003. It was comparing standard laparoscopic Heller myotomy versus needlescopic Heller myotomy. The needlescopic approach demonstrated shorter duration of surgery and a shorter length of stay with similar analgesia requirements, complications and conversions.

The surgical myotomy has been compared to endoscopic treatment. It is associated with the best long term results with 95% of dysphagia relief at 5 years versus 65% for dilatation. Even in the elderly population, the myotomy is associated with a smaller number of interventions and the best results in terms of long-term relief of symptoms.

**Necessity of Fundoplication**

Without a fundoplication, Heller myotomy is associated with a 30–60% incidence of reflux. Post Heller myotomy GERD is hard to diagnose and the symptoms are not reliable. The addition of a fundoplication to the myotomy has been shown to reduce the incidence of reflux after the surgery without compromising relief of dysphagia. A partial fundoplication should be used as it has been demonstrated to diminish the risk of dysphagia in long term follow-up. Esophageal dilatation can be considered a contraindication to Nissen fundoplication after myotomy because it is associated with an unacceptable rate of postoperative dysphagia at 5 years.

3.8 Principles of Heller Myotomy

- Myotomy of both the longitudinal and the circular fibers.
- Myotomy on 50% of the mucosa surface to prevent refusion of the fibers.
- Myotomy extends for 7 cm from esophagus (5 cm) to the stomach (2 cm).
- Fundoplication to prevent reflux and protect the exposed mucosa.

3.9 Instrumentation for Needlescopic Heller Myotomy and Dor Fundoplication

- The instrumentation is the same as for needlescopic Nissen fundoplication.
3.10 Technique of Needlescopic Heller Myotomy and Dor Fundoplication

- The patient is placed in semi-lithotomy position on a bean bag.
- The creation of the pneumoperitoneum and the trocars positioning follow the same principles used for a needlescopic Nissen fundoplication (Fig. 33).
- The liver is retracted using a 3 mm grasper with teeth anchored to the diaphragm (Fig. 34).
- The phrenoesophageal ligament is opened using electrocautery and blunt dissection to expose the gastroesophageal (GE) junction and lower esophagus (Fig. 35).
- Vessels encountered during this dissection are dissected and pinch burnt (Figs. 36a, b).
The anterior vagus nerve is exposed and protected (Fig. 37).

The dissection is carried upwards to expose 6-7 cm of esophagus into the lower mediastinum (Figs. 38–40).
A 7 cm long suture is used to measure the length of the myotomy (Figs. 41a, b).

The anterior surface of the esophagus is then scored using the electrocautery (Figs. 42a, b).
The longitudinal and circular muscles are gently teased off the esophagus on at least 50% of the circumference of the esophagus (Figs. 43, 44).

The myotomy is continued down to the gastric wall where the oblique fibers are encountered (Fig. 45).

The fundoplication is then started. First the mobility of the gastric fundus is assessed. It is not always necessary to mobilize the short gastric for a Dor fundoplication. If the short gastrics are to be controlled, a pinch burn technique is usually sufficient; larger vessels can be taken with 5 mm clips (Fig. 46).
The fundoplication is done using non-resorbable braided suture stitches. First, the fundus is tacked to the left crural pillar incorporating esophageal musculature in the stitch (Figs. 47, 48).

Few others sutures are then used to fix the fundus to the left side of the myotomy (Fig. 49).

The fundus is fixed to the upper part of the hiatus (Figs. 50a, b).
Then the fundus is fixed to the right crus and the right side of the myotomy (Fig. 51).

Other stitches complete the fundoplication by anchoring the fundus to the right side of the myotomy until the myotomy is completely covered (Figs. 52, 53).

A Floppy Nissen fundoplication can also be used as an anti-reflux procedure. In this case, the posterior dissection is conducted as described previously. Other authors preferred the Toupet partial fundoplication. This technique results in a fundoplication that tends to keep the edges of the myotomy apart, providing the theoretical advantage of preventing the closure of the myotomy. The downside of this approach is the absence of coverage of the myotomy. It is not recommended to use this technique when a perforation has been repaired.

3.11 Appearance of Incisions at the End of the Procedure
3.12 Intra-operative Esophageal Perforation

Previous dilatation or botulinum toxin injection can make the myotomy more challenging because of tissue scarring. This scarring can fuse the plans, rendering perforation a more frequent occurrence. In a recently published review, a perforation occurred in 6.9% of myotomy and were repaired and the index surgery. Only 0.7% of patients developed clinical manifestation of the perforation. The rate of symptomatic perforation was found to be similar in the surgical group compared to the endoscopic dilatation group (0.7 vs 1.6%).

If a perforation is suspected, it can be assessed using air insufflation or methylene blue through an orogastric tube. An intra-operative upper endoscopy is another option to evaluate the integrity of the mucosa. If a perforation occurs during the procedure, it can be fixed by interrupted stitches of 3-0 resorbable suture (Fig. 56). Simple or double layer repair are acceptable. The anterior fundoplication is then used as a serosal patch to reinforce the repair.

3.13 Long-term Cosmetic Result
3.14 Results of Heller Myotomy

**Immediate Result**

90% of patients can be discharged within 48 hours of the surgery. There is a 6% risk of perioperative complications and a 0.1% risk of mortality.\(^{23}\)

**Long-term Relief of Dysphagia**

A study on the long term effects of the myotomy found 80% of dysphagia improvement at a mean follow-up of 6.4 years. Most of the failures were caused by fibrosis of the LES or by end stage esophageal dysfunction. The mean time to recurrence was 21.3 months. The patients with failed Heller myotomy were treated with either repeated myotomy or esophagectomy.\(^{30}\) Factors associated with good outcomes in this study include: elevated LES tone, short duration of symptoms, absence of sigmoid esophagus and absence of previous endoscopic treatment. Another option for patients experiencing symptoms recurrence is endoscopic pneumatic dilatation with a success rate as high as 97% in some series.\(^{22}\)

**Long-term Quality of Life**

Few study report very long term results of myotomy plus partial fundoplication. In a 2006 publication, Csendes reports the very long follow-up of 67 patients. More than 20 years after surgery, only 65% of patients reported excellent or good result. The main source of complaints of those patients was GERD causing 93% of failure. Only one patient had an incomplete myotomy.\(^{31}\)

**Long-term Complications**

The most frequent long term complication of Heller myotomy is GERD with an incidence of around 14% in meta-analysis.\(^{32}\) Incomplete myotomy with food fermentation is to be considered in the differential diagnosis of a patient presenting with heartburn after a myotomy. A 24h pH study is used as a diagnostic tool. GERD after myotomy must be aggressively treated because the impaired esophageal peristalsis of the esophagus increased the contact time of acid with the mucosa and also increased the risk of GERD complications. There is a poor correlation between the symptoms of heartburn and the presence of GERD on the pH study. Because of that some authors recommend a routine pH study after Heller myotomy.\(^{22}\)

3.15 Special Consideration

**Mega-esophagus**

Mega-esophagus or sigmoid esophagus is defined by an esophagus that is more than 6 cm wide. This condition is associated with a higher rate of re-intervention after a myotomy. However, less than 10% of patients with mega-esophagus need an esophagectomy as the treatment of their condition. It is recommended to proceed with a myotomy as the initial treatment. Patti et al published the results of Heller myotomy and Dor fundoplication in 19 patients with an esophagus > 6 cm. Eighty-nine percent of patients had excellent or good results after a mean follow-up of 22 months.\(^{33}\) A series of 4 cases including mega-esophagus up to 12 cm demonstrated the feasibility and the good outcomes of the myotomy.\(^{34}\) Patients who still have symptoms after the myotomy can be offered pneumatic dilatation with good results in up to 59% of patients. The option of esophagectomy should be reserved for patients who failed myotomy and dilatation. Esophagectomy is a morbid surgery with a mortality rate of 3% and a perioperative morbidity rate of 17%\(^{35}\) and it should be considered as a last resort option.

3.16 Conclusion

Heller myotomy with Dor fundoplication is considered the preferred approach for treatment of achalasia. The principles of this surgery can be respected when performed with needlescopic instruments. Needlescopic Heller myotomy with Dor fundoplication is a safe and feasible option in well selected patients.
References

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HOPKINS® Telescopes

Diameter 3.3 mm

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<td>HOPKINS® Straight Forward Telescope 0°, enlarged view, diameter 3.3 mm, length 25 cm, autoclavable, fiber optic light transmission incorporated, color code: green</td>
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<td>HOPKINS® Telescope 45°, enlarged view, diameter 5 mm, length 29 cm, autoclavable, fiber optic light transmission incorporated, color code: black</td>
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533TVA

Adaptor, autoclavable, permits telescope changing under sterile conditions
**Trocars**

Size 3.5 mm

with connector for insufflation
for use with instruments size 3 mm

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<th>Size:</th>
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<td>Color code:</td>
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| Trocar, with pyramidal tip including: | 30114GL | 30114GKX |
| Cannula, with LUER-Lock connector | 30114G2 | 30114G3 |
| Trocar only | 30114C | 30114KX |
| Silicone Leaflet Valve | 30114L1 | 30114L1 |

| Trocar, with blunt tip including: | 30114GAL |
| Cannula, with LUER-Lock connector | 30114G2 |
| Trocar only | 30114A |
| Silicone Leaflet Valve | 30114L1 |

| Trocar, with conical tip including: | 30114GZL | 30114GZX |
| Cannula, with LUER-Lock connector | 30114G2 | 30114G3 |
| Trocar only | 30114ZL | 30114ZX |
| Silicone Leaflet Valve | 30114L1 | 30114L1 |

It is recommended to check the suitability of the product for the intended procedure prior to use.
Trocars
Size 3.5 mm

with connector for insufflation
for use with instruments size 3 mm

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<td>Silicone Leaflet Valve</td>
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Standard Trocar
Size 6 mm

30160GP

Trocar, with pyramidal tip, with Luer-Lock connector for insufflation, size 6 mm, working length 10.5 cm, color code: black for use with instruments size 5 mm, including:

Cannula
Trocar only
Silicone Leaflet Valve
Dissecting and Grasping Forceps
CLICKLINE – rotating, dismantling, insulated, with connector pin for unipolar coagulation

Size 3 mm
Operating instruments, length 36 cm, for use with trocars size 3.5 mm

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Double Action Jaws

<table>
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<td><img src="image7" alt="Images of forceps" /> CLICKLINE KELLY Dissecting and Grasping Forceps, long</td>
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| 30310MDG | 30351MDG 30352MDG 30353MDG 30356MDG 30321MDG 30325MDG 30327MDG |
| ![Images of forceps](image8) CLICKLINE KELLY Dissecting and Grasping Forceps |

| 30310RG | 30351RG 30352RG 30353RG 30356RG 30321RG 30325RG 30327RG |
| ![Images of forceps](image9) CLICKLINE Dissecting and Grasping Forceps, jaws right angled |

| 30310KG | 30351KG 30352KG 30353KG 30356KG 30321KG 30325KG 30327KG |
| ![Images of forceps](image10) CLICKLINE Grasping Forceps, atraumatic, fenestrated |
Dissecting and Grasping Forceps
CLICKLINE – rotating, dismantling, without connector pin for unipolar coagulation

Size 3 mm
Operating instruments, length 36 cm, for use with trocars size 3.5 mm

<table>
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Double Action Jaws

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</tr>
<tr>
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Single Action Jaws

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CLICKLINE Grasping Forceps, with fine atraumatic serration, fenestrated
### RoBi® Bipolar Rotating Instruments

**Size 3.5 mm**

Operating instruments, **length 36 cm**, for use with trocars size 3.5 mm and 3.9 mm

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<td>RoBi® Grasping Forceps, Modell CLERMONT-FERRAND, with connector pin for bipolar coagulation, with fine atraumatic serration, fenestrated, double action jaws</td>
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<tr>
<td>38910MW</td>
<td>RoBi® Scissors Insert with Outer Sheath, METZENBAUM Scissors Insert with Outer Sheath, CLERMONT-FERRAND model, curved blades, double action jaws</td>
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Scissors
CLICKLINE – rotating, dismantling, with connector pin for unipolar coagulation

Size 3 mm

Operating instruments, length 36 cm, for use with trocars size 3.5 mm

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<th>Handle</th>
<th>Handle</th>
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Double Action Jaws

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<tr>
<td>30310MWG</td>
<td>30351MWG 30321MWG 30325MWG 30327MWG</td>
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</tbody>
</table>

CLICKLINE Scissors, serrated, curved, conical
Coagulating and Dissecting Electrodes
without suction channel, insulated sheath,
with connector pin for unipolar coagulation

Size 3 mm

Operating instruments, length 36 cm,
for use with trocars size 3.5 mm

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Special Features:
- The hook electrode is suitable for resection, isolating structures as well as dissection and coagulation.
- The distal tip is semicircular: The thick outer curvature enables safe dissection.
- The thin inner curvature enables a controlled coagulation.
- The striated handle facilitates gripping.

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<td><img src="image5.png" alt="Image" /></td>
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</table>
Needle Holders, Palpation Probe

Size 3 mm

Operating instruments, length 36 cm, for use with trocars size 3.5 mm

26167FN

26167FNL  KOH Ultramicro Needle Holder, jaws curved to left, with tungsten carbide inserts, straight handle, with disengageable ratchet, size 3 mm, length 36 cm

26167FKL  KOH Ultramicro Needle Holder, jaws slightly curved to right, with tungsten carbide inserts, straight handle, with disengageable ratchet, size 3 mm, length 36 cm

26167TL

26167TL  Palpation Probe, with cm-marking, size 3 mm, length 36 cm
**Suction and Irrigation Tube**

**Size 3 mm**

Operating instruments, **length 36 cm**, for use with trocars size 3.5 mm

26167LHL **Suction and Irrigation Tube**, size 3 mm, length 36 cm, for use with Two-Way Stopcock 26167 H or modular handles for irrigation and suction

26167H **Two-Way Stopcock**, for use with Suction and Irrigation Tubes 26167LH/LHS/LHL

**Accessories**

for use with Suction and Irrigation Tube 26167LHL

26167A **Adaptor**, for use with Handles 30805, 30810, 37112 A and 37113 A
IMAGE1 S Camera System

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

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

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

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

*FULL HD image*
- CLARA
- CHROMA
- SPECTRA A*
- 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**

**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

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<tr>
<td>Format signal outputs</td>
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<tr>
<td>LINK video inputs</td>
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For use with **IMAGE1 S**

**IMAGE1 S CONNECT** Module TC200EN

**TC300**

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

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

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<td>305 x 54 x 320 mm</td>
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<tr>
<td>Weight</td>
<td>1.86 kg</td>
</tr>
</tbody>
</table>

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

For use with IMAGE1 S Camera System

*IMAGE1 S CONNECT Module TC200EN, IMAGE1 S H3-LINK Module TC300*

*and with all IMAGE1 HUB™ HD Camera Control Units*

---

**TH100**  
**IMAGE1 S H3-Z Three-Chip FULL HD Camera Head,**  
50/60 Hz, IMAGE1 S compatible, progressive scan, soakable, gas- and plasma-sterilizable, with integrated Parfocal Zoom Lens, focal length f = 15–31 mm (2x), 2 freely programmable camera head buttons, for use with IMAGE1 S and IMAGE1 HUB™ HD/HD

**Specifications:**

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

---

**TH104**  
**IMAGE1 S H3-ZA Three-Chip FULL HD Camera Head,**  
50/60 Hz, IMAGE1 S compatible, autoclavable, progressive scan, soakable, gas- and plasma-sterilizable, with integrated Parfocal Zoom Lens, focal length f = 15–31 mm (2x), 2 freely programmable camera head buttons, for use with IMAGE1 S and IMAGE1 HUB™ HD/HD

**Specifications:**

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

9619NB  
19" HD Monitor,  
color systems PAL/NTSC, max. screen resolution 1280 x 1024, image format 4:3,  
power supply 100–240 VAC, 50/60 Hz,  
wall-mounted with VESA 100 adaption,  
including:
External 24 VDC Power Supply  
Mains Cord

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

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

<table>
<thead>
<tr>
<th></th>
<th>9619NB</th>
<th>9826NB</th>
</tr>
</thead>
<tbody>
<tr>
<td>DVI-D</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Fibre Optic</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>3G-SDI</td>
<td>–</td>
<td>●</td>
</tr>
<tr>
<td>RGBS (VGA)</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>S-Video</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Composite/FBAS</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

**Outputs:**

<table>
<thead>
<tr>
<th></th>
<th>9619NB</th>
<th>9826NB</th>
</tr>
</thead>
<tbody>
<tr>
<td>DVI-D</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>S-Video</td>
<td>●</td>
<td>–</td>
</tr>
<tr>
<td>Composite/FBAS</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>RGBS (VGA)</td>
<td>●</td>
<td>–</td>
</tr>
<tr>
<td>3G-SDI</td>
<td>–</td>
<td>●</td>
</tr>
</tbody>
</table>

**Signal Format Display:**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>4:3</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>5:4</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>16:9</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Picture-in-Picture</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>PAL/NTSC compatible</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

## Optional accessories:

- 9826SF **Pedestal**, for monitor 9826NB
- 9626SF **Pedestal**, for monitor 9619NB

### Specifications:

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

- **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

**Cold Light Fountain XENON NOVA® 175**

- 20131501 **Cold Light Fountain XENON NOVA® 175**, power supply: 100–125 VAC/220–240 VAC, 50/60 Hz including:
  - **Mains Cord**
- 20132026 **XENON Spare Lamp**, 175 watt, 15 volt
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.

**ENDOFLATOR® 40** with KARL STORZ SCB
with High Flow Insufflation (40 l/min.)

UI400S1 **ENDOFLATOR® 40 SCB**
including:
- **ENDOFLATOR® 40 with KARL STORZ SCB**
  power supply 100 – 240 VAC, 50/60 Hz
- Mains Cord
- 6x Single-use insufflation tubing set
  with gas filter, sterile*
- Universal Wrench
- SCB Connecting Cable, length 100 cm

**Please note:** For fully utilizing maximum insufflation capacity of the **ENDOFLATOR® 40** the use of KARL STORZ HiCap® Trocars is recommended. For additional information see catalog LAPAROSCOPY.
**Equipment Cart**

**Equipment Cart**
wide, high, rides on 4 antistatic dual wheels equipped with locking brakes 3 shelves, mains switch on top cover, central beam with integrated electrical subdistributors with 12 sockets, holder for power supplies, potential earth connectors and cable winding on the outside,

*Dimensions:*
- Equipment cart: 830 x 1474 x 730 mm (w x h x d),
- Shelf: 630 x 510 mm (w x d),
- Caster diameter: 150 mm

*Incluing:*
- **Base module equipment cart**, wide
- **Cover equipment**, equipment cart wide
- **Beam package equipment**, equipment cart high
- **3x Shelf**, wide
- **Drawer unit with lock**, wide
- **2x Equipment rail**, long
- **Camera holder**

**Monitor Swivel Arm,**
height and side adjustable, can be turned to the left or the right side, swivel range 180°, overhang 780 mm, overhang from centre 1170 mm, load capacity max. 15 kg, with monitor fixation VESA 5/100, for usage with equipment carts UGxxx
Recommended Accessories for Equipment Cart

**Isolation Transformer,**
200 V–240 V; 2000 VA with 3 special mains socket, expulsion fuses, 3 grounding plugs, dimensions: 330 x 90 x 495 mm (w x h x d),
for usage with equipment carts UGxxx

**Earth Leakage Monitor,**
200 V–240 V, for mounting at equipment cart, control panel dimensions: 44 x 80 x 29 mm (w x h x d),
for usage with isolation transformer UG310

**Monitor Holding Arm,**
height adjustable, inclinable, mountable on left or right, turning radius approx. 320°, overhang 530 mm, load capacity max. 15 kg, monitor fixation VESA 75/100,
for usage with equipment carts UGxxx
Notes: