



Comparison of trans-anal endoscopic operation and trans-anal excision of rectal tumors



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HIGHLIGHTS

- TEO is treatment modality of choice in addressing lower rectal lesions.
- Evolving of TEO technique facilitate higher standard of academic teaching.
- TEO has few drawbacks; first, long term learning curve; second, technique is demanding (through single port + narrow space).
- TEO has promising results in the field of surgical oncology with equivalent results to conventional surgery.

ARTICLE INFO

Article history:

Received 7 September 2016
Received in revised form
24 December 2016
Accepted 25 December 2016

Keywords:

Rectal tumors
Trans-anal endoscopic operation
Trans-anal excision operation

ABSTRACT

Background: Trans-anal endoscopic operation (TEO) has developed to facilitate proper tumor location and ensure excision safely.

Methods: We reviewed 92 patients enrolled in our database between 2006 and 2014 who were diagnosed with early rectal tumors and who underwent conventional trans-anal excision (TAE) or TEO. Clinical data were collected prospectively to compare safety and feasibility between two techniques.

Results: Ninety-two patients underwent trans-anal local excision for lower rectal tumors. TEO and TAE were performed in 48 and 44 patients, respectively. Age, sex, and comorbidities were similar. There was no significant difference in tumor diameter (1.6 ± 1.68 cm vs. 1.17 ± 1.17 , respectively). Tumor height, however, was higher in the TEO (7.46 ± 3 cm) than the TAE group (3.84 ± 1.88 cm, $p < 0.001$). Four complications, perianal abscess, and two perforations, occurred in the TEO group, whereas no major complications occurred in the TAE. Seven patients (14.6%) underwent TEO underwent a salvage operation compared to only a single patient in TAE group (2.3%, $p = 0.039$). Eight patients (17.4%) diagnosed with adenocarcinoma developed recurrence, four in each group. Disease-free survival was similar between groups (TEO – 41.8 months, 95% RI 39.4–44.1; TAE 79.7 months, 95% RI 72.2–87.3). However, more TAE patients ($n = 7$, 15.9%) than TEO patients ($n = 2$, 4.2%) underwent chemotherapy.

Conclusions: TEO treatment of local rectal tumors is safe and feasible and can achieve an adequate resection margin. Local recurrence was similar in both groups. However, the numbers of salvage operations and minor complications were higher in the TEO group.

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1. Introduction

Total mesorectal excision (TME) is considered the standard procedure of care in rectal cancer; however, morbidity, sexual urinary dysfunction, and stoma complication rates are at high rate [1,2]. Radical resection is therefore indicated for tumors invading the submucosa layer. Trans-anal excision (TAE) is performed for early rectal cancer or accessible low rectal benign tumors to avoid unnecessary major surgery or postoperative

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sexual urinary dysfunction. Stitzenberg et al. [3] demonstrated that the rates of non-TME, local resection for stage I rectal cancer increased between 1998 and 2010: for T1 cancers, rates increased from 39.8% to 62%, and for T2 cancers, from 12.2 to 21.4% in 2007. You et al. [4] reported a rise in local excision rate and a near tripled risk of local recurrence following local therapy compared with radical surgery.

Methods to localize and visualize the lesion in the setting of an anal endoscopic operation (TEO) as well as trans-anal endoscopic microsurgery (TEM) have benefitted from recent technological advances. These modern techniques are well established and offer a stable operating platform with magnified stereoscopic view for precise full-thickness excision of the rectal wall as far as 15–20 cm from the anal verge [5]. However, TEO is inappropriate for deeper tumors; the TEO procedure was developed for local treatment of early rectal tumor. Lymphadenectomy is not achieved when there is a risk of lymph node metastasis. Mesenteric nodal positivity is approximately 10–13% in T1 cancers and 17–22% in T2 cancers [6,7]. Accurate preoperative tumor and nodal staging are therefore both necessary for correct procedure selection.

For T1 cancers, deep invasion into the submucosal layer is a predictor of nodal positivity [8]. Local excision is considered an inferior approach to radical resection because of higher local recurrence rates and lower overall survival [9,10]. T1 cancers that have not metastasized to mesorectal lymph nodes can be appropriately treated with local excision as long as adequate margins are obtained. Therefore, the most critical aspect in treating T1 rectal cancers with local excision is to identify low risk tumors with superfascial submucosa invasion. If one-third of the submucosa is invaded (SM1) or two-thirds of the submucosa is invaded (SM2), a low risk of lymph node metastases is assumed, and local excision can be performed if technically feasible [11].

National Comprehensive Cancer Network (NCCN) guidelines [12] suggest that well-to moderately-differentiated T1 cancers less than 3 cm in size that occupy less than 30% of the circumference and that show no evidence of lymphovascular invasion are suitable for local excision. However, with technological advances in the TEO procedure, indications for trans-anal excision have been modified to include larger and higher level tumors. In addition, TEO and TEM techniques result in fewer fragmented specimens and fewer positive margins than TAE [13]. Memorial Sloan-Kettering Cancer Center reported local recurrence rates of 13.2% for TAE versus 2.7% for TME [14]. In this study, we compared the recurrence and disease-free survival rate of patients with rectal tumors who underwent conventional TEO or the TAE procedure.

2. Methods

2.1. Patients

The study protocol was reviewed and approved by our hospital's Institutional Review Board. This study is a retrospective study. A prospectively maintained database was used to identify all patients who underwent TEO and TAE for rectal tumors from 2006 to December 2014. Surgery was performed at Severance Hospital, Yonsei University College of Medicine in Seoul, Republic of Korea. Ninety-two consecutive patients aged 18 years or older with rectal tumors (within 15 cm of the anal verge) provided consent for enrollment in the study. All rectal cancers were staged according to the guidelines of the American Joint Committee of Cancer. We excluded patients who were unfit for surgery, those with an ASA score of III–IV, a tumor deeper than T1 sm2, or those not willing to undergo minimally invasive surgery.

2.2. Inclusion criteria

The indications for transanal excision were T1 adenocarcinomas with a superficial depth estimated by endorectal ultrasound (ERU), adenomas, carcinoid tumors <2 cm, and other submucosal tumors, as well as re-excision of a positive resection margin after endoscopic resection. Palliative local excision of rectal adenocarcinoma after preoperative chemoradiotherapy advocated in older patients, those unfit for major surgery, and those who refused radical rectal resection. Transanal excision also performed in those patients showing good response after chemotherapy to the level of no residual tumor. Thus, transanal excision performed to rule out any residual disease. In addition, tumors between 3 and 15 cm from the anal verge were considered for local excision procedures. All tumors <75% of rectal wall circumference and at any position were indicated for TEO. Those Patients who had a higher tumor location >15 cm from anal verge, T2 lesion or presence of distant metastasis were excluded from our study. Whether TEO or TAE performed is all based on surgeon preference.

2.3. Tumor diagnosis and follow-up

All patients underwent preoperative evaluation including history taking, digital rectal examination, routine laboratory tests, chest radiography, endorectal ultrasound (ERU), and colonoscopy with biopsy. For suspected cancers that were biopsied, proper staging for systemic disease was requested. The level of serum carcinoembryonic antigen, chest X-ray, computed tomographic scan, and/or magnetic resonance imaging were performed if needed. The treatment strategy for all patients was discussed at a multidisciplinary team meeting. All patients underwent bowel preparation before surgery and received a single prophylactic dose of antibiotics 30 min before anesthesia induction or at skin incision. The five senior professors who were involved in this study had each performed in excess of 200 colorectal cancer resections. Postoperatively, patients were monitored for a few days and discharged as soon as they tolerate food orally and pass flatus without complications. Two weeks after discharge, patients visited the outpatient clinic for follow-up. Adjuvant chemotherapy (5-Fluorouracil and leucovorine) is prescribed if tumor has showing malignant feature in the final histopathology. Radical surgery is advocated if tumor depth infiltrating through the last third of submucosa. Chemo-radiotherapy regimen composite of radiation therapy at a dose of 45 Gy (25 × 1.8 Gy) along with daily dose of 1650 mg/m² capecitabine was administered orally, divided into two equal doses per day.

2.4. Statistical analysis

Data are summarized as frequencies and percentages for categorical variables. Medians and ranges are used for continuous variables. Chi-squared tests were used to compare proportions, and the independent *t*-test was performed for comparison of continuous variables. Univariate analysis of OS and DFS was carried out by the Kaplan-Meier method. Results were considered statistically significant if the *p* value was less than 0.05. Statistical Package for the Social Sciences for Windows (Version 20.0, Chicago, IL) was used for data analyses. Disease-free survival was defined as the time from surgery to any recurrence documented during follow-up. Postoperative complications were defined as any adverse events occurring within 30 days. Recurrence was identified if any mass or nodule was observed in imaging studies during follow-up. Conversion was defined as the need to convert from a minimally

invasive technique to exploratory laparotomy. Length of hospital stay was defined as the number of nights the patient spent from the day of surgery until discharge. All tumor infiltration through submucosa only are considered T1 lesion. Tumor level was defined as the distance from the inferior margin of the tumor to the anal verge.

2.5. Trans-anal endoscopic operation technique

All patients underwent transanal local excision by either the conventional method or by a modern and minimum invasive technique installed in the TEO system (Karl Storz Endoscopy, Tuttingen, Germany). The newer technique was performed as follows.

General anesthesia was inducted in all patients. The patient was positioned in the lithotomy position regardless of tumor location (anterior, posterior, or lateral). Digital rectal exam and rigid sigmoidoscopy were performed in the operating room to confirm tumor location. Local anesthetic was injected circumferentially at the submucosa to facilitate surgical dissection. A TEO system was installed and fixed at the side of the operating table. A rectoscope was inserted into the rectum at the tumor level with appropriate selection of rectoscope size (7.5 or 15 cm long, 4 cm in diameter). The working attachment used with the rectoscope had three channels: two for 5-mm-diameter instruments (30-degree angled camera and grasper) and one channel for instruments up to 12 mm (see Fig. 1). In addition, there were two CO₂ channels for insufflation, smoke evacuation, and irrigation. The operating field was visualized through a monitor connected to the system.

Distal and proximal margins were obtained by marking at least 0.5–1 cm circumferentially around the tumor. The dissection plane deepened into the muscle layer approaching the perirectal fat for full-thickness excision to achieve an adequate circumferential resection margin (CRM) (Fig. 2). The excised specimen was aligned well by a pin needle for a pathologist to recognize the exact tumor margin. Rectal wall defects were irrigated with normal saline and closed by interrupted absorbable sutures supported by a knot

pusher (Karl Storz Endoscopy) or continuous V-Loc sutures (Covidien). Procedure details are visualized in Fig. 2.

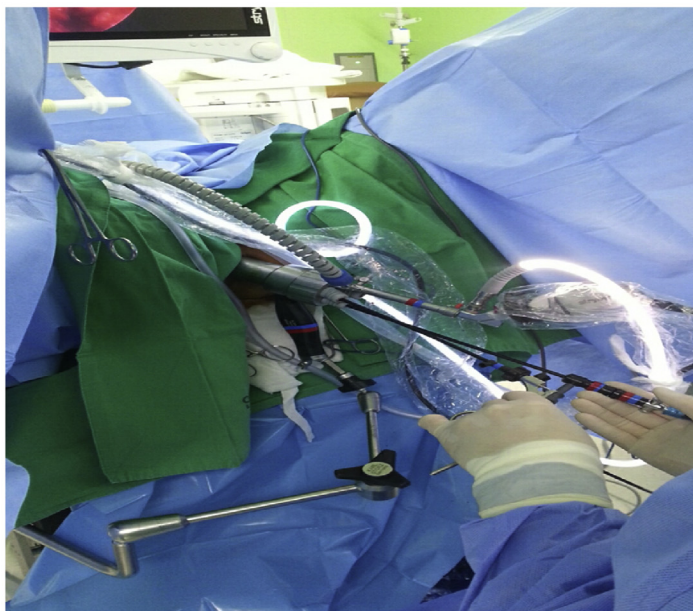
3. Results

3.1. Patients and tumor characteristics

From January 2006 to December 2014, 92 patients underwent trans-anal excision at our institute. Of these, 48 patients underwent TEO, whereas 44 patients underwent TAE. Median age of the TEO and TAE groups was 58 and 62 year, ($p = 0.39$), respectively. The majority of patients were male in both groups 32 (66.7%) in the TEO group and 23 (51.1%) in the TAE group ($p = 0.16$). Adenocarcinoma was the most common rectal tumor, with an incidence of 15 (31.2%) in the TEO group and 22 (50%) in the TAE group ($p = 0.239$). Adenoma, neuroendocrine tumor (NET), gastro-intestinal stromal tissue (GIST), and melanoma were the other tumor types. Trans-anal excision was performed because of a positive margin after endoscopic mucosal resection (EMR) in 16 (33.3%) subjects in the TEO group and five (11.4%), ($p = 0.673$) in the TAE group. In addition, patient also underwent surgery if they responded well to chemoradiotherapy and were down-staged to the level of no clinical evidence of cancer. In these patients, trans-anal excision was performed to rule out any residual cancer; this was carried out by TEO in two patients (4.2%) and TAE in seven patients (15.9%), ($p = 0.10$). Patient characteristics are detailed in Table 1.

3.2. Pathology outcomes

Mean tumor size was similar between the TEO and TAE groups at 1.6 ± 1.68 cm and 1.17 ± 1.17 cm, respectively ($p = 0.148$). Final histopathology diagnosed adenocarcinoma in 16 (33.3%) vs. 20 (45.5%) patients in the TEO versus TAE groups, ($p = 0.082$), while adenoma was reported in seven TEO patients (14.6%) vs. six TAE patients (13.6%), NET in 24 TEO patients (50%) vs. 13 TEO patients



Trans-anal scope channel with three entries, one for the camera and two for TEO instruments, to facilitate tumor dissection.

Fig. 1. TEO System Installed on the Side of the Operating Table. Trans-anal scope channel with three entries, one for the camera and two for TEO instruments, to facilitate tumor dissection.

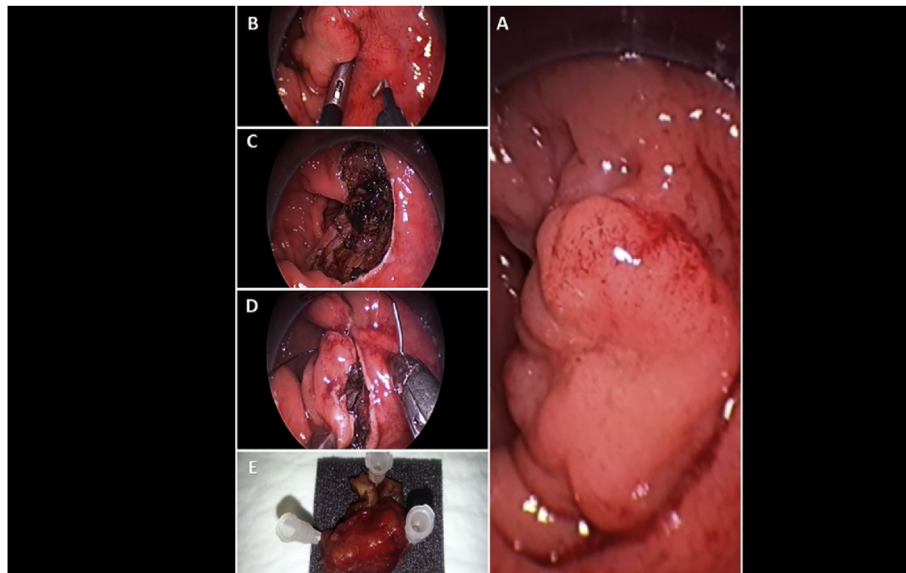


Fig. 2. TEO Procedure from Early Tumor Identification to Defect Closure. A: Polypoid mass in the lower rectum, B: Procedure starts with circumferential resection all around the tumor, C: Complete excision of the tumor, D: Closure of the defect, E: Alignment of the tumor on a brush ship using a needle pin to determine the resection margin.

Fig. 2. TEO Procedure from Early Tumor Identification to Defect Closure. A: Polypoid mass in the lower rectum, B: Procedure starts with circumferential resection all around the tumor, C: Complete excision of the tumor, D: Closure of the defect, E: Alignment of the tumor on a brush ship using a needle pin to determine the resection margin.

(32.5%), and GIST/melanoma in two TEO patients (4.2%) vs. three TAE patients (6.8%) ($p = 0.239$), respectively. For the adenocarcinomas, tumor depth (T stage) was T1 submucosa 1 (sm1) in 6 (37.5%) TAE vs. 7 (35%) TEO patients, sm2 in two TEO (12.5%) vs. three (15%) TAE patients, and T1SM3 in two (12.5%) TEO vs. three (15%) TAE patients. Tumor depth was T2 in three (18.8%) TEO patients vs. two (10%) TAE patients and T3 in one (6.2%) TEO vs. 0 (0%) TAE patients ($p = 0.082$). Interestingly, tumors located higher in the TEO group had a mean distance from the anal verge of 7.46 ± 3 cm compared to 3.84 ± 1.88 cm in the TAE group ($p < 0.001$). Positive tumor resection margin and the presence of lympho-vascular invasion were similar in the TEO and TAE groups 3 (6.4%) vs. 1 (2.3%), ($p = 0.339$) for positive tumor resection margin and 3 (6.2%) vs. 0 (0%), ($p = 0.320$) for the presence of lympho-vascular invasion, respectively. Histopathology results are presented in Table 2.

3.3. Complications and treatment differences

Surgical conversion occurred in two patients in the TEO group

Table 1
Patient characteristics.

Variable	TEO (n = 48)	TAE (n = 44)	P-value
Sex			
Male	32 (66.7%)	23 (51.1%)	
Female	16 (33.3%)	21 (47.7%)	
Age (median, range)	58 (30–85)	62 (28–85)	0.39
Preoperative diagnosis			0.239
Adenocarcinoma	15 (31.2%)	22 (50%)	
Adenoma	7 (14.6%)	6 (13.6%)	
NET	24 (50%)	13 (32.5%)	
GIST/Melanoma	2 (4.2%)	3 (6.8%)	
Surgery indications			0.015
Other	30 (62.5%)	32 (72.7%)	0.673
s/p EMR	16 (33.3%)	5 (11.4%)	
s/p CRTx	2 (4.2%)	7 (15.9%)	0.10

GIST: Gastrointestinal stroma tissue tumor, NET: neuroendocrine tumor, TEO: trans-anal endoscopic operation, TAE: trans-anal excision, other: adenocarcinoma, carcinoid, polyps, and benign tumors, S/P: status post.

(conversion from local transanal excision to exploratory laparotomy); however, there was no conversion in the TAE group [2 (4.2%) vs. 0 (0%), $p = 0.051$, respectively]. Complications in the TEO group include bleeding ($n = 1$, 2.1%), perianal abscess ($n = 1$, 2.1%), and perforation ($n = 3$, 4.2%). Bleeding was self-limited and did not require surgical intervention, Abscess treated by incision and drainage, whereas perforation managed by radical resection. No complications were reported for the TAE procedure ($p = 0.028$ comparing

Table 2
Comparison of pathological outcomes between TEO and TAE.

Parameters	TEO (n = 48)	TAE (n = 44)	P-value
Margin invasion			0.339
No	44 (93.6%)	43 (100%)	
Yes	3 (6.4%)	1 (2.3%)	
LVI			0.320
No	45 (93.8%)	43 (100%)	
Yes	3 (6.2%)	0 (0%)	
AV (mean, cm)	7.46 ± 3	3.84 ± 1.88	<0.001
Tumor size (mean, cm)	1.6 ± 1.68	1.17 ± 1.17	0.148
T status (cancer only)	N = 16	N = 20	
No residual cancer	2 (12.5%)	5 (25%)	0.769
T1Sm1	6 (37.5%)	7 (35%)	
T1Sm2	2 (12.5%)	3 (15%)	
T1Sm3	2 (12.5%)	3 (15%)	
T2	3 (18.8%)	2 (10%)	
T3	1 (6.2%)	0 (0%)	
Final pathology			0.082
No residual tumor	10 (20.8%)	1 (2.3%)	
Adenocarcinoma	16 (33.3%)	20 (45.5%)	
Adenoma	4 (8.3%)	7 (15.9%)	
NET	16 (33.3%)	13 (29.5%)	
Other (GIST/Melanoma)	2 (4.2%)	3 (6.8%)	

AV: anal verge, GIST: gastrointestinal stroma tissue tumor, NET: neuroendocrine tumor, TEO: trans-anal endoscopic operation, TAE: trans-anal excision, T1sm1: tumor depth at one-third of the submucosa, T1SM2: tumor depth at second third of the submucosa, T1SM3: tumor depth at the last third of the submucosa, other: adenocarcinoma, carcinoid, polyps, and benign tumors, S/P: status post, LVI: lympho-vascular invasion.

Bold values indicate that $p < 0.05$ is statistically significant.

Table 3
Complications and treatments for TEO and TAE.

Variable	TEO (n = 48)	TAE (n = 44)	P-value
Adjuvant therapy			0.037
No	47 (97.9%)	38 (86.4%)	
Yes	1 (2.1%) - CRTx	6 (13.6%) – 3 CTx, 3 CRTx	
Complication			0.028
Bleeding	1 (2.1%)	0 (0%)	
Perianal abscess	1 (2.1%)	0 (0%)	
Perforation	3 (4.2%)	0 (0%)	
Conversion			0.051
No	46 (95.8%)	44 (100%)	
Yes	2 (4.2%) – bowel perforation (size 6 cm, 3 cm)	0 (0%)	
Salvage operation			0.039
No	41 (85.4%)	42 (97.7%)	
Yes	7 (14.6%)	1 (2.3%)	

CTx: chemotherapy, CRTx: chemoradiotherapy, TEO: trans-anal endoscopic operation, TAE: trans-anal excision.

complication rate between TEO and TAE). Salvage operation was performed in seven (14.6%) TEO patients vs. one (2.3%).

TAE patient ($p = 0.039$). Furthermore, adjuvant chemoradiotherapy (CRT) was administered to one (2.1%) patient in the TEO group compared to six (13.6%) patients in the TAE group ($p = 0.037$). Among TAE patients, three patients received only adjuvant chemotherapy, while three patients underwent CRT, as shown in Table 3.

3.4. Recurrence rate and disease-free survival

Local recurrence was documented in a total of eight patients diagnosed with adenocarcinoma, four in each operation group, as shown in Table 4. Disease-free survival was similar in both groups: TEO – 41.8 months, 95% RI 39.4–44.1; TAE 79.7 months, 95% RI 72.2–87.3 as shown in Fig. 3.

4. Discussion

The TEO procedure was developed to overcome the limitations of conventional TAE. TEO is a minimally invasive technique that utilizes a 30° camera and laparoscopic instruments to expose the operation field, including tumor location and tumor margin, and can transmit the entire operation to a monitor for adequate visualization and for teaching purposes. The most critical consideration in rectal surgery is adequate resection margin, followed by good visualization of the operative field. If these goals are not achieved, remnant tumor could lead to a high local recurrence rate. Research has therefore focused on improving visualization. In the Norwegian Rectal Cancer study [15] that compared trans-anal excision and radical resection of stage I–III rectal cancer, rate of local recurrence

Table 4
Comparison of recurrence rates between the two techniques.

Variable	TEO (n = 48)	TAE (n = 44)	P = value
Recurrence rate			0.898
No	44 (91.7%)	40 (90.9%)	
Yes	4 (8.3%)	4 (9.1%)	
Recurrence among cancer	Total adenoca (16)	Total adenoca (20)	0.720
No	12 (75%)	16 (80%)	
Yes	4 (25%)	4 (20%)	

Adenoca: invasive adenocarcinoma, TEO: trans-anal endoscopic operation, TAE: trans-anal excision.

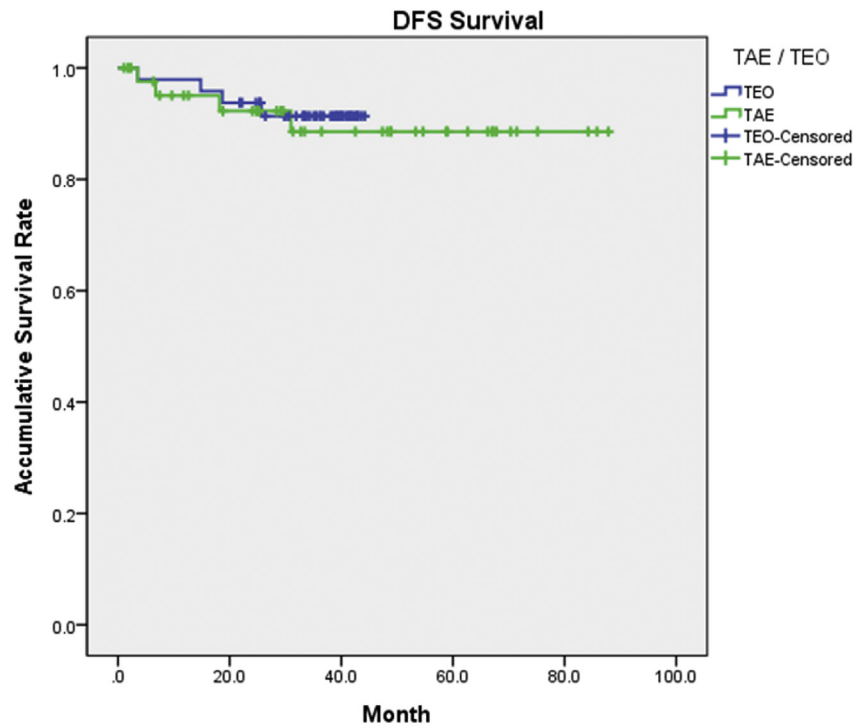
was greater in the TAE group than the radical surgery group at 12% vs. 6%, ($p = 0.01$). Mellgren et al. [6] compared recurrence rates of 153 patients with low rectal cancer who underwent TAE and radical resection; they reported a 9% overall recurrence for T1N0 tumors and a 16% rate for T2N0 tumors. The high rate of overall recurrence was due to the presence of malignancy in the regional lymph node that must be targeted in a curative surgery. Nevertheless, colorectal cancer submucosal invasion is associated with lymph node metastasis in 6%–12% of cases [16,17]. Therefore, revision of transanal excision techniques and indications is necessary to avoid dismal prognosis. Gangping et al. [18] analyzed 116 patients with rectal cancer who underwent transanal excision and concluded that TAE for rectal cancer is satisfactory for T1 stage tumors, but it is not suitable for T2 stage tumors due to the high local recurrence rate in T2 lesions (6% vs. 15%, respectively).

Milestone improvements of the technology used in the TEO setting have improved operative field exposure and the feasibility of completely excising rectal tumors in a safe manner. TEO has achieved success in the field of benign rectal tumors. Moreover, TEO has become an alternative to the TME procedure in early rectal cancer. Hur et al. [19] confirmed the safety of the TEO procedure in 46 patients with rectal tumors. The TAE procedure is also safe, with minimal trauma and no disturbance of urinary and sexual functions [20]; however, technical obstacles and unsuitability of this technique for higher tumor levels have contributed to the demand for a better alternative technique. In the NCCN guidelines, TAE is indicated for tumors with a diameter less than 3 cm and less than one-third of the rectum circumference. TEO procedure, however, we were able to operate at a higher level and could excise larger tumors in a well-visualized operative field in a comfortable setting. Conventional TAE is possible for rectal tumors <8 cm from the anal verge whereas TEO could approach rectal tumor as high as 7.46 ± 3.8 cm from the anal verge, which is close to the distance that can be obtained using the TEM technique [21,22].

Perforation is the most frequently intraoperative complication of TEO, ranging from 2 to 30% [23,24]. Only two of our TEO patients (4.2%) had perforation into the peritoneum. we claimed two reasons of these perforation events in our series; tumor size (6 and 3 cm) and tumor set anteriorly at high level high (10 cm from anal verge). Conversion to exploratory laparotomy was performed to treat perforation. In addition, Morino et al. [25] studied risk factors attributed in high rate of perforation into the peritoneum cavity with a risk of 3.2% if the tumor was located more than 6 cm from the anal verge or if it was located anterior and above the peritoneal reflection [19].

A second important factor to consider is post-operative bleeding. This issue has not addressed well in the literature. Few articles correlated risk of bleeding with tumor dimensions and the lateral position of the tumor in TEM [26,27]. In our study, no case of post-operative bleeding was observed after the TEO procedure.

Local recurrence has not been widely investigated in the context of the TEO technique, but it has been studied for TEM. Local recurrence rate for TEM was initially high due to inclusion of cases with tumors penetrating deep into the submucosa [range, 0–23%] [28,29]. However, with the limited indications for trans-anal excision, the rate of local recurrence was reduced to 3% [30]. TEO or TEM are alternative techniques for radical rectal surgery, particularly for low-risk rectal tumors. Selection criteria for this treatment include a mobile tumor, size <4 cm, favorable histology without lymphovascular invasion, and anatomic accessibility with the ability to achieve 1-cm circumferential margins. A prospective randomized clinical trial comparing TEM with TME in 70 patients who had received neoadjuvant treatment reported no significant differences in local recurrence rates or survival rates between the two techniques [31]. They reported Two local recurrences (5.7%)



DFS: disease-free survival, TEO: trans-anal endoscopic operation, TAE: trans-anal excision.

Fig. 3. Disease-Free Survival. DFS: disease-free survival, TEO: trans-anal endoscopic operation, TAE: trans-anal excision.

were observed after TEM and 1 (2.8%) after local resection that is equivalent to our results.

In our study, we posted re-excision after endoscopic mucosal resection (EMR) in 21 (44.7%). For rectal tumors, TEO can be used to evaluate muscle invasion, achieve full thickness excision for appropriate local staging, and obtain an adequate margin, which make it a better alternative than EMR (excision at the submucosa level only).

To our knowledge, this is the first comparative study of the TEO and TAE procedures. Patient data were recorded in an electronic system, minimizing the chances of incorrect or missing data. The study was conducted in a well-developed tertiary institute by highly trained surgeons. However, our patient sample was relatively small, as we have only performed the TEO procedure for the last 5 years and many patients prefer radical rectal surgery to local excision. Although this is a retrospective study, data were traced electronically, which allowed us to gather all relevant information. Lastly, preoperative staging and appropriate tumor depth measures are obligatory to determine the correct surgical plan and management. Commonly used staging measures are digital rectal examination, enteroscopy, and endorectal ultrasonography.

5. Conclusions

Given the substantial differences in treatment options and outcomes for early rectal cancer, the TEO procedure is safe and feasible for excision of low- and mid-rectal tumors in an appropriate patient population. The TEO technique is a viable alternative to radical resection and conventional trans-anal excision.

Ethical approval

Study has approved from research center belong to the

department of surgery without the need of formal agreement.

Sources of funding

- No third party supporting the current study.
- This study conducted by no any external resources.

Author contribution

Study concept and design: Mahdi H Al Bandar, MD, Syed Asim Razvi, MD, Min Soo Cho, MD, HyukHur, MD, ByungSoh Min, MD, Kang Young Lee.

Acquisition of data: Yoon Dae Han, Mahdi H Al Bandar, MD.

Analysis and interpretation: Mahdi H Al Bandar, MD.

Study supervision: Nam Kyu Kim.

Conflicts of interest

No conflict of interest.

Trial registry number

researchregistry1612.

Guarantor

The Guarantor: Mahdi Al Bandar and Nam Kyu Kim are responsible for this study form and analysis.

Acknowledgement

This work has accomplished by contribution of all authors without participating of other third party. This research received no

specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

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