CHAPTER

GENERAL INTRODUCTION
AND OUTLINE OF THIS THESIS

S. Velthuis
EVOLUTION OF MINIMALLY INVASIVE COLORECTAL SURGERY

Laparoscopic surgery was introduced in the 1990s in order to improve patient outcomes. As with all new procedures, surgeons started with relatively simple procedures like appendectomies and hysterectomies. Extensive research showed many benefits of laparoscopic surgery for the patient with respect to time to recovery, duration of hospital stay, perioperative pain and morbidity and cosmetic results. Consequently, the range of abdominal surgical procedures performed by laparoscopy has grown enormously. For certain procedures such as cholecystectomy, laparoscopy has already replaced open surgery as the standard of care.

1-5 The clear advantages of laparoscopic surgery generated an increased interest among surgical and gastroenterological communities to further reduce surgical trauma through 'scarless' surgery. These advances in minimally invasive surgery include the development of natural orifice translumenal endoscopic surgery, laparoendoscopic single-site surgery and the recent development of transanal minimally invasive surgery.

NATURAL ORIFICE TRANSLUMENAL ENDOSCOPIC SURGERY

Although the first colpotomy to perform a hysterectomy was already described in 1813, most research on NOTES took place in recent years since Kalloo et al. described diagnostic and therapeutic flexible transgastric peritoneoscopy in porcine models in 2004.7-9 In NOTES the surgeon accesses the peritoneal cavity through a hollow viscus, instead of the abdominal wall, to perform diagnostic and therapeutic procedures. Initially the transgastric route was evaluated, first in porcine models, later in human. More recently, other orifices such as the vagina, urethra and anus are used as an entrance to incise respectively the posterior vaginal wall, the bladder and the rectum or colon.10
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Advantages

NOTES avoids the need for abdominal incisions which may reduce postoperative pain, may facilitate a shorter hospital stay, may limit postoperative complications such as wound infections and incisional hernias, and improves cosmetic results. Therefore, NOTES could be the next major paradigm shift in surgery.\textsuperscript{10}

Challenges in clinical practice

Despite the potential advantages of NOTES, critics expressed concerns about its safety and implementation in clinical care. As a result, a working group consisting of expert laparoscopic surgeons from the SAGES (Society of American Gastrointestinal Endoscopic Surgeons) and members of the ASGE (American Society for Gastrointestinal Endoscopy) came together for a meeting in 2005. This meeting led to the development of the Natural Orifice Surgery Consortium for Assessment and Research (NOSCAR). With ‘The White Paper’ they published a document that would serve as a guide for the responsible development of NOTES and they identified ten potential barriers that will impact the safety of NOTES (table 1).\textsuperscript{11}

The amount of publications on NOTES has shown a significant growth since 2005. However, widespread implementation of NOTES has still not occurred due to the mentioned potential barriers.
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<tr>
<th>Table 1. Potential barriers to clinical practice^1</th>
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<tr>
<td>Access to peritoneal cavity</td>
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<td>Gastric (intestinal) closure</td>
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<td>Prevention of infection</td>
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<td>Development of suturing device</td>
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<td>Spatial orientation</td>
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<td>Development of a multitasking platform</td>
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<td>Control of intraperitoneal haemorrhage</td>
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<td>Compression syndromes</td>
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<td>Training other providers</td>
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<td>Physiologic untoward events</td>
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LAPAROENDOSCOPIC SINGLE-SITE SURGERY

During extensive research on NOTES new ideas emerged. The design of a single, multichannel port led to a sidetrack of NOTES: laparoendoscopic single-site surgery (LESS). LESS is known by many different names and refers to a laparoscopic access technique that uses a single incision, usually the umbilicus, but also a future ileo- or colostomy site or transanally in case of transanal minimally invasive surgery (TAMIS).

The indications for LESS are similar to those for multiport laparoscopic surgery. Frequently performed procedures are cholecystectomy^12, appendectomy^13, inguinal hernia repair^14, salpingectomy^15, tubal ligation^16, nephrectomy^17, and colon resection^18.

Compared to conventional laparoscopy, the laparoscopic single-site approach is considered more challenging due to several technical factors. These technical factors include loss of triangulation and loss of depth perception, reduced range of motion of the instruments, limited extracorporeal working space with ‘clashing’ of the instruments, and a suboptimal view as the result of difficult instrument and camera position.^19

Laparoendoscopic single-site techniques are still in development in many abdominal and pelvic surgery fields, sometimes in combination with other novel devices, like robotic surgery. In 2008,
the Laparoendoscopic Single-Site Surgery Consortium for Assessment and Research (LESSCAR) was formed to coordinate and advance the technique of LESS in a cohesive and safe manner.  

**TAMIS / taTME**

Transanal endoscopic microsurgery (TEM) was successfully introduced in 1983 by Buess et al. to resect rectal adenomas and selected early stage rectum carcinomas. This technique initially required a large rigid proctoscope and was regarded as relatively technically challenging and expensive. Atallah et al. demonstrated the possibility to use a single-port to gain endoscopic access for the resection of rectal tumours. The endoscopic access of the rectum by using a single-port and laparoscopic instruments is termed transanal minimally invasive surgery (TAMIS) and created new possibilities in the minimally invasive treatment of rectum carcinomas.

The introduction of the total mesorectal excision (TME) for rectum carcinomas by Heald in 1982 and its subsequent worldwide standardisation has led to significant improvements in oncological outcomes. The cornerstone of TME is dissection of the presacral plane, also known as the ‘holy plane’ and removal of an intact mesorectum. Especially in case of low rectal cancer (about 0-5 centimetres from anal verge) it is often challenging to achieve a complete mesorectal excision, regardless of the use of an open or laparoscopic technique.

To potentially improve oncological outcomes, transanal TME (taTME) or TAMIS TME has been developed, which is still practically a combination of single- or multiport laparoscopy and NOTES. In 2013, Heald stated that transanal TME would revolutionise the practice of rectal cancer surgery. In taTME, rectal cancer is approached from distal through the anus instead of proximal through the abdomen as in traditional TME. Small patient series have demonstrated feasibility of this technique and showed the ability to perform complete mesorectal excisions with adequate circumferential resection margins (CRM).
OUTLINE OF THIS THESIS

This thesis focuses on the advances in minimally invasive surgery and its implementation in clinical practice. It represents the growth in surgical techniques from a ‘simple’ cholecystectomy towards complex rectal cancer surgery.

In chapter 2 we evaluate our experience with single-incision laparoscopic (SILS) right colectomy for colon cancer in a two-centre study. In a prospective case-controlled study of 100 patients, SILS right colectomy is compared to the conventional multiport laparoscopic right colectomy. During this study, some of the surgeons experienced an increased physical burden with SILS when compared to multiport laparoscopy, mainly due to clashing of the instruments. This observation resulted in chapter 3, an ergonomic study in which the differences in physical workload between SILS and multiport laparoscopy was evaluated in surgeons and surgical residents.

From single-incision laparoscopy we progressed to our first hybrid-NOTES procedures. In The Netherlands, we were the first to perform a hybrid-transvaginal cholecystectomy on a regular basis. Chapter 4 shows the clinical and cosmetic outcomes after one year of performing transvaginal cholecystectomy. In chapter 5 we demonstrate the clinical and cosmetic results of a case-controlled study comparing single-incision, transvaginal and multiport laparoscopic techniques for cholecystectomy.

In chapter 6 we describe the use of a single-port platform for the endoscopic excision of rectum tumours as an initial step towards the development of transanal TME. Chapter 7 describes the surgical technique and the short-term and pathological results of the first five consecutive patients who underwent a transanal TME for rectal cancer. Chapter 8 is a descriptive article about taTME, which was published in a well-read Dutch medical journal to obtain more awareness about this new technique among Dutch physicians. To further investigate the oncological quality of taTME, a matched case-controlled study comparing the specimens after taTME and multiport TME was performed (chapter 9). In chapter 10 we focussed on the presence and clinical significance of peritoneal bacterial contamination after taTME. The transition to NOTES has been a slow process, partly because of concerns about bacterial translocation. In case of taTME this would be translocation from the rectum to the intraperitoneal space during the procedure. In chapter 11...
we demonstrate our short-term clinical and oncological results regarding the first 80 performed taTME procedures for rectum carcinomas.

To date, no randomised controlled trial has been designed to compare the clinical and oncological outcomes of taTME with multiport laparoscopic TME. **Chapter 12** comprises a description of the study protocol for a future multicentre randomised clinical trial comparing transanal TME and traditional laparoscopic TME for mid and low rectal cancer on behalf of the COLOR III study group.

The general discussion (**chapter 13**) summarizes the main results of this thesis and discusses future perspectives on personalised surgery.
REFERENCES


Basingstoke Bowel Cancer Research Project. 


