Original Article

The Learning Curve of Two-team TaTME for Rectal Cancer: Single Center Experience

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Key Words
Transanal total mesorectal excision;
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Purpose. The transanal total mesorectal excision (TaTME) technique provides excellent visualization of the lower pelvis and dissection of the mesorectal fascia plane. To date, few observational studies have analyzed the TaTME learning curve, and published studies have either examined single-team or mixed two-team operations. Hence, we report on the learning curve and advantages of two-team TaTME at our institute.
Methods. Data were retrospectively collected from an institutional database. We collected data on preoperative, perioperative, and postoperative parameters. A learning curve analysis was performed by applying the cumulative sum method to estimate cutoff values. We compared a preproficiency group and a postproficiency group.
Results. We analyzed 36 patients, 21 (58%) male, and their median age was 61 years. Of these patients, 3 (8.3%), 3 (8.3%), 29 (80.6%), and 1 (2.8%) had stage I-IV rectal cancer, respectively. The mean operation time was 199 min, and a decrease in operation time occurred after the 10th case. No intraoperative adverse events or conversion occurred. The 2 groups were not significantly different in any parameters, including their 30-day postoperative complications and readmission. The rates of major postoperative complications were similar, and their anastomotic leakage and stenosis rates did not differ significantly.
Conclusions. Two-team TaTME is a complex technique for which at least 10 cases are required to achieve proficiency, defined as high-quality total mesorectal excision in which the operative duration is reasonably short.

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The transanal total mesorectal excision (TaTME) technique, which was proposed in 2009 by Funahashi et al., provides excellent visualization of the lower pelvis and the dissection of the mesorectal fascia plane.[1] This surgical method is preferred for patients with obesity or a narrow pelvis. Relative to the conventional method, TaTME produced more favorable short-term outcomes but made no difference to oncological outcomes. Because of the surgical challenges of TaTME, the incidence of incorrect plane dissection in patients was reported to be 7.8%, and the reported incidence of intraoperative technical problems during operations was 39.3%.[2]

High proficiency in TaTME resulted in fewer postoperative complications and less intraoperation conversion to laparoscopic total mesorectal excision (TME).[3] Because patient-related outcomes are directly correlated with an operating surgeon's experience, the training and monitoring of TaTME skills should be emphasized to reduce the risk of postoperative com-

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plications during the period in which a surgeon's TaTME skills are improving. To date, few observational studies have analyzed the TaTME learning curve, and the published studies have either examined one-team or mixture of one-team and two-team operation.[4-6]

Herein, we report on the learning curve and the advantages of two-team TaTME at our institute.

Materials and Methods

Data source

A retrospective cohort study of two-team TaTME operation conducted at the medical center Changhua Christian Hospital was performed.

Patient selection

Thirty-six patients underwent elective TaTME for rectal cancer between May 2018 and April 2022 at the hospital. All these patients' data were included and retrospectively analyzed. These patients all underwent TaTME because of neoplasm.

Data collection

Data were retrospectively collected from an institutional database. The collected data comprised sex, age, body mass index, history of abdominal surgery, Charlson comorbidity index (CCI), American Society of Anesthesiology (ASA) score, preoperative tumor stage, preoperative neoadjuvant treatment, preoperative hemoglobin concentration, preoperative albumin concentration, interspinous distance (measured through magnetic resonance imaging (MRI) or computed tomography (CT)), distance of the tumor from the anal verge (measured through colonoscopy), operative time, blood loss, conversion, tumor maximum dimension, p/yp stage, distance from the distal margin in pathological staging, circumferential resection margin (CRM) status, evaluated lymph nodes, postoperative hospital stay, 30-day postoperative complications, 30-day postoperative morbidities, reoperation, presence of anastomotic leakage according to the definition provided by the International Study Group of Rectal Cancer,[7] presence of anastomotic stenosis, and readmission. The stage of each tumor was determined per the 8th edition of the AJCC-TNM (American Joint Committee on Cancer-tumor, lymph node, metastasis) classification. Thirty-day postoperative complications were classified per the Clavien-Dindo classification system; a major postoperative complication was defined as a grade 3-5 complication. Postoperative leakage was defined per the definition established by the International Study Group of Rectal Cancer. A positive CRM was defined as CRM < 1 mm.

Perioperative preparation

Before surgery, all patients underwent colonoscopy and bowel preparation. Through a positioning device system, the patients were positioned in a lithotomy position and received general anesthesia. Prophylactic antibiotic was administered 30 min before skin incision. A Foley catheter was inserted to monitor fluid input and output.

Surgical technique

The surgeons examined in the present study had extensive experience in colorectal surgery (both minimally invasive and open surgeries). All transanal procedures were performed by two colorectal surgeons (Y-Y C and K-C W), and transabdominal procedure was performed by a colorectal surgeon. Ileostomy was performed for most patients.

The laparoscopic procedure was performed by following the standard steps for a laparoscopic anterior resection as follows: a vascular approach to the inferior mesenteric artery, medial to lateral mesocolic mobilization, and release of the splenic flexure and upper mesorectal dissection to the peritoneal reflection. The transanal component of the procedure was conducted simultaneously. A Lonestar® retractor was placed to efface the anal canal, and a GelPOINT® Path Transanal Access Platform was applied. A closed purse string was created with 2-0 prolene below the tumor level, and the purse string was secured airtight. The rectal wall was incised circumferentially with a mono-

polar cautery, and a full-thickness division of the rectal wall was performed. The mesorectal plane was then dissected from the bottom-up until a rendezvous occurred. Particular attention was paid to preserving the integrity of the surrounding structures. Each specimen was extracted transabdominally. Reconstruction was achieved with a transanal-circular-stapler coloanal anastomosis and a diverting loop ileostomy.

Statistical analysis

For patient characteristics, data were collected on age, sex, body mass index, history of laparotomy, CCI, clinical tumor node metastasis stage (0-4), neoadjuvant treatment (yes or no), ASA score, preoperative neoadjuvant treatment, preoperative hemoglobin concentration, preoperative albumin concentration, interspinous distance, and distance of a tumor from the anal verge. The outcome measures were distance of tumor from the anal verge (as measured through colonoscopy), operative time, operative blood loss, TaTME conversion to open, maximum dimensions of tumor, tumor staging (p/yp stage (1-4)), tumor resection margin (distance from the distal margin during pathological staging), CRM status, number of lymph nodes (as determined through an evaluation), postoperative hospital stay, 30-day postoperative complications, Clavien-Dindo classification grade (1-5), need for reoperation, presence and severity of anastomotic leakage, presence of anastomotic stenosis, and readmission. Statistical analyses were performed using SPSS software (version 25). Continuous data are expressed as the mean ± standard deviation or median (interquartile range (IQR)), and categorical proportions are expressed as number (percentage).

A learning curve analysis was performed by applying the cumulative sum method to estimate the cutoff values for the number of procedures required for ability to stabilize. We divided the included patients into a pre-proficiency group and a post-proficiency group to determine their differences.

Result

Patients

The present study examined 36 patients who underwent TaTME, which was performed together by two experienced colorectal surgeons. The characteristics of the patients are presented in Table 1. Of the patients, 21 (58%) were male, the median age was 61 years, and 19.4% had prior abdominal surgery, which in most cases was related to gynecological operations.

Table 1. Baseline demography and clinical characteristics

	Overall (N = 36)	Pre-proficiency (N = 10)	Post-proficiency (N=26)	*p*-value
Age	61 ± 12	70 ± 9	58 ± 11	< 0.01
Male gender	21 (58%)	5 (50%)	16 (61.5%)	0.53
Body mass index (kg/m^2)	23.8 ± 4.2	22.4 ± 3.9	24.3 ± 4.2	0.30*
Abdominal surgery history	7 (19.4%)	2 (20%)	5 (19.2%)	0.96
Charlson comorbidity index, median (IQR)	5 (3-5)	5 (5-6)	4 (3-5)	0.11
Preoperative Hb (g/dl)	12.8 ± 1.9	13.2 ± 1.9	12.6 ± 1.9	0.43*
Preoperative albumin (g/dl)	4 ± 0.5	3.5 ± 0.6	4.2 ± 0.4	< 0.01*
Interspinous distance (mm)	94.9 ± 12.3	93.6 ± 15.7	96.4 ± 10.7	0.57*
ASA, median (IQR)	2(2-3)	2.5 (2-3)	2(2-3)	0.82
Clinical stage				
1	3 (8.3%)	2 (20%)	1 (3.8%)	0.36
2	3 (8.3%)	0 (0%)	3 (11.5%)	
3	29 (80.6%)	7 (70%)	22 (84.6%)	
4	1 (2.8%)	1 (10%)	0 (0)	
Neoadjuvant therapy	24 (66.8%)	4 (40%)	20 (76.9%)	0.04

Abbreviation: Hb, hemoglobin.
Data are presented as number (%), mean ± standard deviation, or median (range).
* Mann-Whitney U test.

Twenty-four (66.8%) patients required neoadjuvant treatment. In accordance with the AJCC classification standards, 3 (8.3%), 3 (8.3%), 29 (80.6%), and 1 (2.8%) patients had stage I-IV rectal cancer, respectively.

Analysis of cumulative sum (CUSUM) charts

The mean operation time was 199 min. A significant decrease in operation time occurred after the 10th case (Fig. 1). Thus, we inferred that at least 10 surgical cases were required to stabilize the learning curve, and we divided our patients into two groups, namely the pre-proficiency group (first 10 patients) and post-proficiency group (remaining 28 patients).

Subgroup analysis

The median overall operative time was 199 min. No intraoperative adverse events or surgical method conversion occurred. The intraoperative blood loss of the two groups was comparable ($p = 0.93$). Postoperative complications occurred in 22.2% of the patients (Table 2), and the two groups did not exhibit a signi-

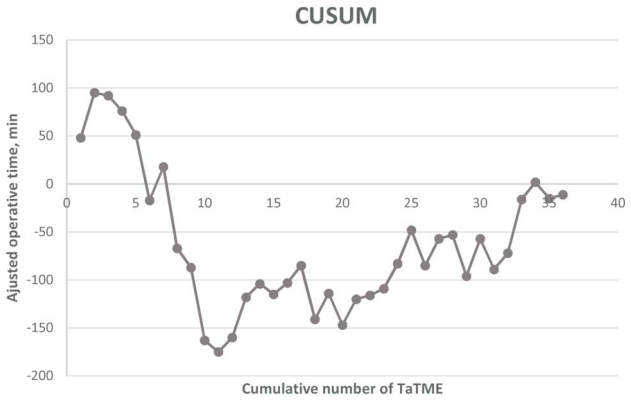

Fig. 1. CUSUM curves associated with for operative time.

Table 2. Perioperative and postoperative outcomes

	Overall (N = 36)	Pre-proficiency (N = 10)	Post-proficiency (N = 26)	*p*-value
Mean operative time (mins)	199 ± 36	215 ± 49	193 ± 28	0.24*
Median EBL, mL, median (IQR)	100 (30-137)	75 (45-112)	100 (30-150)	0.93*
Evaluated lymph node	20 ± 11	14 ± 7	22 ± 12	0.16*
Tumor max size (cm)	3 ± 3.1	3.2 ± 2.0	3.0 ± 3.4	0.36*
Distal margin (cm)	1.7 ± 1.4	1.5 ± 1.0	1.9 ± 1.5	0.69*
CRM involvement	1 (2.8%)	1 (10%)	0(0)	0.28
p/yp stage				
Complete response/stage 0	6 (16.7%)	0 (0)	6 (23.1%)	0.25
1	6 (16.7%)	2 (20%)	4 (15.7%)	
2	8 (22.2%)	0 (0)	8 (26.9%)	
3	14 (38.9%)	6 (60%)	8 (30.8%)	
4	2 (5.6%)	1 (10%)	1 (3.8%)	
Median total LOS, median (IQR)	6 (6-7)	6 (6-8.5)	6 (6-7.3)	0.88*
30-day readmissions	4 (11.1%)	1 (10%)	3 (11.5%)	0.89
Major complication	3 (8.3%)	1 (10%)	2 (7.7%)	0.82
30-day postoperative complications	8 (22.2%)	3 (30%)	5 (19.2%)	0.49
Clavien-Dindo grade				
0	28 (77.7%)	7 (70%)	21 (80.8%)	0.68
1	1 (2.8%)	0 (0)	1 (3.8%)	
2	4 (11.1%)	2 (20%)	2 (7.7%)	
3	3 (8.3%)	1 (10%)	2 (7.7%)	
4	0 (0%)	0 (0)	0(0)	
Anastomotic leakage	2 (5.6%)	1 (10%)	1 (3.8%)	0.47
Anastomotic stenosis	1 (2.8%)	0 (0)	1 (3.7%)	0.53

Abbreviation: EBL, estimated blood loss.

Data are presented as number (%), mean ± standard deviation, or median (range).

* Mann-Whitney U test.

ficant difference in this regard ($p = 0.49$). The two groups' 30-day readmission rates did not differ significantly ($p = 0.89$). The median overall hospital length of stay was 6 days, and the length of stay of the two groups was comparable ($p = 0.88$).

The two groups' outcomes were similar with respect to their 30-day postoperative complications, readmission, and major postoperative complications. Furthermore, the two groups did not differ significantly with respect to the presence of anastomotic leakage or stenosis or their reoperation rate.

The pathological outcomes of the patients were stable. One patient in the pre-proficiency group had positive CRM. The number of lymph nodes evaluated was more than 12; the post-proficiency group had more evaluated lymph nodes than the pre-proficiency group, but the difference was nonsignificant. The mean maximum tumor size was 3 cm.

Discussion

TaTME was proposed to improve the dissection of middle and lower rectal cancers. However, this technique's oncological safety and technical difficulty are debated by some proctologists. Two-team TaTME may reduce the difficulty and ease of learning the technique. Though there are some literatures about learning curve of two-team operation, they still included one-team till technique evolved.[8] To the best of our knowledge, the present study is the first to evaluate the learning curve for two-team TaTME. We observed a significant decrease in operative time after the first 10 cases. Relative to the one-team model, the two-team model reduces the operative time and conversion rate of TaTME. The median operative time for the one-team model in a previous study was 210 min, whereas in the present study, the two-team model yielded a mean operative time of 193 min.[9] Nguyen et al. compared the TaTME outcomes achieved through the one-team and two-team models. For the two-team model, the TaTME operation time taken was 180 min.[10] In a systemic review conducted by Deijen, the weighted mean operative time was 264.5 (range, 204-360) min and 209.8 (range, 166-369) min for the one-team and two-team models, respectively.[11] The results of our post-proficiency group analysis are comparable to those of other studies. Analyses of the pre-proficiency and post-proficiency groups did not reveal any significant differences. This may have been due to our small case numbers; nevertheless, a shorter operative time was achieved through the two-team model. A study revealed 40-50 cases as the turning point for the one-team model, and close supervision is reportedly required.[8] The two-team model has two advantages, namely the ability of a surgeon to discuss and confirm matters with their partner and the ability to perform countertraction intraoperatively to ease dissection. Furthermore, the two-team TaTME and one-team TaTME models were discovered to result in similar pathological characteristics.[10]

In regard to safety and feasibility, findings suggest that relative to low-volume centers, high-volume centers that perform more than 30 cases have fewer cases of CRM involvement, surgical conversions, and major complications while also having shorter operative times and lower rates of local recurrence.[11] Although we examined only a small number of cases, our results are comparable to those of high-volume centers.

Four patients were readmitted within the postoperative 30-day period; 2 patients had urinary tract infection, 1 patient had an ileostomy prolapse, and 1 patient experienced acute renal failure. A meta-analysis reported an ileostomy prolapse rate of 2%.[12] In the present study, 1 patient (2.7%) experienced an ileostomy prolapse caused by intestinal obstruction. A study reported that the rate of high ileostomy output was approximately 4%.[12] Chronic kidney disease is a risk factor for high ileostomy output. In our study, the patient who experienced high output and urinary tract infection had chronic kidney disease.

High-quality TME involving laparoscopy is a technically demanding procedure, especially for tumors in the lower two-thirds of the rectum. Circumferential resection margin is a surgical resection metric that is related to local recurrence. The CRM rates associated with laparoscopy varied from 4% to 16% in the COLOR II trial and the MRC CLASICC trial.[13,14] Therefore, TaTME was developed and proposed to provide more favorable results for the dissection of the distal

rectum.[15] A pooled network meta-analysis revealed that TaTME was equivalent to laparoscopic TME in terms of their outcomes. The positive CRM rate for TaTME was 4.7%.[16] In the present study, one positive CRM of TaTME occurred only in our pre-proficiency group. However, the results of the present study were limited by its small sample and the examined patient characteristics. Notably, the post-proficiency group was more likely to undergo neoadjuvant therapy and achieved more pathological complete responses relative to the pre-proficiency group.

The presence of anastomotic leakage after rectal surgery is a major postoperative complication and is associated with increased risk of morbidity. In a study of 100 patients (85 with anastomosis) who were treated by a single surgeon, Caycedo-Marulanda et al. reported that the 50th procedure was the turning point, after which a 50% improvement in anastomosis leakage rate was observed.[6] The leakage rate within 30 days of anastomotic reconstruction performed through the one-team model was 7.1%. TaTME did not differ significantly from laparoscopic TME in terms of the presence of anastomotic leakage or chronic presacral sinus. In one study, the reported anastomosis leakage rate (including late anastomosis leakage) was 15.8%.[17] The present study obtained an anastomosis leakage rate of 5.6%, and all the patients with this condition were hospitalized patients who did not undergo operation treatment.

The present study has several limitations. First, the analyzed data were sourced from a single high-volume specialist center with surgeons who were experienced in transanal surgery. Therefore, the results of the present study may not be generalizable to all institutions. Second, the present study was a single-center study, and the number of patients included was small, especially with respect to the pre-proficiency group. The subgroup analysis was limited by the insufficient power for demonstrating differences in postoperative complications.

Conflicts of Interest

The authors declare that they have no conflict of interest.

Ethics Approval

No ethical approval is required according to institutional policies.

Consent to Participate

All patient-related info was de-identified so patient consent was waived.

Consent for Publication

All patient-related info was de-identified so patient consent was waived.

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References

1. Funahashi K, Koike J, Teramoto T, et al. Transanal rectal dissection: a procedure to assist achievement of laparoscopic total mesorectal excision for bulky tumor in the narrow pelvis. *Am J Surg* 2009;197:e46-50.
2. Penna M, Hompes R, Arnold S, et al. Transanal total mesorectal excision: international registry results of the first 720 cases. *Ann Surg* 2017;266:111-7.
3. Munini M, Popeskou SG, Galetti K, Roesel R, Mongelli F, Christoforidis D. Transanal (TaTME) vs. laparoscopic total mesorectal excision for mid and low rectal cancer: a propensity score-matched analysis of early and long-term outcomes. *Int J Colorectal Dis.* 2021;36:2271-9.
4. Koedam TWA, Veltcamp Helbach M, van de Ven PM, et al. Transanal total mesorectal excision for rectal cancer: evaluation of the learning curve. *Tech Coloproctol* 2018;22:279-87.
5. Lee L, Kelly J, Nassif GJ, deBeche-Adams TC, Albert MR, Monson JRT. Defining the learning curve for transanal total mesorectal excision for rectal adenocarcinoma. *Surg Endosc* 2020;34:1534-42.
6. Caycedo-Marulanda A, Verschoor CP. Experience beyond the learning curve of transanal total mesorectal excision (TaTME) and its effect on the incidence of anastomotic leak. *Tech Coloproctol* 2020;24:309-16.
7. Rahbari NN, Weitz J, Hohenberger W, et al. Definition and

grading of anastomotic leakage following anterior resection of the rectum: a proposal by the International Study Group of Rectal Cancer. *Surgery* 2010;147:339-51.
8. Persiani R, Agnes A, Belia F, D'Ugo D, Biondi A. The learning curve of TaTME for mid-low rectal cancer: a comprehensive analysis from a five-year institutional experience. *Surg Endosc* 2021;35:6190-200.
9. Rubinkiewicz M, Truszkiewicz K, Wysocki M, et al. Evaluation of the learning curve of transanal total mesorectal excision: single-centre experience. *Wideochir Inne Tech Maloinwazyjne* 2020;15:36-42.
10. Nguyen TX, Ho HT, Phan HT, Vu HA, Pham NH. The effectiveness of double team for transanal total mesorectal excision in treatment of mid-low rectal cancer. *International Journal of Surgery Open* 2021;34:100359.
11. Deijen CL, Tsai A, Koedam TW, et al. Clinical outcomes and case volume effect of transanal total mesorectal excision for rectal cancer: a systematic review. *Tech Coloproctol* 2016; 20:811-24.
12. Gavriilidis P, Azoulay D, Taflampas P. Loop transverse colostomy versus loop ileostomy for defunctioning of colorectal anastomosis: a systematic review, updated conventional meta-analysis, and cumulative meta-analysis. *Surg Today* 2019;49:108-17.
13. van der Pas MH, Haglind E, Cuesta MA, et al. Laparoscopic versus open surgery for rectal cancer (COLOR II): short-term outcomes of a randomised, phase 3 trial. *Lancet Oncol* 2013; 14:210-8.
14. Guillou PJ, Quirke P, Thorpe H, et al. Short-term endpoints of conventional versus laparoscopic-assisted surgery in patients with colorectal cancer (MRC CLASICC trial): multicentre, randomised controlled trial. *Lancet* 2005;365:1718-26.
15. Vignali A, Elmore U, Milone M, Rosati R. Transanal total mesorectal excision (TaTME): current status and future perspectives. *Updates Surg* 2019;71:29-37.
16. Wang X, Zheng Z, Yu Q, et al. Impact of surgical approach on surgical resection quality in mid- and low rectal cancer, a Bayesian network meta-analysis. *Front Oncol* 2021;11:699200.
17. Jang HB, Kang SB, Lee H, Choi BJ, Lee SC. Anastomotic leakage and chronic presacral sinus after transanal total mesorectal excision (TaTME) for rectal cancer: a comparative study to laparoscopic TME. *Asian J Surg* 2022;45:2197-202.

原　著

雙人團隊腹腔鏡經肛門全直腸繫膜切除手術於直腸癌的學習曲線：單醫學中心經驗

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目的　腹腔鏡經肛門全直腸繫膜切除手術提供於低位骨盆腔有較好視野和繫膜面的剝離，至今，許多觀察性研究分析發表學習曲線，研究中是單人團隊或是混和單人和雙人團隊結果，本研究提出雙人團隊的學習曲線和優勢。

研究方法　研究收集資料庫中的術前、術中和術後因子，根據累積和去做學習曲線分析，預估臨界值，透過臨界值分成精通前和精通後兩組，去比較兩組差異。

結果　此研究共收集 36 名患者。21 名 (58%) 是男性，平均年紀是 61 歲，3 名是第一期，3 名第二期，29 名第三期，1 名第四期。平均手術時間 199 分鐘，我們觀察到在第 10 名會有手術時間下降，術中無事件或是轉成開腹手術。兩組間無明顯差異，30 天的術後併發症或是再入院也沒差別，主要術後併發症也相同，吻合處滲漏和狹窄也沒差別。

結論　雙人團隊需要至少 10 名才能達到高水準的全直腸繫膜切除且較短手術時間。

關鍵詞　經肛門執行全直腸繫膜切除手術、直腸癌、學習曲線。