Transanal Minimally Invasive Surgery (TAMIS) and Transanal Total Mesorectal Excision (taTME)

Sam Atallah
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To all the minds filled with youthful curiosity for surgery and the life sciences, who endeavor to learn and to achieve and who have witnessed an entire body of knowledge materialize in the span of a decade – this is for you. It is for those who believe that the ingenuity of the human mind can capture imagination itself. It is for those who believe that the future of surgery is ours to shape.

Upon writing this, I finally understood the true meaning of the expression "labor of love." And it's with deep love that I dedicate this book to the people who made me who I am today. To the surgeons who have mentored me throughout my arduous years of training and, most of all, to my mother Areej, my father Bisher, my brother Asa, and my wife Michelle. To my four children, whom I love more than they can possibly imagine – Olivia, Andrew, Sidney, and Addyson.

Sam Atallah

Foreword

It is now been over 5 years since Sam Atallah first published on the subject of TAMIS TME surgery. I was invited to respond by the editor of *Techniques in Coloproctology* and wrote at the time: "I believe that 2013 will be the year of endoscopic transanal approaches to radical low rectal cancer dissection and anastomosis." I should have said 5 years, or perhaps 10! I had been following the NOTES initiatives in Strasbourg by Jacques Marescaux, Joel Leroy, and their colleagues and so was conscious of the unexploited potentials of the fundamental orifice!

About the same time, I was invited by Antonio Lacy to share in his endeavors to develop and spread the transanal TME operation in Europe. He used the medium of a dedicated TV channel, perhaps more effectively than anyone has done before – "Advances in Surgery" (AIS) – and thus reached surgeons in far-off places who could never have afforded direct access to the pioneers and teachers. Regular visits to South America and elsewhere have repeatedly confirmed the impact of this channel on surgical practice worldwide.

All clinicians involved will find that the documentation and technical detail in this book provide a valuable practical reference, volumes to digest all that threatens to change our surgical lives as we work in the depths of the pelvis.

Twenty years ago, the late Professor Takahashi and I co-convened the "First International Conference on the Lateral Ligament of the Rectum" in Tokyo. The very term "lateral ligament" summarizes the widespread ignorance of that time about the true anatomy of the lowest one third of the true pelvis. The ignorance of that century persists as the key surgical challenge of this one: how best to dissect the mesorectal envelope from the inferior hypogastric plexus and the neurovascular bundles – from above or from below? Add to that the challenge of the perineal body in abdominoperineal resection and you have two of the battlegrounds that will decide the defining importance of TAMIS.

I have followed throughout the intervening years the details of the posterior compartment of deep pelvic surgery both from above and from below: open, laparoscopically, and with the robots. Starting with the simplest comparison between "from above" and "TAMIS" – the stapling is intrinsically better with the latter – despite all improvements with angled instruments, etc., the placement of the transverse staplers from above by any form of minimally invasive surgery is often less than optimal both in angle and placement and sometimes removes more rectum than is necessary to clear the cancer.

Provided enough care is taken to avoid cell implantation, the actual anastomosis can be more precisely placed to optimize the retained anorectal segment in a TAMIS operation. It is on this segment and its nerve supply, and incidentally its freedom from radiation damage, that surgeons desperately seek functional improvement for their patients. This is particularly true for the lowest possible anastomoses where function may be threatened.

At the time of going to the press, it remains unproven as to which route best facilitates access to the nerves and muscles of "pelvic happiness" and how the oncological results from rectal cancer surgery can best be optimized. The "happiness" aspect is perhaps at the top of the priority list at this time, comorbidity and metastatic disease fast becoming the final frontiers. Having performed and then watched many thousands of TME operations by various approaches, I have become acutely conscious that each important step requires just the right amount of traction and countertraction, the correct wattage, and the gentlest of touches with the diathermy, what my friend Amjad Parvaiz calls "painting."

Above all, perfect vision from 4 K and more is the greatest single gift of technology to surgery this century and a key component of the potential of much in this book. But in order to exploit what she/he can now see, the surgeon must acquire a total understanding of the anatomy of the fascial layers of the human pelvis and retroperitoneum.

When it comes to the visualization and preservation of the autonomic nervous system within the pelvis, a skirmish continues between minimally invasive abdominal surgery, particularly when performed robotically, and TAMIS. The battle is not as fundamental as it might sound, since the great majority on the TAMIS side favor laparoscopic support from above. It is really an argument of whether the key dissection deep in the pelvis is best done from above or from below, which operating team is dominant, and whether or not it can all be done perfectly from above. Comparisons between approaches need to analyze the angles that best facilitate the pursuit of the correct planes.

Embryologically defined envelopes of tissue, with surgical and MRI definable margins and recognizably shiny surfaces, present the careful surgeon with particular opportunities for cure – reflecting the fundamental truth that the primary spread of carcinoma is often contained within these envelopes. These same margins provide the basis for modern image guidance from MRI scanning, not only in planning for surgery but in modern radiotherapy (RT) as well. Furthermore, respect for the surrounding layers and the understanding of their anatomy, in both surgery and radiotherapy, have a major potential – not only for more actual "cures" but also for the preservation of the important autonomic functions of the surrounding nerve plexuses. The areas that demand the greatest attention are those that we used, in our ignorance, to call the "lateral ligament" and in the lowest anterior plane in the male.

The importance of understanding those crucial two extra layers between the mesorectal and parietal fasciae – Denonvilliers' and Waldeyer's – is seminal to pelvic anatomy. When the transanal route is chosen, the great dangers of extending laterally outside Waldeyer's fascia cannot be overemphasized

and have indeed threatened the good name of the whole transanal enterprise. All is revealed herein!

The talent and creative imagination in these pages gathers together the experience and skill of most of those great pioneers who have established what is essentially a major new subspecialty – transanal minimally invasive surgery.

The Pelican Cancer Foundation has been administering and recording an international database which is carefully monitoring progress. How much of our work will in 10 years time be performed transanally? What follows will help you make some current decisions for yourselves. It is certain, however, that technology, instrumentation, and surgical virtuosity will continue to be as fascinating in the coming years as this book is right now.

Bill Heald
Pelican Centre, Basingstoke Hospital, UK

Preface

A decade of new knowledge has been neatly compressed into this first of its kind surgical textbook. Although a decade has eclipsed us seemingly with the blink of an eye, it is hard to recall a time before TAMIS and before taTME. Neither of these acronyms, which are this book's rubric, were spoken prior to 2009 – and yet today, they are household names to anyone in the field. It was exactly 2 years to the day, after completing my colorectal fellowship in Houston, that on June 30, 2009, I performed the first TAMIS in OR Rm. #2 at a small, unassuming community hospital. As a young impressionable surgeon fresh out of training, it left me totally entranced, and I realized at that very moment that life had been given to an altogether new kind of operation.

Of course, at that time, the operation lacked a name. I can still recall the afternoon that Sergio, Matt, and I sat down for Turkish cuisine in Winter Park, Florida, to establish one. In hand were a few sheets of blank paper and a pen as we brainstormed what to call this "thing" we had just invented. After scratching out what seemed like 100 potential names, we rationalized that, at its core, it was a minimally invasive surgical (MIS) technique, and this had to be its key identifier. We narrowed our selection down to "minimally invasive transanal surgery" (MITA) and "transanal minimally invasive surgery" (TA-MIS). Eventually, we decided on the latter, the hyphen was dropped, and the term TAMIS was officially coined.

Innovation is often a function of circumstance. The impetus for TAMIS was borne out of necessity. You see, my local hospital system could not afford the upfront capital requirement of a TEM platform. This forced consideration for alternative options and, with a little ingenuity, paved the way for the quite serendipitous creation of TAMIS. In this context, many commonly referred to TAMIS as a "poor man's TEM" during the early days after inception. For the first time, it allowed advanced transanal surgery to be performed by ordinary colorectal surgeons like myself, whose only prerequisite was an MIS skillset and access to an operating theater. With just six TAMIS cases under our belts, we were certain this was going to be the next big thing.

Sure, there was instant value in the technique for high-quality local excision of rectal neoplasia. But one could begin to envision TAMIS as a technique that could be applied more broadly – only to be honest, at the time, I really didn't have *any* clue how. It was not long afterward that the puzzle pieces would find their fit the day taTME materialized, and these two separate techniques would soon be melded into a singular one. As though on a

preordained collision course, the original article describing TAMIS was published in the same scientific journal and on the same week as the first human case of, what would later be termed, taTME – originally performed by Sylla, Lacy, and colleagues in Barcelona (both articles published online in *Surgical Endoscopy*, February, 2010). This would bring together not only two techniques but, far more importantly, a group of pioneers and innovators (the vast majority of which are authors herein) who would collectively shape TAMIS and taTME into what they are today. Indeed, the union of TAMIS and taTME marked the dawn of a new era in advanced transanal surgery and a quantum leap forward for our field.

The modern taTME is a harmonious amalgam of the most important developments in rectal cancer surgery to transpire over the past 40 years. Specifically, taTME is a unification of Heald's TME, Marks' TATA, Buess' 1984 TEM invention, and the concept of natural orifice specimen extraction (NOSE) as developed by Franklin. In addition, it built upon the evolution of natural orifice transluminal endoscopic surgery (NOTES) to include the creation of the single-port access channel, keyhole surgery, and, finally, the advent of TAMIS. As these techniques merged into one, we began to understand the newfound value of the taTME approach. Routed in methods for improved access to the most difficult portion of the rectum and deep pelvis, better-quality surgery was possible, not only for invasive rectal neoplasia but also for benign and premalignant disease spectra.

But, there was something intangible about TAMIS and taTME that extended beyond technical sophistication. The two approaches, in fact, had sparked our imagination and interest in exploring what could be accomplished through innovation. Rather than merely thinking outside of the box, we were, instead, kicking the box to the curb, thereby bringing a renaissance of new ideas and unorthodox surgical strategies for consideration. Hence, TAMIS and taTME had a truly transforming effect, and these approaches successfully granted mainstream appeal to advanced transanal surgery – which once had been an obscure niche mastered by only a relative handful.

It was this zest for exploring new pathways that had placed these techniques at center stage and had led to adjunctive advancements in rectal cancer surgery, including robotics for taTME, of which a multitude of next-generation platforms are actively being tooled for transanal applications. We have also witnessed the utility of biofluorescence for perfusion analysis and structure localization, as well as image-guided navigation for taTME, which collectively represents key steps toward the digitization of complex pelvic surgery and the integration of artificial intelligence into operative algorithms. Indeed, we now stand on the precipice of exponential growth in technology that will lead us to realize possibilities never before imagined.

The uptake of TAMIS and taTME has been so rapid that unique academic models had to be developed to meet the educational demand. It inspired the development of resource apps, modules, and synchronized deferred live surgery – all recently introduced to aid with the educational process for delegate trainees. These have been painstakingly designed as adjuncts to de novo training pedagogies and mentorship programs for taTME worldwide.

Moreover, transcontinental registries have been established to assure responsible and safe implementation.

This book captures the cornerstone developments in a new body of knowledge. Like fabric, it encompasses content woven together by leading TAMIS and taTME authorities from across the globe, thereby assuring a collective representation. It is through this circle of pioneers, who reside in the four corners – Asia, Europe, Australia, and the Americas – that this book is able to deliver enriching perspectives.

Soon, we will embark upon a new journey, with 2030 visible on the horizon. What new challenges and discoveries lie ahead? With finite and precious time on Earth, fulfillment comes from knowing our collective contributions will remain indefinitely – and may provide the foundation for what transpires next. I consider myself truly fortunate to be part of a group shaping the future of surgery. To be able to ride atop this epic wave of innovation has been the stuff of dreams.

Orlando, FL, USA Sam Atallah

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Part I

Transanal Minimally Invasive Surgery (TAMIS)

1 Historical Perspectives and Rationale for Development

Sergio W. Larach and Beatriz Martín-Pérez

Introduction

Rectal lesions, whether of benign or malignant histology, present a special challenge for surgeons because of the difficulty of access and exposure to the rectal lumen. Traditional transanal methods, such as Parks transanal excision (TAE), have been associated with a high incidence of local recurrence, thus unleashing the development of newer approaches. Heralding the era of the expansion of endoscopic surgery, transanal endoscopic microsurgery (TEM) represented a milestone in the approach to rectal lesion excision, as it achieved minimally invasive access to the upper rectum, a better quality of excision with improved likelihood of achieving negative resection margins. As a result, decreased recurrence rates and improved disease-free survival were observed, all due to improved access and the concomitant improvement of visual field and dissection quality. Despite these advantages, TEM use was limited, mainly due to a steep learning curve, complex surgical setup, and cost of instrumentation. It was with this pretext that transanal minimally invasive surgery (TAMIS) was born, combining TEM principles with conventional laparoscopic instrumentation, creating an important new option for appropriately trained minimally invasive colorectal surgeons.

From Miles Resection to Parks Excision

Surgical management of rectal lesions represents a challenge for the colorectal surgeon. Through the twentieth century, the approach to rectal cancer has largely evolved from invasive radical resections to organ-sparing techniques. Jacques Lisfranc de St. Martin (1790–1847) pioneered transanal rectal cancer excision, when in 1826 he described the removal of the anus and rectum through the perineum, resulting on a perineal colostomy [1]. In 1875, Kocher and Verneuil tried to improved rectal access and described the posterior approach including coccygectomy; this was subsequently refined by Paul Kraske (1851–1930) [2]. Abdominoperineal resection (APR) for rectal cancer was later described in 1908 by Dr. Ernest Miles, reducing local recurrence rates from 100% to 30% [3]. However, the morbidity associated with APR was high, ranging from 15% to 61% [4–7].

Surgeons continued to search for less-invasive options to manage rectal cancer, particularly within the distal one-third of the rectum. The objective would be to develop sphincter-preservation techniques that could spare patients

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from the high morbidity of APR while maintaining acceptable oncologic outcomes. In the case of premalignant lesions including carcinoma in situ, the benefits of local operations for tumor removal present a significant advantage, as such less-invasive surgery by this modality avoids the morbidity of radical surgery with virtually no oncologic compromise.

In the early twentieth century, screening and endoscopic techniques were less developed than at present, for which these group of patients with benign neoplasia or T1 cancers were subjected to a radical surgery, permanent colostomy, and a high rate of morbidity. Despite radical surgery, patients had a high rate of local recurrence even for early-stage rectal cancer [4, 6]. In this quest for better approaches, local excision for rectal lesions was born as an organ preservation surgery for suitable lesions.

The pathway for management of early-stage rectal cancer followed the treatment model of early-stage breast cancer – which was treated with either (a) breast-conservation surgery and radiotherapy or (b) radical mastectomy alone [8]. Local excision for premalignant and early-stage rectal cancer (predominately via Parks transanal excision, TAE) aimed to offer patient an improved quality of life, through stoma-free surgery and maintenance of normal bowel and urogenital function, while obtaining similar disease-free survival and cure rates to those observed with radical resection. This technique was performed with transanal retractors, which provide suboptimal exposure of the rectal lumen (Fig. 1.1). Electrocautery and conventional surgical instruments were used for the local excision of rectal neoplasms, and the full-thickness defects were closed with suture. Illumination of the rectal lumen and overall operative field exposure was limited by external field lights (headlights only modestly improve visualization, and are difficult to direct and maintain onto targets). Due to these constraints, only low-lying rectal lesions (i.e., palpable lesions, whose upper edge does not extend beyond <7 cm from the verge) were accessible by this approach, and complete, margin-negative excision of specimens could be quite challenging due to this limited exposure.

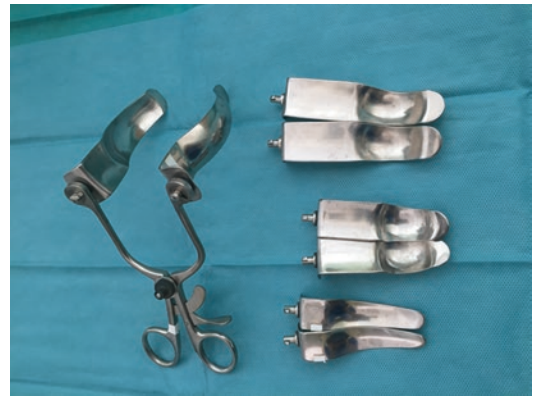

Fig. 1.1 Parks anal retractor

Despite these limitations, early series from the 1970s were able to demonstrate that local excision for early-stage rectal cancer with favorable histopathological features had equivalent oncologic outcomes when compared with radical resection. In a landmark study by Morson et al., the data for local excision revealed a failure rate (as defined by locoregional recurrence) that measured 8.4%, which was felt to be quite acceptable [9].

In the 1990s, the results of a prospective, multi-institutional study from the Cancer and Leukemia Group B (CalGB) reinforced the idea of local excision and organ preservation for select, early-stage rectal cancer [10]. Fifty-nine cases of T1 were treated with local excision alone and 51 cases of T2 undergoing adjuvant external beam radiotherapy after local excision (local excision was performed utilizing the conventional Parks TAE technique). The 6-year overall survival of 85% and disease-free survival rates of 78% for this treatment seemed promising, particularly when compared to the 20–30% failure rates after standard oncologic resection prior to the era of TME surgery [5, 6]. These encouraging early results were very well received by the surgical community, which resulted in an overall increased rate of local excision as a modality of treatment [11]. Unfortunately, subsequent series published inferior results even in the same selection of T1 patients, whereby the observed local recurrence rate increased from 8% to 18% for T1