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Transanal minimally invasive surgery using laparoscopic instruments of the rectum: a review

TAMIS using laparoscopic instruments

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Abstract

Transanal minimally invasive surgery (TAMIS) was first described in 2010 as an alternative to transanal endoscopic microsurgery (TEM). The TAMIS technique can be access to the proximal and mid-rectum for resection of benign and early-stage malignant rectal lesions and also used for noncurative intent surgery of more advanced lesions in patients who are not candidates for radical surgery. TAMIS has a shorter learning curve, reduced device setup time, flexibility in instrument use, and versatility in application than TEM. Also, TAMIS shows similar results in a view of the operation time, conversion rate, reoperation rate, and complication to TEM. For these reasons, TAMIS is an easily accessible, technically feasible, and cost-effective alternative to TEM. Overall, TAMIS has enabled the performance of high-quality local excision of rectal lesions by many colorectal surgeons. As TAMIS becomes more broadly utilized such as pelvic abscess drainage, rectal stenosis, and treatment of anastomotic dehiscence, the acquisition of appropriate training must be ensured, and the continued assessment and assurance of outcome must be maintained.

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Core Tip: Transanal minimally invasive surgery (TAMIS) was introduced in 2010 as a crossover between single-incision laparoscopic surgery and transanal endoscopic microsurgery (TEM). The TAMIS technique can be resected to the proximal and mid-rectal lesion for benign, early- stage cancer, and more advanced lesions in selective patients. TAMIS is an easily accessible, technically feasible, and cost-effective alternative to TEM. TAMIS has proven its usefulness in a wide range of applications

outside of local excision, including pelvic abscess drainage, rectal stenosis, and treatment of anastomotic dehiscence. TAMIS like TEM and TEO with platform difference can achieve the high quality excision superior to traditional TAE or endoscopic resection, despite the limitations of evidence for large volume or randomized controlled studies.

INTRODUCTION

Traditionally, proctectomy with total mesorectal excision (TME) has been a gold standard for curative treatment of rectal tumors[1,2]. However, its postoperative morbidity and mortality risks are high, with a negative impact on the patient's quality of life [3-6]. These significant complications have interested the use of sphincter preserving local excision in certain patients who have benign or early-stage rectal cancer with a low risk of lymphovascular metastasis [3,4]. Conventional transanal excision (TAE) uses open surgery instruments under direct vision. Because of limited visualization, TAE is performed when the tumor was located within 6 to 8 cm of the anal verge and was less than 4 cm in diameter. Additionally, it also shows poor oncologic outcomes and higher specimen fragmentation [7,8].

 To overcome these limitations, Dr. Gerhard Buess introduced transanal endoscopic microsurgery (TEM) in 1983 [9]. TEM is technically more advanced than TAE, with better visualization, more proximal approach, and less fragmentation. Due to these advantages, TME results in improved oncologic outcomes compared to conventional TAE in early rectal cancer [10,11]. Despite its feasibility and efficacy, TEM is not widely implemented Despite its feasibility and efficacy, TEM is not widely implemented for various reasons, such as the expensive instruments for specialized shape, its high learning curve, and risk of defective anorectal function [12,13].

Transanal minimally invasive surgery (TAMIS) is the new and innovative technique to perform excision of rectal lesions as a feasible alternative to TME, which is a novel hybrid between TEM and single port laparoscopy [13]. TAMIS was designed to be used before any single-access multichannel port, ordinary laparoscopic instruments

including cameras and standard CO2 insufflator systems. Since it was first described in 2010, TAMIS provides benefits of low cost with familiar instruments, minimal setup time, and total exposure of the rectal lumen without repositioning during the operation, while TEM requires higher or lower repositioning [13].

PREOPERATIVE STAGING

If there is a rectal lesion, a patient must undergo colonoscopy to exclude any synchronous lesions, and subsequently a rectal lesion biopsy. Physical examination including digital rectal exam and rigid proctoscopy should be performed by the surgeon to assess the size of tumor, mobility, location, circumferential involvement, and distance from the anal verge. If the biopsy returns a malignant lesion, further work up is necessary for accurate staging using endorectal ultrasound (EUS) or magnetic resonance imaging (MRI) of the rectum. Also, computed tomography (CT) scan of the chest, abdomen, and pelvis should be performed to exclude metastatic lesions.

PATIENT SELECTION

TAMIS has indications similar to compare with conventional TAE and TEM, for benign and early-stage malignant lesions [14,15]. For early-stage malignant masses, which are found to be confined to the submucosal layer on preoperative rectal MRI or EUS, TAMIS is generally an appropriate technique. If the patients with early-stage cancer on preoperative staging return poor histologic features (lymphatic/vascular/perineural invasion, poor differentiation, tumor budding) or deeper invasion (submucosal levels: sm^2 or sm^3) as defined by the Kikuchi classification which may mean potential metastasis to lymph nodes, they should be managed as having T2 (tumor staging: 2) lesions [15,16].

For patients with indetermined lesions (T1 *vs* T2) without evidence of lymph node metastasis, TAMIS can provide as definitive tumor staging, approving and managing further treatment of the finalized pathology. Such patients should be advised pre-operatively, that if the tumor becomes as a T1 lesion with good pathologic features,

curative surgery would be performed without any further intervention. If, however, it becomes as a T1 tumor with poor pathologic features or a T2 tumor, they may still require further radical surgery or intervention.

TAMIS is not generally an appropriate technique in patients with advanced lesions (T3). However, in select patients who are medically unfit to have a more radical surgery, TAMIS can be considered. Lee *et al* reported that 10 patients with pT3 cancer did not undergo radical surgery or chemoradiotherapy after TAMIS due to extensive comorbid diseases. The indications for TAMIS can be extended to include local excision of clinical T0 (cT0) lesions after neoadjuvant chemoradiotherapy, about locally advanced rectal cancer for confirming pathologic complete response (pCR: ypT0) [17-19]. This method can be considered a valid surgical option as the risk of occult node positivity for ypT0 Lesions is predictably low, at 3–6% [20-22].

Other indications for TAMIS were including anastomotic dehiscence, rectal stenosis, the patients required re-excision for R1 resection in previous excision, and inappropriate candidates for endoscopic lesion removal, because of the tumor size, localization, and morphology *etc.* Based on the National Comprehensive Cancer Network (NCCN) guidelines, localized transanal excision was performed in selected rectal lesions such as movable and nonfixed rectal tumors, small sized tumors less than 3 cm, tumors invading less than one-third of the circumference of the rectal wall.

SURGICAL PREPARATION

All patients should be prepared by following standard protocols for colorectal surgery, however, there are differences in the details of pre-surgical preparation according to the surgeon's preference. A commonly used perioperative antibiotic for prophylaxis is intravenous cephalosporin. Surgeons in some studies used cephalosporin and oral or intravenous metronidazole [23,24]. Deep vein thrombosis (DVT) is a major complication after colorectal cancer surgery, and hence, prophylaxis is important; the most commonly used anticoagulant was intravenous low-molecular weight heparin. However, in Asian races, especially in Koreans, intravenous DVT prophylaxis was not

recommended initially due to the low incidence rate of DVT; mechanical prophylaxis (graduated compression stocking or intermittent pneumatic compression) was generally performed [25]. Beta blockers were used to decrease bowel motility. However, as most of the patients were not priorly used to TAMIS, some surgeons used Buscopan (hyoscine butylbromide) which has an effect similar to beta blockers for reduce bowel movement [26]. Bowel preparation is essential, but it is up to the surgeon's preference to decide the type. The most commonly performed preparation was complete mechanical bowel preparation; however, distal bowel preparation by flexible sigmoidoscopy (oral laxative and two enemas) was also performed [27].

Lithotomy position was used generally in TAMIS, regardless of the location of the mass. This facilitated faster setting time in the operating room and was prefered by most anesthesiologists because of the better airway control and less risk of perioperative complications associated with it. Prone jack-knife or lateral decubitus position have also been described subject to the location of the lesion. The prone jack-knife position can be considered for anteriorly located lesions, although having to reposition the patient in this position is difficult for approach during peritoneal entry.

Endotracheal general anesthesia was performed in most TAMIS procedures. This is done to decrease bowel movement and so that the patients do not experience bowel discomfort due to gas insufflation during the procedure. In only one study, the surgeons performed spinal anesthesia for over 20 cases, and stated that it was adequate for the TAMIS procedure [28].

EQUIPMENT

The GelPOINT Path (Applied Medical, Rancho Santa Margarita, CA) and SILS Port (Covidien, Mansfield, MA) are medical devices used for transanal access in TAMIS and have been approved by the Food and Drug Administration (FDA). These devices are easy to place transanally and provide gas insufflation for pneumorectum through a designated channel. However, most surgeons were observed to be using the SILS port for TAMIS [12]. The SILS port has an advantage as its shape adapts easily to the

anatomical shape of the anal canal. It is also produced by a sponge-like substance that is flexible, soft and of a smaller diameter, so as to avoid anal sphincter injuries [26,29]. Pneumorectum was achieved using a CO_2 insufflator within a typical laparoscopic tower case. Initial gas pressure was set between 10 and 20 mmHg and could be increased if there was difficulty visualizing and maintaining abdominal distention.

A 30- or 45-degree angled 5 mm laparoscope, ideally with inline or right-angled optical cables, was found to provide better maneuverability and visualization during dissection than a 0-degree scope. Bariatric length laparoscopes and flexible tipped scopes could also be used to prevent instrument size conflicts [27,30]. Maryland graspers, or a similar instrument, may be used for retraction, and a hook-type monopolar electrocautery was adequate for dissection in general. This apparatus can be connected to a standard suction irrigator to facilitate the suctioning of fluid or smoke during the procedure. Advanced bipolar energy devices such as a harmonic scalpel can also be used. These are excess for submucosal dissection but may be suitable for a full- thickness resection. Recently, robotic technique has been spreading globally and is generally adopted in various operations; it is also being attempted for TAMIS. Robotic instruments, including scopes, have flexible and articular movement, which overcome the limitation of ordinary straight laparoscopic instruments. However, the cost of the former is higher than the latter [31,32].

The defect could be closed with simple laparoscopic suturing using standard needle holders, or advanced laparoscopic closure devices such as a laparoscopic linear stapler. These devices are more expensive but shorten the operating time, as a defect closure is one of the most time-consuming parts of the entire procedure. Laparoscopic suture clips can be used to decrease the closure time as well. However, the indication of each of these devices is limited, and the final decision of which laparoscopic closure device must be used is based on the surgeon's preference.

TAMIS TECHNIQUE

Resection of lesions should be performed while maintaining high-quality through an adequate resection margin and no fragmentation. Benign lesions can be resected in the submucosal plane with negative resection margins of at least 5 mm. In case of malignant lesions, a 1-cm margin should be marked around the entire mass prior to a full-thickness resection. It is of utmost importance that the device remains perpendicular to the tumor, so as to not compromise the deep margins.

 Rectal wall defect closure is one of the most time-consuming parts of the entire procedure. Submucosal resection (such as, for a benign lesion) can be open, while a full-thickness resection defect is generally closed. Resection of a posterior rectal defect can be left open in select cases [33]; however, this matter is still controversial. The closure is generally performed with absorbable interrupted sutures. Closure can also be performed in an interrupted suture with knot-tying facilitated by disposable-suture devices such as the Cor- Knot® System (LSI Solutions) or by laparoscopic knot pushers. Alternatively, in recent times, continuous V-Loc™ suture (Covidien) has also been used to maintain tension, negating the need for knot-tying. The defect is closed transversely to prevent narrowing of the lumen of the rectum. Laparoscopic linear stapler can also be used for large rectal wall defects; however, it is not possible to close the defect transversely with this device, and hence, it can cause rectal stenosis or stricture.

 In the middle or upper third of the rectum, lesions that are located anteriorly carry with them a higher risk of peritoneal entry, because of the lower peritoneal reflection on the anterior and lateral surfaces of the rectum. If peritoneal entry occurs, the patient should be placed on the steep Trendelenburg position to displace the abdominal contents from the pelvic cavity. Although most peritoneal entries can be closed through the TAMIS port, sometimes it can be difficult to maintain pneumorectum and sufficient visualization of the peritoneal defect. In this case, converting to a laparoscopic-assisted approach should not be delayed to help the defect[16]. Some authors recommended that the patients be placed in the prone position if peritoneal entry is likely, so that the abdominal pressure limits the amount of gas insufflation that can get into the peritoneal cavity [34].

In very distal lesions located at or just above the dentate line, a hybrid approach with traditional TAE and TAMIS instrument can make resection easy [35]. The distal margin should be incised using the conventional TAE platform by the standard transanal retractor, and then, the TAMIS port inserted to be used for the rest of the proximal dissection. This approach aoofrds better visualization of the proximal extent of the tumor and less fragmentation of the specimen. The closure of the distal defect is easier, as a single stitch can be placed on the proximal edge in the midline of the excision site and used to re-approximate the distal edge *via* a standard transanal approach [12,16].

OPERATIVE OUTCOMES

Although there is no large-scale randomized controlled study on TAMIS yet, 1241 TAMIS procedures performed in 41 retrospective studies and case series for more than 5 cases have been published between 2009 and 2020. Some studies were excluded because the cases were duplicated or cited in a learning curve study.

Studies to date have shown that TAMIS is safe and feasible not only for oncologic outcomes but also for postoperative results, demonstrating hospital stay, positive resection margins, low specimen fragmentation, high concordance rate between preoperative and postoperative diagnosis and low recurrence (Table 1).

Endoscopic mucosal resection (EMR) using snaring for rectal mass (1.5~2cm) is most cost-effective, safe, and feasible. However, the rate of en bloc and R0 resection of rectal masses (>2cm) that require piecemeal resection is lower than that of lesions (<2cm), and the recurrence rate increases by more than 20%[36–38]. Endoscopic submucosal resection (ESD) was introduced to overcome the limitations of EMR and has been widely applied with the development of injectable lifting solutions, adaptive electrosurgical generators, and edoscopic knives and scissors. Oka *et al.* showed that ESD lowers the local recurrence rate (ESD *vs* EMR = 1.4% *vs* 6.8%), allows larger tumor resection (ESD *vs* EMR = 39.6mm *vs* 26.7mm) and has higher en bloc resection rate (ESD *vs* EMR = 95% *vs* 53.2%) than EMR[39]. EMR, ESD has higher en bloc resection and curative resection rate and lower recurrence rate than EMR in some meta-analysis and systematic reviews[36–

38]. However, ESD is performed selectively according to the following indications by European Society of Gastrointestinal Endoscopic (ESGE) clinical guideline; colorectal lesions with high tendency for superficial submucosal invasion, and lesions cannot be radically removed by snare-based techniques such as standard polypectomy or EMR[40].

To date, there is no randomized controlled trial comparing TAMIS and ESD, but Arezzo *et al* reviewed TEM which is similar to TAMIS and ESD; for large noninvasive rectal lesions, R0 and en bloc resection rates, and recurrence rate were significantly better in TEM; 74.6%, 87.8%, and 5.2% in ESD, 88.5%, 98.7%, and 2.6% in TEM, respectively (p<0.001). They concluded that TEM was advantageous in terms of higher R0 resection and en bloc resection rates by full thickness resection, and reduced need for further interventions such as transanal resection and abdominal resection [41]. In patients who need radical surgery for residual or recurrent neoplasia after ESD, TAMIS could become an alternative to radical surgery. The reason why TAMIS can be used to accurately evaluate the depth of submucosal invasion because full-thickness resection including muscular layer is possible, and it can be performed in patients with submucosal fibrosis from previous endoscopic procedures that interferes with EMR or ESD. Clancy *et al* showed that TEM is superior oncologically with higher negative resection rate, lower specimen fragmentation rate, and recurrence than traditional transanal excision[11].

There were five retrospective studies comparing TEM or Transanal endoscopic operation (TEO) (*n* = 452) and TAMIS (*n* = 317), including TEO with a rigid proctoscopy platform similar to TEM. There was no significant difference in resection margin involvement, complication or recurrence rate in these studies. In a case matched cohort study by Lee *et al*, which has the largest sample size, TAMIS was shown to have advantages of less operative time, less blood loss, shorter length of hospital stay, and higher defect closure rate compared to TEM, and there was no difference in poor quality excision, intraperitoneal entry, and postoperative complications. TAMIS is, therefore, an oncologically safe and feasible technique with no difference in cumulative 5-year disease free survival [42].

Thirty-seven of 41 studies with TAMIS showed resection margin status, which were positive in 101 of 1173 patients (8.6%). Although some studies included advanced rectal cancer and palliative resection for symptom relief, R0 resection rate was 91.4%. Of the 78 patients with positive resection margin as a result of pathology in 22 studies, 29 of 359 (8.1%) patients had rectal cancer and 49 of 505 (9.7%) had a benign tumor, and there was no significant difference in positive resection margin rate.

Positive resection margins in benign tumors frequently occured in larger carpet adenomas. Sumrien *et al* showed that the average tumor size with positive resection margin was 57 mm (40–93 mm), and Caycedo-Marulanda *et al* explained that most of the large adenomas were fragmented specimens due to piecemeal resection, making it difficult to evaluate resection margins, and that positive resection margins occurred frequently[43,44]. Kang *et al* also reported that the positive margin in adenomas was larger than 7 cm. In the case of margin positivity in benign tumors, closed follow-up or treatment with re-TAMIS or colonoscopic resection was performed[45]. Of 29 patients with positive resection margin in malignant tumors, 26 patients were treated with radical resection (*n* = 15), radiotherapy (*n* = 4), closed surveillance (*n* = 4), re TAMIS (*n* = 1), palliative chemotherapy (*n* = 1), and chemoradiotherapy (*n* = 1), and three patients refused treatment.

The rate of specimen fragmentation was found to be 42/797 (5.3%) by analyzing 18 studies. Lee *et al* reported similar results in a matched cohort study comparing TAMIS and TEM with specimen fragmentation of 4% and 3%, respectively [42]. In another retrospective study of 200 TAMIS procedures, tumor fragmentation occurred in 5%, and there was no difference between benign and malignant lesions[24]. Conversely, Hahnloser *et al* showed that 6 (8%) patients with specimen fragmentation only had a benign lesion[33] .

Most of the studies (21/26, 80.8%) showed length of hospital stay to be within 3 days, and discharge was possible after surgery on the same day. The possibility of ambulatory surgery can be explained through studies showing the results of short hospital stay within 1 day.

Pathologic findings of 1235 patients were benign adenoma (n = 683, 55.3%), adenocarcinoma (n = 595, 48.2%), neuroendocrine tumor (NET) (n = 100, 8.1%), Gastrointestinal stromal tumor (GIST) (n = 5, 0.4%) and others such as cicatricial fibrosis, leiomyoma, granulation, hyperplastic polyp, and inflammatory polyp. TAMIS was also used to treat rectal stenosis, rectal sinus, and for anastomosis, in which granuloma was found in the biopsy results.

The concordance rate between preoperative and postoperative diagnosis was 81.6% (n = 528/647). In patients with diagnosis discordance, 71.4% (n = 85/119) were underestimated at initial workup and upstage such as from adenoma to malignancy or worsening T stage was observed. Caycedo-Marulanda et al showed that 12% of cases were overestimated and 16% cases were underestimated on initial workup; the overall rate of diagnostic discordance was 28%[44]. The rate of discordance may be high because the indication of TAMIS includes masses which are too large to be removed endoscopically, and due to accuracy rate of initial workup, and requiring re-resection due to positive margins after endoscopic mucosal resection. Forty-nine upstage patients were treated with radical LAR (n = 14), observation (n = 12), re-TAMIS (n = 2) radiotherapy (n = 2) TAE (n = 1), and abdominoperineal resection (APR) (n = 1), while four patients refused treatment.

Recurrence was described in 16 papers, and the rate was 54/746 (7.2%) (Table 2). After diagnosis of recurrence, 3 patients refused salvage by radical resection. Nine patients with recurrence were previously recommended to undergo radical surgery for rectal cancer with high-risk features after TAMIS, but the patients refused. The mean time to recurrence was 14.3 mo (2.1–40 mo). Treatments of recurrence included re-TAMIS, endoscopic snaring, colonoscopic resection, or closed surveillance in benign tumors and re-TAMIS, radical salvage resection, adjuvant radiotherapy, or chemotherapy in rectal cancer.

COMPLICATIONS

By analyzing 31 recent papers on TAMIS, we found that the rate of complication is 18.4% (n = 222/1205). The types of complications including postoperative complications, reoperation, re-admission, conversion, and penetration into peritoneal cavity are summarized in Table 3. The postoperative complication that mainly occur after TAMIS include bleeding, postoperative urinary retention, fever, and penetration into the peritoneal cavity. Most complications are resolved with conservative treatments such as antibiotics and blood transfusions, but surgical treatment is required in 9.9% of the cases.

Caycedo-Marulanda *et al* showed that peritoneal injuries can be closed with transanal sutures on the TAMIS platform, but anterior injuries are not easy to suture, and therefore laparoscopic sutures may often be required [44]. Lee *et al* reported that the lesions in patients with peritoneal entry mostly occurred more than 10 cm from the anal verge, especially in the anterior or lateral side of the rectum [24]. Mean tumor distance from anal verge in retrospective studies about TAMIS was found to be 7.18 cm (0–20 cm). Tumors far from the anal verge have a higher probability of peritoneal injury, and it is important to determine whether the tumor is located anteriorly, laterally or posteriorly by colonoscopy.

The conversion rate of TAMIS was 5.1% (n = 41/810), mainly due to intrarectal retractor expansion failures, a large prostate gland, failed anal dilatation, close distance to the tumor, and single port and peritoneal violation. At the time of conversion, TAMIS was replaced with other surgical methods such as TAE, TEO, TEM, low anterior resection, endoscopic debulking, laparoscopic suturing, a hybrid method combining TAMIS and laparoscopic repair, or a stoma.

Peritoneal entry occurred in 6.0% of patients, and most of them were treated with transanal repair or laparoscopic repair, but open laparotomy was sometimes performed when there was heavy intraperitoneal contamination or laparoscopic repair was difficult, as reported by Hahnloser *et al* [33]. Reoperation was performed due to bleeding, rectal perforation, residual cancer, pelvic abscess, and nonhealing wound. Khan *et al* reported closure of the rectal defect, which accounts for a major part of the operating

time. It has also been reported that defect closure reduces the risk of re-bleeding, but has no effect on postoperative infection and hospital stay [46]. However, in the case of peritoneal entry, complications and the possibility of reoperation may increase, and hence, it is better to perform defect closure.

FUNCTIONAL OUTCOMES AND QUALITY OF LIF

To avoid immediate postoperative complications, functional problems, and impaired quality of life (QoL) due to radical surgical resection, transanal excision including TEM, TEO, and TAMIS was introduced in highly selective patients including low risk T1 cancer, endoscopically unresectable benign neoplasms, or palliative resection.

Marinello *et al* systematically reviewed that the functional outcomes after TEM and TAMIS are assumed to have no effect on continence and QoL. Since this review was based on a heterogenous group without standardized functional tests and the same questionnaire, the possibility of functional deterioration after surgery may have been underestimated [47].

Clermonts *et al* conducted a case-matched study comparing the QoL of 37 patients who underwent TAMIS for rectal neoplasms with a healthy population through the Short-Form 36 Health Survey (SF-36) questionnaire and Fecal Incontinence Severity Index (FISI) questionnaire. This study showed that patients had an impaired QoL in the domains of physical functioning, general health perception and social functioning, and higher QoL in the mental health and bodily pain domain in comparison with the healthy reference group. At the three-year follow-up, 26 of 37 patients had fecal incontinence. Based on FISI score, 9 patients had improved, 19 patients had deteriorated, and 9 patients had remained same. There was no correlation between fecal incontinence severity and QoL [48].

On the contrary, Noura *et al* evaluated fecal incontinence using the Wexner score at 3-, 6-, 9-, and 12 mo following TAMIS. Fecal incontinence improved over time, and continence was recovered after 9 mo [49]. Goldenshluger *et al* demonstrated that TAMIS achieved good long-term outcome in the evaluation of bowel function using the low

anterior resection syndrome (LARS) score [50]. Approximately 73.9% of the patients had no definitive LARS after TAMIS. The use of the validated Cleveland Clinic Incontinence Score questionnaire (CCIS) to assess the fecal incontinence severity following TAMIS was studied by Karakayali *et al* They enrolled ten patients; the CCIS score increased three weeks after TAMIS, flatus incontinence, and defecation urge were seen in one patient, and symptoms resolved after six weeks. According to anorectal manometric parameters, the minimum rectal sensory volume significantly decreased 3 wk postoperatively, but the rectoanal inhibitory reflex and sphincter reflex contraction was well maintained [51]. Verseveld *et al* evaluated the functional outcome and QoL using the FISI, Fecal Incontinence Quality of Life (FIQL) and generic (EuroQol EQ-5D) questionnaires at the preoperative stage and six months after TAMIS; the mean FISI score decreased at postoperatively. Fifteen of 24 patients were completely continent, and five patients with deterioration in the FISI score had a mass closer to the dentate line, and a larger tumor. Coping behavior in the FIQL subscale and general QoL score improved six months after TAMIS[52].

Schiphorst *et al* also demonstrated that the FISI score decreased and continence improved after TAMIS, especially in patients with impairment of continence preoperatively. Postoperative soiling developed in three of 18 patients with normal continence, and two of them recovered after 6 mo. Out of 17 patients who had an increase in FISI score before surgery, 15 patients (88%) improved postoperatively. However, there were no independent factors associated with improvement or deterioration of FISI score after TAMIS in the univariate linear regression analysis [53].

In the study results of TEM, it was reported that the FISI score improved after surgery, similar to TAMIS. Fenech *et al* described the reasons for which patients with large villous adenomas had higher FISI scores: large villous adenomas can cause symptoms by producing mucus, and decrease anorectal function by inducing persistent internal anal sphincter reflex through the mass of the tumor itself. These patients have symptoms and tend to have a higher FISI score and continence in them may improve significantly after surgery [54]. In Schiphorst`s study, the average tumor area was 18.0

cm²; contrarily, in Lee`s study, including all patients with normal FISI, the average tumor area was 5.4 cm², and the average tumor area may have affected preoperative continence [53]. Lee *et al* reported that FISI score and EUS 3 mo after TAMIS did not show anal sphincter injury or fecal incontinence-related signs. They explained that TAMIS might decrease chances of sphincter injury in comparison with TEM because of the smaller diameter of the platform and flexible port material [28]. Although these studies have shown various results, TAMIS does not reveal serious impairment of continence and QoL through the FISI score, manometric score, EUS, and various questionnaires related QoL.

FOLLOW-UP

The most important factor for follow-up is the decision of the treatment direction after surgery based on the results of biopsy. Because full thickness excision is performed in most cases of TAMIS, the depth of invasion can be accurately determined. Surgery is recommended if a T1 Lesion has high-risk features including positive margins, lymphovascular invasion, poorly differentiated tumors, or sm³ invasion. Radical salvage resection or chemoradiotherapy is recommended in patients with pT2 or pT1 with high-risk features. The schedule of postoperative follow-up was found to be different in each study. However, it is recommended to determine the method of surveillance after TAMIS by referring to the National Comprehensive Cancer Network (NCCN) guidelines. Currently, more frequent colonoscopies are recommended in patients with colorectal cancer before age 50. Proctoscopy with EUS or MRI for detecting anastomotic or local recurrence is only recommended for patients undergoing transanal local excision.

In the reviewed studies, surveillance for transanal excision only included proctoscopy with EUS or MRI with contrast evaluation every three to six months for the first two years postoperatively, and then every six months for a total of five years. Standardized postoperative follow-up for rectal cancer consisting of a physical examination, including digital rectal examination, complete blood count, liver function test, serum

CEA analysis, and chest radiography, was performed every three to six months for the first two postoperative years, and then every six months for a total of five years. Positron emission tomography and CT (PET-CT) was not recommended.[9] Benign lesions underwent repeat endoscopic evaluation at six to twelve months and then additional follow-up as indicated.

Mean follow up period after TAMIS was 19.5 mo (2.1-60 mo) in 24 studies. In these studies, the minimum time to recurrence was 2.1 mo; therefore, proctoscopy or sigmoidoscopy at three months after surgery is recommended.

CONCLUSION

Despite limitations of lack of large scale randomized controlled trial or meta-analysis, TAMIS can achieve excision superior in quality to traditional TAE or endoscopic resection, based on the available literature retrospective studies. As measures of oncologic outcomes including recurrence, rate of positive resection margin and specimen fragmentation, TAMIS shows results similar to TEM in terms of operation time, conversion rate, reoperation rate, and complications. TAMIS uses existing laparoscopic instruments which are familiar to surgeons and does not require special instruments such as proctoscopy used in TEM. TAMIS is mostly performed for the resection of low risk early-stage rectal cancer, malignant polyps, lesions with inadequate or unknown margin, post-endoscopic excision or polypectomy and recurrent polyps following previous excision by any kind of surgery.[8] Currently, TAMIS can be implemented for additional indications such as pelvic abscess drainage, rectal stenosis, and treatment of anastomotic dehiscence. Transanal total mesorectal excision (taTME) is based on the concept of a "down-to-up" or "bottoms up" procedure through the TEM, TEO, and TAMIS with laparoscopic assistant. TAMIS is developing toward synergic effect in combination with other surgical procedure.

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8   Antonio Caycedo-Marulanda, Henry Y. Jiang, Erica L. Kohtakangas. "Transanal minimally invasive surgery for benign large rectal polyps and early malignant rectal cancers: experience and outcomes from the first Canadian centre to adopt the technique", Canadian Journal of Surgery, 2017
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