Long-term oncologic outcomes of transanal TME compared with transabdominal TME for rectal cancer: a systematic review and meta-analysis

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Abstract
Background  Transanal total mesorectal excision (TaTME) appears to have favorable surgical and pathological outcomes. However, the evidence on survival outcomes remains unclear. We performed a meta-analysis to compare long-term oncologic outcomes of TaTME with transabdominal TME for rectal cancer.

Methods  PubMed, EMBASE, and the Cochrane Library were searched. Data were pooled, and overall effect size was calculated using random-effects models. Outcome measures were overall survival (OS), disease-free survival (DFS), and local and distant recurrence.

Results  We included 11 nonrandomized studies that examined 2,143 patients for the meta-analysis. There were no significant differences between the two groups in OS, DFS, and local and distant recurrence with a RR of 0.65 (95% CI 0.39–1.09, I² = 0%), 0.79 (95% CI 0.57–1.10, I² = 0%), 1.14 (95% CI 0.44–2.91, I² = 66%), and 0.75 (95% CI 0.40–1.41, I² = 0%), respectively.

Conclusion  In terms of long-term oncologic outcomes, TaTME may be an alternative to transabdominal TME in patients with rectal cancer. Well-designed randomized trials are warranted to further verify these results.

Keywords  Rectal cancer · Transanal TME · Transabdominal TME · Prognosis · Survival
a systematic review and meta-analysis to evaluate survival outcomes such as 2-year or 3-year survivals, or if possible 5-year survivals, and recurrence rates of TaTME in comparison with transabdominal TME in patients with rectal cancer. Evaluated outcomes were overall survival (OS), disease-free survival (DFS), and local and distant recurrence.

**Methods**

This meta-analysis followed the recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement [14]. Multiple comprehensive databases were searched for studies that assessed the long-term oncologic outcomes of TaTME compared with transabdominal TME for rectal cancer. The study protocol used Cochrane Review Methods [15]. IRB approval was not needed for this article.

**Data and literature sources**

Studies were identified from PubMed (January 1, 1976 to April 7, 2020), EMBASE (January 1, 1985 to April 7, 2020), and the Cochrane Central Register of Controlled Trials (CENTRAL) (January 1, 1987 to April 7, 2020). There were no restrictions regarding the year of publication, and articles in any language were permitted for review. The search terms were "rectal cancer," "transanal TME," "recurrence," "prognosis," and "survival." After the preliminary electronic search, further articles were searched for manually to retrieve additional studies. Finally, all articles were assessed individually for inclusion.

**Study selection and data extraction**

Article titles and abstracts were screened and full texts were independently reviewed by two reviewers (JY Moon and GW Ha) according to the selection criteria. Any differences in judgment regarding inclusion were resolved through discussion between the reviewers.

The included studies assessed survival outcomes, including OS, DFS, local recurrence, and distant recurrence, in patients with rectal cancer who were treated with TaTME or transabdominal TME. All of the surgical modalities such as open, laparoscopic, and robotic surgery were included in both TME approaches if possible. Studies were excluded if they (i) did not compare TaTME with transabdominal TME; (ii) assessed patients with stage IV or recurrent rectal cancer; (iii) assessed only patients who received abdominoperineal resection; (iv) had no extractable data and authors were unavailable to provide additional information; or (v) were case series with fewer than 10 patients.

All eligible studies were reviewed and all relevant data were extracted by the two reviewers independently using a data extraction form designed before the review. The variables recorded were (i) standard publication information, including year of publication, name of the first author, and number of patients; (ii) clinical and demographic characteristics of included studies; and (iii) outcomes (OS, DFS, local recurrence, and distant recurrence).

**Assessment of methodological quality**

The methodological quality of the studies included in the meta-analysis was assessed using the Newcastle–Ottawa quality scale (NOS), which attributes a maximum of 9 points to each study and categorizes a study with a score of 6 or more as “high quality” [16]. The quality of the included studies was analyzed using 3 categories: patient selection, comparability, and outcome assessment.

**Statistical analysis**

For dichotomous outcomes, relative risk (RR), variance, and 95% confidence interval (CI) were determined in the meta-analysis. The presence and amount of heterogeneity were assessed using the Q test and I^2 index, respectively; a p-value less than 0.1 was considered statistically significant [17]. The DerSimonian-Laird random-effects model (REM) was used to pool data in light of cross-study heterogeneity [18].

First, we performed a meta-analysis to evaluate survival outcomes such as OS, DFS, and local and distant recurrence of TaTME in comparison with transabdominal TME in patients with rectal cancer. Second, we performed a meta-analysis to compare CRM involvement, incompleteness of TME, and anastomotic leakage between the two groups. Sensitivity analyses were performed to assess the robustness of the meta-analysis findings [19, 20]. First, studies with a higher rate of CRM involvement in the transabdominal TME group than in the TaTME group were analyzed. Second, studies with a higher rate of incomplete TME in the transabdominal TME group than in the TaTME group were analyzed. Third, studies with a higher rate of anastomotic leakage in the transabdominal TME group than in the TaTME group were analyzed. Fourth, studies with large outlying effects or studies with a score less than 6 in the NOS scale, indicating low quality, were excluded. Fifth, the
trim-and-fill method and analysis with an alternative effect size were performed.

Funnel plots were used to determine the presence of publication bias by visual inspection of funnel plots and the Egger-weighted linear regression test; a p-value less than 0.1 was considered statistically significant [21, 22]. Data analyses were performed using Review Manager software (version 5.4) from the Cochrane Collaboration and Comprehensive Meta-Analysis software (version 3).

Results

Description of studies

The predefined search strategy identified 1,831 potentially relevant articles. We excluded 451 articles because they were duplicates and 1,365 articles because their titles and abstracts did not fulfill the selection criteria. After full text review of the remaining 15 articles, we excluded 4 articles because of the exclusion criteria of this study. Therefore, we included 11 nonrandomized studies that examined 2,143 patients for qualitative analysis and meta-analysis (Fig. 1). Among included patients, 529 patients received TaTME. Six studies evaluated OS and DFS [23–28], 11 studies evaluated local recurrence [23–33], and five studies evaluated distant recurrence [23, 26, 30–32]. Most of the included studies evaluated patients who underwent laparoscopic TaTME, while one study evaluated patients who underwent open TaTME [24]. Most of the included studies evaluated patients who underwent transabdominal TME with the laparoscopic approach only; two studies included patients who underwent transabdominal TME with laparoscopic or open approaches [24, 33], and one study included patients who underwent transabdominal TME with a robotic TME approach [30]. Evaluation of methodological quality showed that all studies scored at least 6 points (≥6) on the NOS scale. Tables 1 and 2 summarize the characteristics of the included studies.

Long-term oncologic outcomes of TaTME compared with transabdominal TME

Analysis of oncologic outcomes for TaTME in patients with rectal cancer indicated that 6 studies (604 patients) reported data on OS; there were no significant survival differences between TaTME and transabdominal TME (risk ratio [RR] = 0.65, 95% confidence interval [CI] = 0.39–1.09, I² = 0%) (Fig. 2). Six studies (604 patients) reported data on DFS; there were no significant survival differences between the two groups (RR = 0.79, 95% CI = 0.57–1.10, I² = 0%) (Fig. 3). Eleven studies (2,143 patients) reported data on local recurrence; there were no significant differences between two groups (RR = 1.14, 95% CI = 0.44–2.91, I² = 66%) (Fig. 4). Five studies (329 patients) reported data on distant recurrence; there were no significant differences between two groups (RR = 0.75, 95% CI = 0.40–1.41, I² = 0%) (Fig. 5). Sensitivity analyses using predefined methods indicated that the results of these meta-analyses were robust.

Analyses of CRM involvement, incompleteness of TME, and anastomotic leakage

Comparing CRM involvement between the two groups, the TaTME group was associated with better outcomes, with a RR of 0.44 (95% CI 0.27–0.87, I² = 0%) (Fig. 6a). Analysis to compare incompleteness of TME showed no significant differences between TaTME and transabdominal TME groups, with a RR of 0.88 (95% CI 0.50–1.55, I² = 0%) (Fig. 6b). Analysis to compare anastomotic leakage...
| Study       | Design | Country | Period    | Number | Age     | Gender (M/F), n | BMI (kg/m²) | ASA score | Inclusion criteria | Exclusion criteria | Surgical method | Follow up (months) | Oncology NOS outcomes |
|-------------|--------|---------|-----------|--------|---------|-----------------|-------------|-----------|---------------------|-------------------|------------------|-------------------|---------------------|
| De' Angelis (2015) | Retro | France | 2011–2014 | 32     | 64.91*  | 67.16*          | 21/11       | 21/11     | 25.19*              | 24.53*            | TaTME, Lap         | 32.06/62.91       | NR                  |
| Marks (2016) | Retro | USA    | 2012–2014 | 17     | 59*     | 60*             | NR          | 26.4*     | 25.9*               | NR                | TaTME, Lap         | 19.5/42.3         | NR                  |
| Lelong (2017) | Retro | France | 2008–2013 | 38     | NR      | NR              | 23/11       | 22/16     | 24 (18.6–32.7)*    | NR                | TaTME, Lap         | 31.9/53.3         | NR                  |
| Xu (2017)    | Retro | China  | 2006–2015 | 41     | 59 ± 12.6* | 62.4 ± 11.2* | 115/0       | 25 ± 2.8 | 24.8 ± 2.3         | I:10.8%            | TaTME, Lap         | 46.1/25.6         | NR                  |
| Denost (2018) | Pros  | France | 2008–2012 | 50     | 64 (39–82)* | 63 (31–90)* | 37/13       | 32/18    | 25.1 (17.3–33.2)* | I:68%              | TaTME, Lap         | 55.4/88.2         | NR                  |
| Lee (2018)   | Retro  | Korea  | 2013–2014 | 24     | <60: 10/18 | ≥60: 11/6*     | 16/5        | 13/11    | 24.4 ± 3.44*       | I:38.1%            | TaTME, Robotic     | 20.1/22.0         | NR                  |
| Mege (2018)  | Retro  | France | 2015–2017 | 34     | 58 ± 14* | 59 ± 13*       | 23/11       | 23/11    | 25 ± 4*            | I:12%              | TaTME, Lap         | 13±25 ± 14         | NR                  |
| Chen P (2019) | Retro | Taiwan | 2013–2015 | 100    | 57.3 ± 11.9* | 58.3 ± 11.3* | 38/12       | 76/24   | 24.2 ± 3.7*        | I:II 66%            | TaTME, Lap         | 44.3±10.5         | NR                  |
| Study          | Design | Country | Period | Number | Age        | Gender (M/F), BMI (kg/m²) | ASA score | Inclusion criteria                                                                 | Exclusion criteria          | Surgical method | Follow up (months) | Oncologic outcomes |
|---------------|--------|---------|--------|--------|------------|---------------------------|-----------|----------------------------------------------------------------------------------|-----------------------------|-----------------|-------------------|-------------------|
| Chen YT       | Retro  | Taiwan  | 2008–  | 39     | 64         | 62 ± 14.9° a 64 ± 12.2° a | 29/10     | TaTME 25.4 ± 4° II: 12.8% I: 7.8% I: 71.8% II: 82.8% III: 15.4% III: 9.4%     | Cancer perforation, T4, stage I–III | TaTME, Lap    | 17.5 ± 8.8/37.5 ± 23.7° | 6                 |
| Gordeyev      | Retro  | Russia  | 2013–  | 26     | 56.5 (25–68)b 63 (38–78)b | 26/0       | 26/0 26.3 (25.4–36.4)b NR | Rectal adenocarcinoma 7 cm from the AV, cT1-4aN0-M0, combination of male gender, BMI (≥ 25 mg/m²), CRT | NR                          | TaTME, Lap     | 28.2b              | 6                 |
| Wasmuth       | Pros   | Norway  | 2014–  | 152    | 1188       | NR                        | NR        | Rectal cancer Stage IV TaTME, Lap 19.5 (0–51) b |                       | TaTME, Lap     | 19.5 (0–51) b     | 6                 |

*Retro* Retrospective observational study, *Pros* Prospective observational study, *TaTME* Transanal total mesorectal excision, *ASA* American society of anesthesiologists, *ARR* anorectal ring, *AV* anal verge, *nCRT* neoadjuvant chemoradiotherapy, *TATA* Transanal abdominal transanal, *NOS* Newcastle–Ottawa scale, *NR* not reported

*a* Mean  
*b* Median  
**TaTME was performed in an open fashion**  
"Number of patients
### Table 2 Clinical characteristics of the included studies

| Study (Year) | Pathological Stage | Tumor location from nCRT (cm) | Interval to Chemotherapy | CRM positive, mean (mm) | DRM positive, mean (mm) | Incompleteness of TME | LN harvest, n | Anatomostic leaks | AdJoX | Recurrence | Survival |
|--------------|--------------------|-------------------------------|--------------------------|-------------------------|-------------------------|-----------------------|---------------|------------------|-------|-------------|----------|
| De' Angelis (2015) [22] | CR:12.5% T1:9.4% T2:37.5% T3:34.4% T4:6.2% N0:84.4% N1:15.6% | 4 (2.5–5) 1 3 5 6 | 3.1%, 9.4%, 6.2% | 9.68, 9.19 | 21.32, 22.92 | Complete: 312% Nearly complete: 29% Incomplete: 5% | 17a | 19a | 0% | LR 3.1% OS 95.5% |
| Marks (2016) [28] | uT2:29.4% uT3:70.6% | 0.9 (-2.0–3.0)* | 0.8 (-1.5–4.0)* | 100 5326/5412a | 5FU/Xeloda | NR 0% | 5.9% | 0% | 5.9% | 0% | OS 100% |
| De' Angelis (2017) [24] | CR:20.6% T1:18.8% T2:26.5% T3:34.1% T4:36.3% N0:73.5% N1:20.6% N2:5.9% | 4 (2–6)b 12 (9–40)b | 14 (4–34)* | 12 (4–25)* | Hand-sewn, AL Hand-sewn, AL | NR NR LR 5.4% | 64% vs 75.5% | DFS 79.5% |
| Xu (2017) [25] | T1:5.4% T2:4.9% T3:4.1% T4:3.5% N0:3.7% N1:2.9% N2:2.5% | 4 (1–5) 5 6 3 5.6 | 12.5 5000 | 5FU/Xeloda | 6 weeks | 2.7% | 4.9% | 17.9±5.3 | 0% | 17 (2–30)b | 17 (9–40)b | 24% vs 38% | LR 2.6% OS 87% |
| Denoot (2017) [26] | T0-2:50% T2:52% T3:23% T4:35% | 4 (2.6)b | 0.8 | 88 4500 | Xeloda | 6 weeks | 4% | 18% | 2% | 8% | 17 (2–30) | 17 (9–40) | 0% vs 2% | 4.8% vs 7.4% | OS 87% |

Notes: 
- Interval to surgery: 3-6 weeks. 
- CRM positive: 3.1%–9.19%. 
- DRM positive: 6.2%–21.32%. 
- AdjOx: 0%–22.92%. 
- Recurrence: 0%–6.3%. 
- Survival: 95.5%–96.6%.
| Study          | Pathological Stage | Tumor location from nCRT received (%) | RT, cGy | Concurrent Chemotherapy | Interval to surgery | CRM positive, mean (mm) | DRM positive, mean (mm) | Incompleteness of TME | LN harvest, n | Anastomosis type, Mortality AdjCtx Recurrence Rate |
|---------------|-------------------|--------------------------------------|--------|------------------------|-------------------|-------------------------|-------------------------|------------------------|--------------|-----------------------------------------------|
|               |                   |                                      |        |                        |                   |                         |                         |                        |              |                                               |
| Lee (2018)    | T0:19%            | T1:20%                               | 50     | NR                     | NR                | NR                     | NR                     | NR                     | NR           | Stapled 85.7%, Hand-sewn 62.5%, DR 9%         |
|               |                   |                                      |        |                        | NR                | NR                     | NR                     | NR                     | NR           | vs 0%                                          |
| Mege (2018)   | CR:29%            | T3:3%                                | 85     | 5000                   | 12 weeks          | 12%, <1.12%            | 15%, <1.6%              | 3%, 13±9     | NR           | Hand-sewn, AL 12%                            |
|               |                   |                                      |        |                        |                   |                         |                         |                        |              | vs 32%                                         |
| Chen P (2019) | CR:16%            | T3:1%                                | 100    | 5040                   | 5.8±2.1 ± 2.2±1.7  | 4       | 10%, NR                                      | NR                     | NR           | Stapled 68%, Hand-sewn 67%                   |
|               |                   |                                      |        |                        |                   |                         |                         |                        |              | vs 0%                                          |
| Chen YT (2019)| CR:10.3%          | T3:1%                                | 48     | 5000                   | 4.3±1.4 ± 5.8±1.2  | 4       | NR, <1.0%                                    | NR                     | NR           | Stapled 89.7%, Hand-sewn 100%                |
|               |                   |                                      |        |                        |                   |                         |                         |                        |              | vs 0%                                          |

*Statistics indicate mean ± standard deviation unless otherwise specified.*
### Table 2 (continued)

| Study | Pathological Stage | Tumor location from nCRT received (%) | RT, cGy | Concurrent Chemo agent | Interval to surgery | CRM positive, mean CRM (mm) | DRM positive, mean DRM (mm) | Incompleteness of TME | LN harvest, n | Anatomosis type, Mortality AdjCtx Recurrence | Survival rate |
|-------|-------------------|--------------------------------------|--------|------------------------|-------------------|---------------------------|-----------------------------|----------------------|-------------|---------------------------------------------|-------------|
| Gordeyev (2019) [31] | | | | | | | | | | | | |
| Go 
  0.23% | T0:19.2% | 7 (4–9)b | 100 | NR | NR | 7.7%, NR | 11.5%, NR | NR, 30 (7–60)b | 7.7% | NR | | |
| 2.26% | T1:2.3% | 100 | NR | NR | NR, 30 (7–60)b | 7.7% | NR | | | | | |
| 3.9% | T2:3.9% | 100 | NR | NR | NR, 30 (7–60)b | 7.7% | NR | | | | | |
| 3.8% | T4a:3.8% | 100 | NR | NR | NR, 30 (7–60)b | 7.7% | NR | | | | | |
| N +:50% | | | | | | | | | | | | |
| Wasmuth (2020) [32] | | | | | | | | | | | | |
| W 0.55% | T0:6% | 8 (2–13)b | NR | NR | NR | 5.1%, NR | 7.6%, NR | NR | NR | NR | AL 8.4% vs 1.3% | 11.6% vs 2.4% |
| 0.6% | T1:8.3% | 8 (2–13)b | NR | NR | NR | 5.1%, NR | 7.6%, NR | NR | NR | NR | AL 8.4% vs 1.3% | 11.6% vs 2.4% |
| 3.6% | T2:33.1% | 8 (2–13)b | NR | NR | NR | 5.1%, NR | 7.6%, NR | NR | NR | NR | AL 8.4% vs 1.3% | 11.6% vs 2.4% |
| 4.7% | T3:48.7% | 8 (2–13)b | NR | NR | NR | 5.1%, NR | 7.6%, NR | NR | NR | NR | AL 8.4% vs 1.3% | 11.6% vs 2.4% |
| 5.1% | T4:3.7% | 8 (2–13)b | NR | NR | NR | 5.1%, NR | 7.6%, NR | NR | NR | NR | AL 8.4% vs 1.3% | 11.6% vs 2.4% |
| N 0.68% | N0:66.8% | 8 (2–13)b | NR | NR | NR | 5.1%, NR | 7.6%, NR | NR | NR | NR | AL 8.4% vs 1.3% | 11.6% vs 2.4% |
| 0.6% | N1:23.4% | 8 (2–13)b | NR | NR | NR | 5.1%, NR | 7.6%, NR | NR | NR | NR | AL 8.4% vs 1.3% | 11.6% vs 2.4% |
| 2.1% | N2:10.0% | 8 (2–13)b | NR | NR | NR | 5.1%, NR | 7.6%, NR | NR | NR | NR | AL 8.4% vs 1.3% | 11.6% vs 2.4% |

nCRT neoadjuvant chemoradiotherapy, Mortality 30 days mortality, Adj Ctx adjuvant chemotherapy

*Mean distant from the anorectal ring

aMean

bMedian
also showed no significant differences between TaTME and transabdominal TME groups, with a RR of 0.94 (95% CI 0.58–1.54, I² = 27%) (Fig. 6c).

**Analysis of oncologic outcomes according to rate of CRM involvement**

Analysis of studies with a higher rate of CRM involvement in the transabdominal TME group than in the TaTME group showed no significant differences between the two groups in analysis of OS, DFS, local recurrence, and distant recurrence with a RR of 0.65 (95% CI 0.39–1.09, I² = 0%), 0.79 (95% CI 0.57–1.10, I² = 0%), 0.72 (95% CI 0.39–1.36, I² = 0%), and 0.75 (95% CI 0.40–1.41, I² = 0%), respectively (Fig. 7).

**Analysis of oncologic outcomes according to rate of TME incompleteness**

Analysis of studies with a higher rate of incomplete TME in the transabdominal TME group than in the TaTME group showed no significant differences between the two groups in analysis of OS, DFS, local recurrence, and distant recurrence with a RR of 0.67 (95% CI 0.39–1.14, I² = 0%), 0.71 (95% CI 0.48–1.05, I² = 0%), 0.57 (95% CI 0.25–1.33, I² = 0%), and 0.59 (95% CI 0.25–1.39, I² = 0%), respectively (Fig. 7).

**Analysis of oncologic outcomes according to rate of anastomotic leakage**

Analysis of studies with a higher rate of anastomotic leakage in the transabdominal TME group than in the TaTME group showed no significant differences between the two groups in analysis of OS, DFS, local recurrence, and distant recurrence with a RR of 0.67 (95% CI 0.39–1.14, I² = 0%), 0.71 (95% CI 0.48–1.05, I² = 0%), 0.65 (95% CI 0.29–1.45, I² = 0%), and 0.74 (95% CI 0.39–1.42, I² = 0%), respectively (Fig. 7).

**Publication bias**

Publication bias was determined by visual inspection of funnel plots and the Egger-weighted linear regression test to assess any asymmetry in the funnel plots. The results showed that the funnel plots for local recurrence (p = 0.045) were asymmetrical, indicating a presence of publication bias.

**Discussion**

To our knowledge, despite a relatively small number of included patients, this study is the first meta-analysis to compare long-term oncologic outcomes between TaTME and transabdominal TME. Since TaTME was introduced in 2010 [5], many studies have reported favorable perioperative, pathological, and functional outcomes, although little is known about the long-term oncologic outcomes of TaTME such as OS, DFS, and distant recurrence. Our findings on the long-term oncologic outcomes of TaTME may illustrate its oncologic safety and support its introduction and application.

Our meta-analysis showed no significant difference between TaTME and transabdominal TME in OS, DFS, local recurrence, and distant recurrence. The TaTME group had favorable CRM involvement compared with the transabdominal TME group. However, despite tendencies for lower rates of incompleteness of TME and anastomotic leakage in the TaTME group, there was no significant difference between the two groups in terms of incompleteness of TME and anastomotic leakage. Based on previous meta-analyses [11, 13], we considered lower rates of CRM involvement, incompleteness of TME, and anastomotic leakage in the TaTME group could demonstrate adequately performed TaTME procedures, which might show survival outcomes properly after overcoming the initial learning curve. Thus, we performed sensitivity analyses using predefined methods, such as analyses of long-term oncologic outcomes related to CRM involvement, incompleteness of TME, and anastomotic leakage, which indicated no statistical significance, suggesting the robustness of these results.

Studies have shown that CRM is an accepted surrogate marker for local recurrence and those with involved CRM have an increased risk of local recurrence [34, 35]. However, in our study, although the TaTME group had favorable CRM involvement and most included studies reported a higher rate of CRM involvement in the transabdominal TME group [23–32], margin involvement does not translate into significant differences in the rates of OS, DFS, distant recurrence, and local recurrence between the two groups. Another surrogate marker for local recurrence is the quality of the mesorectum [36]. In our study, analysis of incompleteness of TME showed no significance, and analysis of studies...
Fig. 2  Forest plot of data on OS in patients with rectal cancer (TaTME vs. transabdominal TME)

Fig. 3  Forest plot of data on DFS in patients with rectal cancer (TaTME vs. transabdominal TME)

Fig. 4  Forest plot of data on local recurrence in patients with rectal cancer (TaTME vs. transabdominal TME)
that reported a higher rate of incomplete mesorectum in the transabdominal TME group [23–26, 29] showed no significance in the rates of OS, DFS, distant recurrence, and local recurrence between the two groups. Anastomotic leakage may also have a negative effect on recurrence and survival outcomes [37–39]. In our study, analysis of anastomotic leakage showed no significance, and analysis of studies that reported a higher rate of anastomotic leakage in the transabdominal TME group [23–26, 30, 31] showed no significance in the rates of OS, DFS, distant recurrence, and local recurrence between the two groups. However, it is important to point out the relatively small number of included patients and the trends for better survival outcomes in TaTME group. The transanal approach with advances in technique and quality control will provide more patient data for analysis of the oncologic impact of TaTME. Consequently, as patient data increases, less CRM involvement, less TME incompleteness, and less anastomotic leakage may have a significantly positive effect on TaTME survival outcomes and recurrence.

Recently, TaTME for rectal cancer was suspended in Norway due to an unexpected higher recurrence rate after TaTME [40]. In our meta-analysis, except for one study [33], all included studies reported an acceptable local recurrence rate. After excluding this study, the result of local recurrence analysis had a trend for better outcomes in the TaTME group. One explanation may involve the technical aspect of rectal transection and air flow during dissection from the perineum, which could potentially allow the spread of tumor cells into the pelvic cavity [41]. Therefore, to ensure complete occlusion of the rectal lumen and reduce the possibility of tumor cells spreading, a modification of the technique to reinforce the purse-string has been proposed [42]. Before full-thickness incision of the rectum, placing a gauze swab in the lumen can also prevent tumor cell spillage [26].

There are some limitations to this study that make it difficult to draw strong conclusions. One limitation of this study is it lacks large randomized trials, and that the majority of the studies are retrospective and have a small number of patients. Second, there may be a potential heterogeneity among the included studies, even though we performed a sensitivity analysis. Clinical characteristics of patients may be various because comparative studies without randomization were included. Moreover, the procedures were performed by many different surgeons, and any non-standardized techniques used may have influenced the oncologic outcomes. Although TaTME is usually recommended as dissection of the distal one-third of the mesorectum [43], the level of rectal dissection via TaTME may vary between patients. Third, there are variations in the follow-up period among the included studies, and this might have affected the results.

In conclusion, although it remains in a stage of development, TaTME may offer favorable long-term oncologic outcomes and be an alternative to transabdominal TME in patients with distal rectal cancer. Well-designed large randomized trials are warranted to provide more definitive survival results.
Fig. 6  

a Analysis of CRM involvement, 
b analysis of incompleteness of TME, and 
c analysis of anastomotic leakage (TaTME vs. transabdominal TME)
Table 1  Sensitivity analysis of long-term oncologic outcomes related to CRM involvement, incompleteness of TME, and anastomotic leakage.

| Study name | Statistics for each study | Risk ratio and 95% CI |
|------------|---------------------------|-----------------------|
| CRM OS     | 0.650 0.369 1.087 -1.643 | 0.100                 |
| CRM DFS    | 0.790 0.569 1.097 -1.405 | 0.160                 |
| CRM LR     | 0.720 0.388 1.345 -1.031 | 0.303                 |
| CRM DR     | 0.750 0.599 1.408 -0.865 | 0.371                 |
| TME OS     | 0.670 0.392 1.145 -1.464 | 0.143                 |
| TME DFS    | 0.710 0.483 1.566 -1.715 | 0.086                 |
| TME LR     | 0.570 0.247 1.315 -1.318 | 0.167                 |
| TME DR     | 0.590 0.259 1.391 -2.010 | 0.228                 |
| AL rectal OS | 0.670 0.392 1.145 -1.464 | 0.143                 |
| AL rectal DFS | 0.710 0.483 1.566 -1.715 | 0.086                 |
| AL rectal LR | 0.650 0.291 1.453 -1.049 | 0.204                 |
| AL rectal DR | 0.740 0.369 1.412 -0.913 | 0.361                 |

Fig. 7  Sensitivity analysis of long-term oncologic outcomes related to CRM involvement, incompleteness of TME, and anastomotic leakage.

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