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**Title:** Robotic Total Mesorectal Excision (TME) or Transanal Total Mesorectal Excision (TaTME) Meta-analysis

**Running head:** TaTME, rectal cancer, robotic TME

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**Abstract**

Backgrounds

Total mesorectal excision (TME) has been established as the standard for oncologic resection of rectal cancer, and has a direct impact on local recurrence and overall survival.[1]

Objectives

Our meta-analysis aims to evaluate the oncological outcomes of the newer techniques of TME – robotic TME versus Transanal TME (TaTME). Primary outcome measures included CRM positivity, R0 resection status, distal resection margins and lymph node yield. Secondary outcome measures were overall complication rates, anastomotic leak and wound infection rates, post-operative ileus rates, and mean operative time.

Data sources and review methods

A systematic literature search was performed to identify relevant studies through PubMEd and Embase from January 2000 to January 2021. Inclusion criteria included English language articles directly comparing TaTME and robotic TME.

Results

714 studies were identified, and only 6 studies were included for this meta-analysis. A total of 1065 participants, of which 632 (59.3%) underwent robotic TME, and 433 (40.7%) had TaTME. Robotic TME had a statistically significant higher lymph node yield (SMD -0.53, p=0.020). There were no significant differences in the overall complication rates, wound infection and anastomotic leak rates, post-operative ileus, mean operative time and CRM positivity.

Conclusion

This is the first meta-analysis assessing the outcomes of robotic TME versus TaTME, and only lymph node yield was statistically higher in robotic TME group. These techniques are potentially complementary rather than competing, and we believe that these 2 approaches can be adopted after appropriate training.

**Keywords:** TaTME, rectal cancer, robotic TME

**Introduction**

Total mesorectal excision (TME) has been established as the standard for oncologic resection of rectal cancer, and has a direct impact on local recurrence and overall survival.[1] The adoption of total mesorectal excision(TME) combined with neoadjuvant chemoradiotherapy in selected patients has reduced locoregional recurrence rates to below 10% and improved cancer-free survival rates to >70%.[2, 3] Recent advances in the treatment of rectal cancer has seen the rise in minimally invasive abdominal approaches such as laparoscopic and robotic TME, with less open TME surgery being performed owing to favourable short-term outcomes, such as less pain, reduced blood loss, and improved recovery time.[3, 4]

Since the inception of TME, the current gold standard quality indicator to minimise the risk of local recurrence includes an intact TME and a negative CRM (more than 1mm) .[1, 5, 6] Over the last two decades, there has been a progressive evolution from an open to a minimally invasive approach, with multiple trials assessing the oncological safety of laparoscopic approach for TME. There are currently five RCTs across the globe assessing whether laparoscopic is equivalent to open TME by performing a "non-inferiority" trial. However, these trials have shown complete opposite results in the quality indicator assessment; with major trials such as ALaCaRT[7] and ACOSOG Z6051[8] demonstrating a higher rate of positive CRM and lower rate of intact TME in the laparoscopic group when compared to the open TME group. However, the COREAN[9] and COLOR II[10] RCTs showed equivalent CRM positivity rate and intact TME. Despite the contrasting conclusions between these trials, to date, none have shown an increase in local recurrence in the laparoscopic arm, and both laparoscopic and open techniques have similar survival outcomes. This was further validated in recent publications of all the trials demonstrating no differences in local recurrence in the intermediate term.

Despite no differences to the intermediate oncological outcomes, there remains a genuine reservation to continue with laparoscopic TME. Hence, there has been a strong push to interrogate other newer and novel approaches such as TaTME and robotic TME to overcome some of the dynamic limitations of a rigid "straight" laparoscopic instrument in an unfavourable conical shape of a narrow pelvis, with a rectum that angles forward in the distal third portion, in order to preserve the benefits of minimally invasive surgery. Regardless of the technique being used, obtaining a negative circumferential resection margin (CRM) resection with a complete

TME is crucial for optimal oncological outcomes. As such, our study aims to compare the newer techniques of TME – robotic TME versus TaTME, in order to evaluate whether there is a difference in outcomes between the two relatively new techniques for mid to low rectal cancers.

**Methods**

*Search strategy*

This review was registered with PROSPERO. A systematic search was undertaken in accordance to the PRISMA guidelines, identifying relevant studies through PubMEd and Embase from January 2000 to January 2021 (Figure S1). A detailed search strategy was performed. Inclusion criteria included English language articles, studies directly comparing TaTME and robotic TME. The search, review and data extraction were performed by two independent authors (JK and MZC). Any discrepancy in the inclusion or exclusion of a study or data was independently reviewed by YKT. The keywords used in combination for the search were as follows: "transanal", "robotic", "robot-assisted", "total mesorectal excision", "TaTME", "TME", "rectal tumour", "rectal adenocarcinoma" and "rectal cancer". Additional studies were also included from full-text review.

*Data extraction, inclusion and exclusion criteria*

Before the commencement of this study, the relevant key questions were ascertained. Inclusion criteria were: (i) comparative studies of TaTME versus robotic TME for rectal cancer; (ii) each study had reported at least one of the short or long-term outcomes. Studies were excluded if there was no direct comparison of TaTME and robotic TME surgery.

*Outcome measures*

The primary outcome measures were CRM positivity, R0 resection rates, DRM length and lymph node yield. Secondary outcome measures were anastomotic leak, overall complications, post-operative ileus and total operative time.

R0 resection was defined as a microscopically negative-margin resection, in which no gross or microscopic tumour remains in the primary tumour bed. R1 resection indicates an involved circumferential margin (<1mm).

*Statistical analysis*

All continuous variables were collected as mean and standard deviation and categorical variables as frequencies and percentages. For each study, odds ratio (OR) and associated 95% confidence interval (CI) were calculated

and median outcomes were converted to mean and its standard deviation. Pooled OR and standardized mean differences (SMDs) were performed using random-effect model for studies with reported heterogeneity. Pooled OR was performed using the Cochran–Mantel–Haenszel test, whereas pooled standard mean difference was performed using the DerSimonian–Laird method with variance component estimator, with the addition of model fit using importance sampling and likelihood-based approach. A sub-analysis was performed for CRM, for studies that reported on T stage and height from anal verge when these showed no difference in both groups (robotic versus TaTME). This is to interrogate whether there is a difference in CRM positivity when adjusted according to these two clinical variables. There was no missing data.

Inter-study heterogeneity assessment was performed using $I^2$ statistic and can be interpreted as: 0–30%, minimal; 30–60%, moderate; 60–90%, substantial; 90–100%, considerable heterogeneity. The Newcastle–Ottawa Scale was used to assess the quality of each study and a score of ≥6 is of good quality. Egger's test was performed to assess for publication bias. All statistical analyses were performed on R Studio version 0.99.486, META-analysis FOr R (metafor) package (Delaware Corporation, Boston, MA, USA) and P-value <0.05 was considered significant.

**Results**

*Overall study characteristics*

After the appropriate search strategy was performed, 714 studies were identified, of which 37 duplicates were excluded. After screening each study title and abstract, 34 studies were eligible for full text review and eventually 6 studies were included for data extraction that formed the basis of this meta-analysis. There were a total of 1065 participants, of which 632 (59.3%) underwent robotic TME, and 433 (40.7%) had TaTME; two prospective studies, and the remaining being retrospective in nature (Table 1). There was no randomised controlled trials in the 6 studies. Patient demographics, tumour status and treatment are described in Table 1, Table S2-S4.

*Study quality and heterogeneity*

Each study was assessed using the Newcastle–Ottawa Scale (Table S1) and were all of moderate quality (score of 8). Significant heterogeneity was identified in the following outcome measures: overall complication rates, distal resection margins, and operation time. Hence pooled analysis was performed for all outcomes using the random-effect model or Cochran-Mantel-Haenszel test. No sensitivity analysis was performed.

*Primary Outcome Measure*

There was no difference in pooled CRM positivity (Figure 1a from four studies. CRM positivity in robotic TME was 5.6% compared to 3.9% in TaTME (OR 1.43; 95% CI 0.76-2.71, p=0.333). When the analysis was adjusted for studies that had documented equivalent proportion of T stage and height from anal verge (Table S3), the CRM positivity was 5.7% in the robotic TME group as compared to 4.2% in the TaTME group, but this was still statistically not significant (OR= 1.35; CI= 0.71,2.60; p=0.449). R0 resection status (Figure 1b) was 96% in TaTME, compared to 94.6% in robotic TME(SMD = 1.34; CI = 0.74, 2.44; p=0.414). Distal resection margins (Figure 2a) were not statistically different (SMD= 0.51; CI= -0.32, 1.34; p= 0.233). Three studies with a total of 222 patients had documented lymph node yield for each technique (Figure 2b). In the pooled analysis, robotic TME produced a statistically significant higher lymph node yieldas compared to TaTME, with standardized mean difference (SMD) of -0.53 (CI = -0.98, -0.8; p= 0.020).

*Secondary Outcome Measure*

There were no statistically significant differences in the overall complications, anastomotic leak, wound infection or post-operative ileus rates (Figure 3a,3b, 4a,4b). Overall complication rates were 18.6% in the TaTME group compared to 15.3% in the robotic TME group (OR = 1.03; CI = 0.63, 1.68; p=0.989). Anastomotic leak rate was 10.5% in TaTME and 8.2% in robotic TME group (OR = 0.74; CI = 0.48, 1.13; p= 0.202); wound infection rates 15.9% in TaTME and 7.1% in robotic TME (OR = 0.37; CI = 0.13, 1.04; p= 0.094); post-operative ileus 3.4% in TaTME and -12.3% in robotic TME (OR = 0.90; CI = 0.60, 1.37; p = 0.707). Themean operative time was longer in TaTME group but was not statistically significant (SMD = 0.11; CI = -0.34, 0.55; p= 0.642) (Figure 5).

**Discussion**

In the recent years, transanal TME (TaTME) has emerged as a new technique for overcoming the difficulty from the abdominal approach in the mid to low rectal cancer. This sphincter preserving technique utilises an advanced transanal platform for TME excision in the distal rectum. It has been reported to overcome the challenges of operating in a narrow pelvis, offers a better access to the distal rectum, and allows for an adequate negative distal resection margin (DRM).[1]

Although the meta-analysis included a small number of studies comparing the two relatively novel approaches to TME; it did show subtle differences in the pathological outcomes, of which a significantly higher lymph node yield was demonstrated for robotic approach, and a longer DRM length was more likely in the TaTME approach although it did not reach significance. All other outcome measures such as CRM positivity, R0 resection and secondary outcomes such as anastomotic leak rates, operative time and overall complications rates were not significantly different comparing these two techniques. This is intuitively not surprising, given the perceived advantages of each platform. It has been known that the robotic platform allows for precise dissection, particularly around the vascular pedicle whereas a transanal approach improves the view of the distal rectal cancer margin; with purse-string closure of the rectum before bottom-up dissection whilst maintaining pneumoperitoneum.

The advantage of the robotic console is that it provides a 3-dimensional depth of field, aided by a stable camera platform with optimal visualisation of the anatomy for precise vessel dissection, lateral pelvic lymph node dissection and the tight angulation of the distal third of the rectum.[7, 11] The robotic dissection is further improved by the flexible articulation of the instruments, providing an almost equivalent retraction to open surgery whilst maintaining a clear view of the dissected planes. This has been shown in observational studies to yield favourable short-term oncological outcomes, better preservation of bladder and sexual functions.[12]

With the COLOR II[10] trial (comparing laparoscopic versus open surgery for rectal cancer) showing an equivalent intermediate term oncological outcome, recent trials were then designed to compare minimally invasive approaches - robotic against laparoscopic approach, instead of an open approach. Major robotic TME versus

laparoscopic TME studies have shown the robotic approach to maintain a low rate of CRM positivity of 0-8%, and that robotic was non-inferior to laparoscopic approaches.[13] The RObotic versus LAparoscopic Resection for Rectal cancer (ROLARR) trial subsequently compared robotic and laparoscopic approaches, and the rate of conversion to open surgery. Although not powered according to oncological outcomes, they reported a CRM positivity rate of 5.1% for robotic approach compared to 6.3% in the laparoscopic approach.[14] The quality of TME and CRM involvement were reported to be comparable.[14] As such, robotic TME surgery has been advocated as an alternative to conventional laparoscopic TME.

On the other hand, TaTME is logically very attractive. The distal margin may be secured before rectal transection, and dissection of anorectum can proceed regardless of pelvic anatomy and patient body habitus. [15, 16] A specific concern for TaTME are urethral injuries, something rarely encountered when approaching from above. It also has a steep learning curve and requires a certain volume to achieve acceptable complication rates. The initial report on TaTME was encouraging and met all the surgical quality indicator for TME resection.[6, 13, 17] This was further validated in a Dutch study comparing TaTME and laparosopic TME,[18] in which CRM involvement was similar in the 2 groups, 4.3% in TaTME and 4.0% in laparoscopic TME.[18] Short-term morbidity and oncologic outcomes were also comparable to laparoscopic TME series.[17] However, recently there has been a Norwegian moratorium, with data showing a higher rate of local recurrence compared to historical national data but what is most concerning is the multifocal local recurrence suggesting an insufflation dissemination during the procedure.[19] More recently, an international cohort study encompassing six tertiary referral centers who performed TaTME demonstrated a 2-year local recurrence rate of 3% (CI 2 – 5) after a median follow-up of 25.5 months.[20] The Australasian TaTME surgeons also reported similar rate of local recurrence, with 2.9% involved CRM and only 1.9% local recurrence rate over a 22-month follow-up.[21]

At this current juncture, there are now four techniques for rectal cancer surgery, with conflicting evidence on the equivalence of laparoscopic to open TME. There are also no published studies directly comparing Robotic TME and TaTME. There is however a RCT - Robotic versus TaTME Rectal Surgery (ROTA STUDY), which will evaluate the effectiveness, complication rates and disease-free survival between the two techniques (Robotic TME vs TaTME).[22] This may provide us with the insight for selecting the most appropriate patient with rectal cancer for one of the novel techniques. Irrespective of which technique is being used, it is important to be aware

that all can be performed well with the appropriate training, expertise, and volume (after the learning curve) of each technique to maintain a high standard of care. However, we recognise that there are limited numbers of operative rectal cancers for each surgeon and we acknowledge that it may be difficult to acquire the appropriate level of competency for both techniques if significant operative numbers are required to master each technique.

Limitations

There were several limitations to this study. Majority of the studies were retrospective in nature with results reliant on the accuracy of record keeping, and small number of patients were recruited for each study. In addition, patient selection bias cannot be adjusted for with this meta-analysis despite efforts to minimise heterogeneity by taking into account the T-stage and height from anal verge for CRM positivity. Another confounding factor was that no other long-term oncological data or follow up were presented in these papers. In addition, although open TME is the gold standard, it has not been included as a comparison group in this analysis, which would have provided a more robust study. Lastly, as both of these approaches are relatively new, there was no way of gauging the point at which each individual surgeon was on the learning curve of these procedures.

**Conclusion**

To the very best of our knowledge, this is the first meta-analysis directly assessing only the outcomes of robotic TME versus TaTME, which showed subtle differences in pathological outcomes with increased lymph node yield in the robotic TME group. It is important to realise there is a learning curve for newer techniques, particularly for TaTME approach, and appropriate training should be undertaken during the adoption of these novel techniques. We believe that these techniques are not superior to one another and are rather potentially complementary to other techniques when used appropriately. Finally, these two approaches can be adopted after appropriate training and that case volume per approach, particularly in TaTME, where volume is critical in maintaining a high quality of surgery.[1]

**Disclosure statement**

None.

**References**

1. Lee L, de Lacy B, Gomez Ruiz M, Liberman AS, Albert MR, Monson JRT, et al. A Multicenter Matched Comparison of Transanal and Robotic Total Mesorectal Excision for Mid and Low-rectal Adenocarcinoma. Annals of surgery. 2019;270(6):1110-6.
2. Deijen CL, Vasmel JE, de Lange-de Klerk ESM, Cuesta MA, Coene PLO, Lange JF, et al. Ten-year outcomes of a randomised trial of laparoscopic versus open surgery for colon cancer. Surgical endoscopy. 2017;31(6):2607-15.
3. Veldkamp R, Kuhry E, Hop WC, Jeekel J, Kazemier G, Bonjer HJ, et al. Laparoscopic surgery versus open surgery for colon cancer: short-term outcomes of a randomised trial. The Lancet Oncology. 2005;6(7):477-84.
4. Bedrikovetski S, Dudi-Venkata NN, Kroon HM, Moore JW, Hunter RA, Sammour T. Outcomes of Minimally Invasive Versus Open Proctectomy for Rectal Cancer: A Propensity-Matched Analysis of Bi-National Colorectal Cancer Audit Data. Diseases of the colon and rectum. 2020;63(6):778-87.
5. Warrier SK, Kong JC, Guerra GR, Chittleborough TJ, Naik A, Ramsay RG, et al. Risk Factors Associated With Circumferential Resection Margin Positivity in Rectal Cancer: A Binational Registry Study. Diseases of the colon and rectum. 2018;61(4):433-40.
6. Melstrom KA, Kaiser AM. Role of minimally invasive surgery for rectal cancer. World journal of gastroenterology. 2020;26(30):4394-414.
7. Stevenson AR, Solomon MJ, Lumley JW, Hewett P, Clouston AD, Gebski VJ, et al. Effect of Laparoscopic-Assisted Resection vs Open Resection on Pathological Outcomes in Rectal Cancer: The ALaCaRT Randomized Clinical Trial. Jama. 2015;314(13):1356-63.
8. Fleshman J, Branda M, Sargent DJ, Boller AM, George V, Abbas M, et al. Effect of Laparoscopic-Assisted Resection vs Open Resection of Stage II or III Rectal Cancer on Pathologic Outcomes: The ACOSOG Z6051 Randomized Clinical Trial. Jama. 2015;314(13):1346-55.
9. Jeong SY, Park JW, Nam BH, Kim S, Kang SB, Lim SB, et al. Open versus laparoscopic surgery for mid-rectal or low-rectal cancer after neoadjuvant chemoradiotherapy (COREAN trial): survival outcomes of an open-label, non-inferiority, randomised controlled trial. The Lancet Oncology. 2014;15(7):767-74.
10. Bonjer HJ, Deijen CL, Abis GA, Cuesta MA, van der Pas MHGM, de Lange-de Klerk ESM, et al. A Randomized Trial of Laparoscopic versus Open Surgery for Rectal Cancer. New England Journal of Medicine. 2015;372(14):1324-32.
11. Simillis C, Lal N, Thoukididou SN, Kontovounisios C, Smith JJ, Hompes R, et al. Open Versus Laparoscopic Versus Robotic Versus Transanal Mesorectal Excision for Rectal Cancer: A Systematic Review and Network Meta-analysis. Annals of surgery. 2019;270(1):59-68.
12. Law WL, Foo DCC. Comparison of early experience of robotic and transanal total mesorectal excision using propensity score matching. Surgical endoscopy. 2018;33(3):757-63.
13. Ryan OK, Ryan É J, Creavin B, Rausa E, Kelly ME, Petrelli F, et al. Surgical approach for rectal cancer: A network meta-analysis comparing open, laparoscopic, robotic and transanal TME approaches. European journal of surgical oncology : the journal of the European Society of Surgical Oncology and the British Association of Surgical Oncology. 2020.
14. Lee KY, Shin JK, Park YA, Yun SH, Huh JW, Cho YB, et al. Transanal Endoscopic and Transabdominal Robotic Total Mesorectal Excision for Mid-to-Low Rectal Cancer: Comparison of Short-term Postoperative and Oncologic Outcomes by Using a Case-Matched Analysis. Annals of coloproctology. 2018;34(1):29-35.
15. Seow-En I, Seow-Choen F. An Initial Experience Comparing Robotic Total Mesorectal Excision (RTME) and Transanal Total Mesorectal Excision (taTME) for Low Rectal Tumours. Annals of the Academy of Medicine, Singapore. 2018;47(5):188-90.
16. Fernández-Hevia M, Delgado S, Castells A, Tasende M, Momblan D, Díaz del Gobbo G, et al. Transanal total mesorectal excision in rectal cancer: short-term outcomes in comparison with laparoscopic surgery. Annals of surgery. 2015;261(2):221-7.

17. Lacy AM, Tasende MM, Delgado S, Fernandez-Hevia M, Jimenez M, De Lacy B, et al. Transanal Total Mesorectal Excision for Rectal Cancer: Outcomes after 140 Patients. Journal of the American College of Surgeons. 2015;221(2):415-23.
18. Detering R, Roodbeen SX, van Oostendorp SE, Dekker JT, Sietses C, Bemelman WA, et al. Three-Year Nationwide Experience with Transanal Total Mesorectal Excision for Rectal Cancer in the Netherlands: A Propensity Score-Matched Comparison with Conventional Laparoscopic Total Mesorectal Excision. Journal of the American College of Surgeons. 2019;228(3):235-44.e1.
19. Larsen SG, Pfeffer F, Kørner H. Norwegian moratorium on transanal total mesorectal excision. The British journal of surgery. 2019;106(9):1120-1.
20. Roodbeen SX, Spinelli A, Bemelman WA, Di Candido F, Cardepont M, Denost Q, et al. Local Recurrence After Transanal Total Mesorectal Excision for Rectal Cancer: A Multicenter Cohort Study. Annals of surgery. 2020.
21. Lau S, Kong J, Bell S, Heriot A, Stevenson A, Moloney J, et al. Transanal mesorectal excision: early outcomes in Australia and New Zealand. British Journal of Surgery. 2021.
22. Shibata D, Paty PB, Guillem JG, Wong WD, Cohen AM. Surgical management of isolated retroperitoneal recurrences of colorectal carcinoma. Diseases of the colon and rectum. 2002;45(6):795-801.

**Figure legends**

Figure 1a and b: Circumferential resection margin (CRM) positivity and R0 resection rates between groups

Figure 2a and b: Distal resection margin (DRM)in mm and Lymph node yield between groups

Figure 3a and b: Overall complications and anastomotic leak rates between groups

Figure 4a and b: Wound infection rates and post-operative ileus rates between groups

Figure 5: Comparison of mean operation time

**List of Supporting Information**

Table S1: Newcastle – Ottawa Scale

Table S2: Patient ASA characteristics

Table S3: Tumour staging characteristics (TNM staging)

Table S4: Location of tumour and adjuvant treatment

Figure S1: PRISMA diagram

**Tables**

| | | | | | | | Sex | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Author and Year** | **Study Period** | **No. of centres** | **Study Design** | **Total patients** | **Total robot** | **Total taTME** | **taTME Male** | **taTME Female** | **Robot Male** | **Robot Female** |
| Law, 2018 | 2014-2017 | 1 | Retrospective study from prospectively collected database | 80 | 40 | 40 | 29 | 11 | 26 | 14 |
| Lee, 2018 | 2013-2014 | 1 | Prospective | 45 | 24 | 21 | 16 | 5 | 13 | 11 |
| Perez, 2018 | 2013-2016 | 2 | Retrospective study from prospectively collected database | 115 | 60 | 55 | 40 | 15 | 44 | 16 |
| Seow-En, 2018 | 2012-2015 | 1 | Retrospective | 27 | 21 | 6 | 3 | 3 | 14 | 7 |
| Lee, 2019 | 2011-2017 | 5 | Prospective | 596 | 370 | 226 | 142 | 84 | 235 | 135 |
| Bedrikovetski, 2020 | 2007-2018 | BCCA | Retrospective study from prospectively collected | 202 | 117 | 85 | 60 | 25 | 74 | 43 |

**Table 1: Patient characteristics**

**Supporting information**

**Table S1: Newcastle – Ottawa Scale**

| Study ID | Selection | Comparability | Outcome | Total |
|---|---|---|---|---|
| Perez, 2018 | 4 | 2 | 2 | 8 |
| Lee, 2019 | 4 | 2 | 2 | 8 |
| Bedrikovetski, 2020 | 4 | 2 | 2 | 8 |
| Lee, 2018 | 4 | 2 | | 8 |
| Law, 2018 | 4 | 2 | 2 | 8 |
| Seow-En, 2018 | 4 | 2 | 2 | 8 |

**Table S2: Patient ASA characteristics**

| | ASA | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Author and Year | taTME ASA 1 | Robot ASA 1 | taTME ASA 2 | Robot ASA 2 | taTME ASA 3 | Robot ASA 3 | taTME ASA 4 | Robot ASA 4 |
| Lee, 2018 | 8 | 7 | 12 | 16 | 1 (includes ASA 4) | 1 (includes ASA 4) | | |
| Perez, 2018 | 7 | 4 | 33 | 29 | 22 | 15 | 5 | 0 |
| Seow-En, 2018 | | | | | | | | |
| Lee, 2019 | | | | | 47 (3+) | 70 (3+) | | |
| Bedrikovetski, 2020 | 19 | 26 | 44 | 62 | 20 | 26 | 0 | 1 |

**Table S3: Tumour staging characteristics (TNM staging)**

| | T- stage | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Author and Year | taTME no tumour | Robot no tumour | taTME Tis | Robot Tis | taTME T1 | Robot T1 | taTME T2 | Robot T2 | taTME T3 | Robot T3 | taTME T4 | Robot T4 |
| Lee, 2018 | 4 | 2 | 0 | 2 | 4 | 4 | 4 | 9 | 8 | 7 | 1 | 0 |
| Perez, 2018 | 5 | 2 | | | 7 | 10 | 18 | 20 | 17 | 25 | 2 | 0 |
| Seow-En, 2018 | | | | | | | | | | | | |
| Lee, 2019 | 39 | 40 | | | 15 | 28 | 62 | 81 | 100 | 199 | 10 | 18 |
| Bedrikovetski, 2020 | 15 | 17 | | | 10 | 19 | 24 | 34 | 36 | 45 | 0 | 2 |

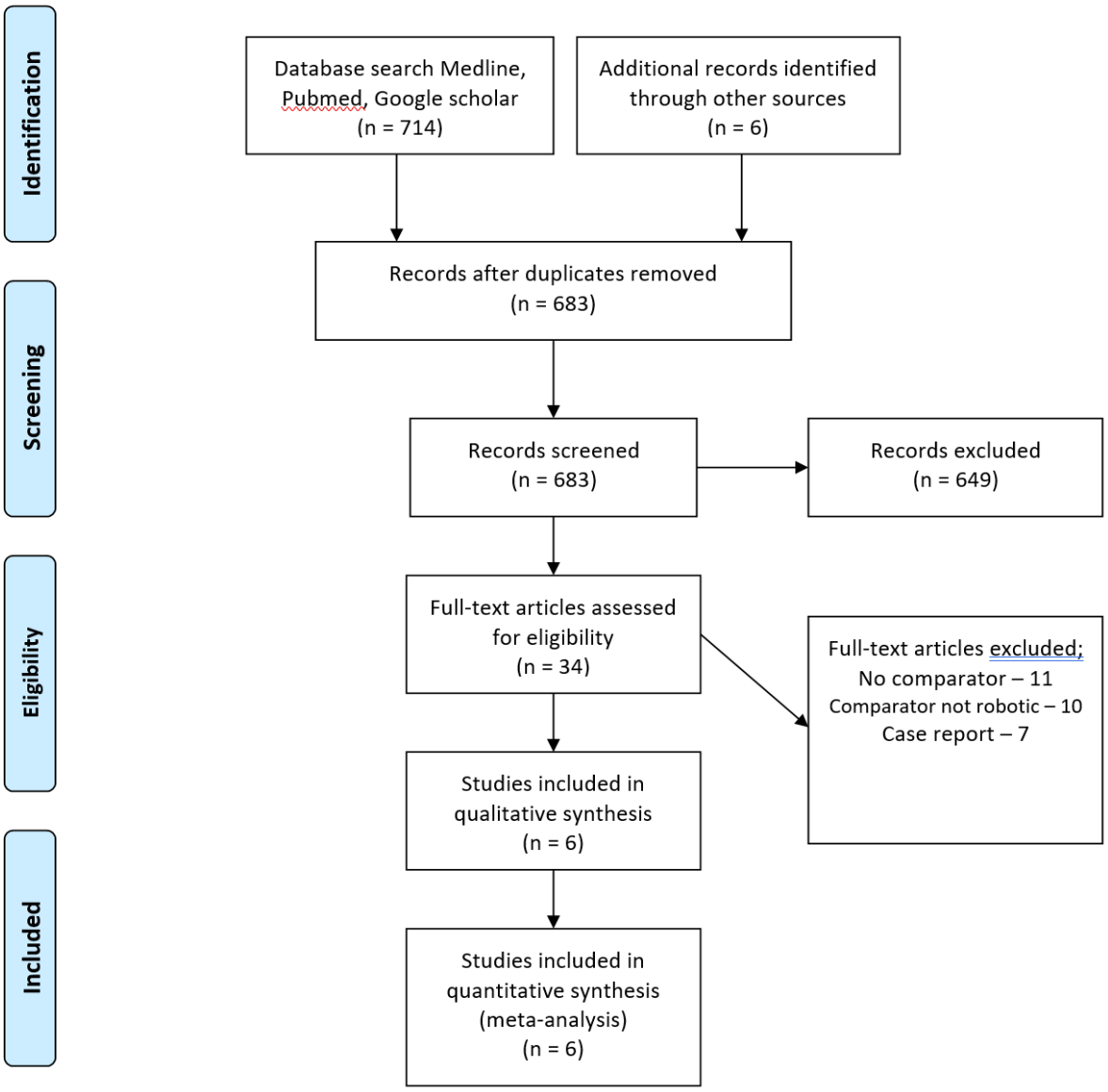
| | N stage | | | | | |
|---|---|---|---|---|---|---|
| Author and Year | taTME N0 | Robot N0 | taTME N1 | Robot N1 | taTME N2 | Robot N2 |
| Lee, 2018 | 15 | 21 | 5 | 3 | 1 | 0 |
| Perez, 2018 | 31 | 37 | 10 | 14 | 4 | 6 |
| Seow-En, 2018 | | | | | | |
| Lee, 2019 | 150 | 219 | 53 | 105 | 23 | 46 |
| Bedrikovetski, 2020 | 59 | 82 | 18 | 26 | 8 | 9 |

| | Overall stage | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Author and Year | taTME Stage 0 | Robot Stage 0 | taTME Stage1 | Robot Stage 1 | taTME Stage 2 | Robot Stage 2 | taTME Stage 3 | Robot Stage 3 | taTME Stage 4 | Robot Stage 4 |
| Lee, 2018 | | | 5 | 4 | 5 | 12 | 5 | 5 | 6 | 3 |
| Perez, 2018 | | | | | | | | | | |
| Seow-En, 2018 | | | 0 | 3 | 2 | 6 | 2 | 9 | 2 | 3 |
| Lee, 2019 | | | | | | | | | | |
| Bedrikovetski, 2020 | | | | | | | | | | |

**Table S4: Location of tumour and adjuvant treatment**

| | Distance from anal verge | | | | | | Neoadjuvant | | Diverting loop ileostomy | |
|---|---|---|---|---|---|---|---|---|---|---|
| Author and Year | taTME <6cm (low) | Robot <6cm | taTME 6-12cm (mid) | Robot 6-12cm | taTME average | Robot average | taTME | Robot | taTME | Robot |
| Lee, 2018 | 6 | 9 | 15 | 15 | | | 14 | 12 | 15 | 11 |
| Perez, 2018 | 26 | 36 | 29 | 24 | | | 35 | 42 | 55 | 24 |
| Seow-En, 2018 | | | | | 7 (5.5-8) | 5 (4.5-8.5) | | | | |
| Lee, 2019 | 117 | 197 | 109 | 173 | | | 160 | 256 | 212 | 299 |
| Bedrikovetski, 2020 | 53 | 70 | 29 | 39 | | | 63 | 61 | 84 | 85 |

**Figure S1: PRISMA diagram**



| *Author and Year* | *RoboTME CRM+ve* | *RoboTME CRM−ve* | *taTME CMR+ve* | *taTME CRM−ve* | *Weight* | *Odds Ratio [95%CI]* |
|---|---|---|---|---|---|---|
| Law et al., 2018 | 2 | 38 | 0.5 | 39.5 | 2.9 | 4.16 [0.18, 95.18] |
| Lee et al., 2018 | 2 | 22 | 1 | 20 | 5.9 | 1.82 [0.15, 21.62] |
| Lee et al., 2019 | 21 | 349 | 12 | 214 | 84.6 | 1.07 [0.52, 2.23] |
| Bedrikovetski et al., 2020 | 6 | 111 | 1 | 84 | 6.6 | 4.54 [0.54, 38.43] |
| ***Total*** | ***31 (5.6%)*** | ***520 (94.4%)*** | ***14.5 (3.9%)*** | ***357.5 (96.1%)*** | ***100%*** | |
| Pooled Odds Ratio | | | | | | 1.43 [0.76, 2.71] |

***Heterogeneity:I2=0.00%, p−value=0.531***

***Cochran−Mantel−Haenszel Test: p−value=0.333***

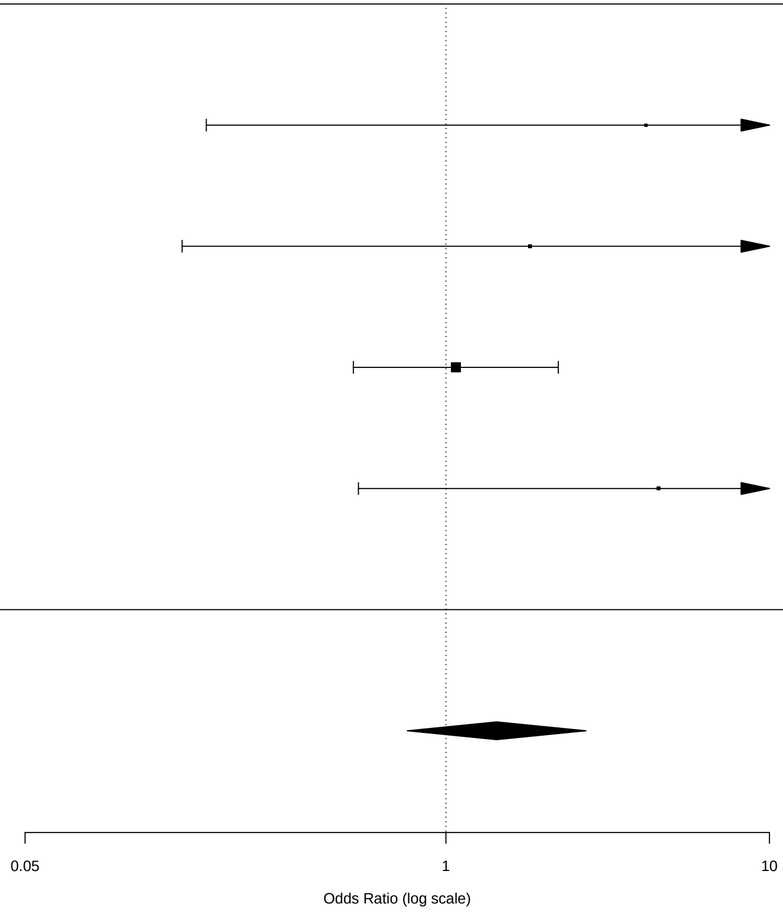



Figure 1a Circumferential Resection Margin (CRM) positivity

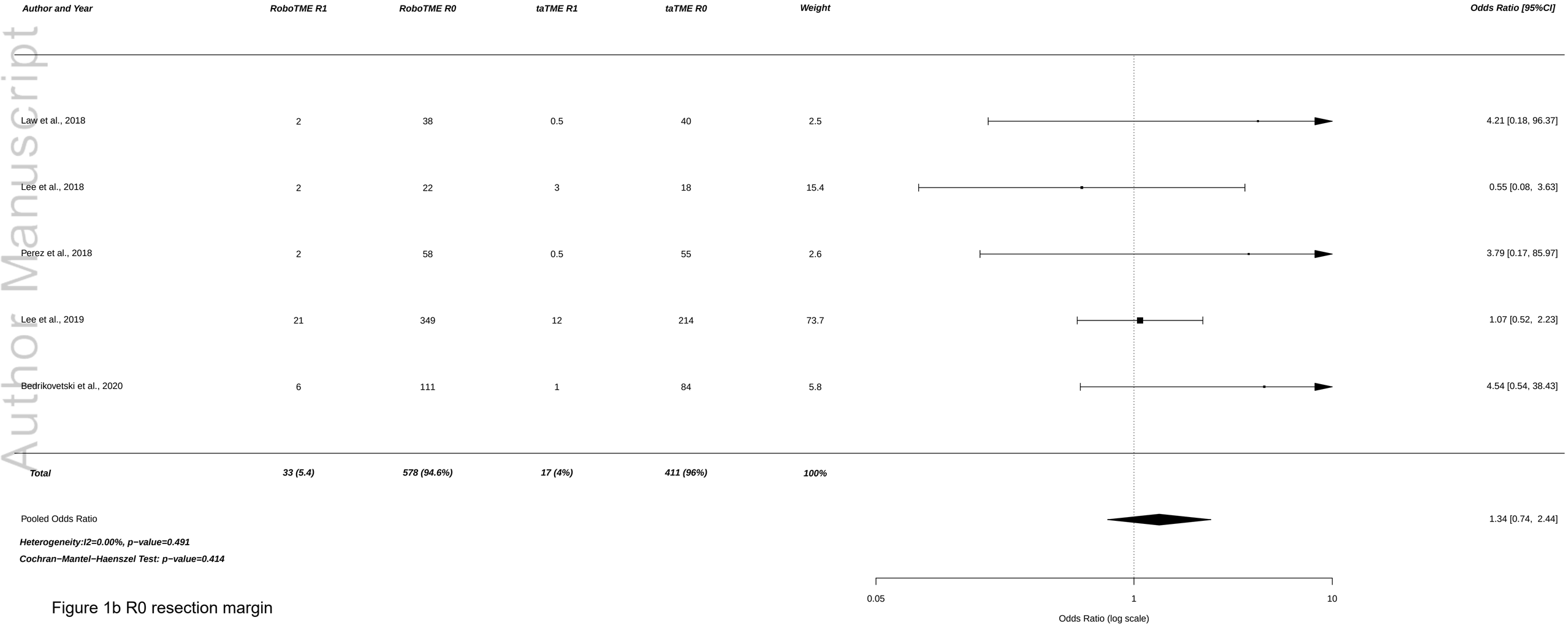



Figure 1b R0 resection margin

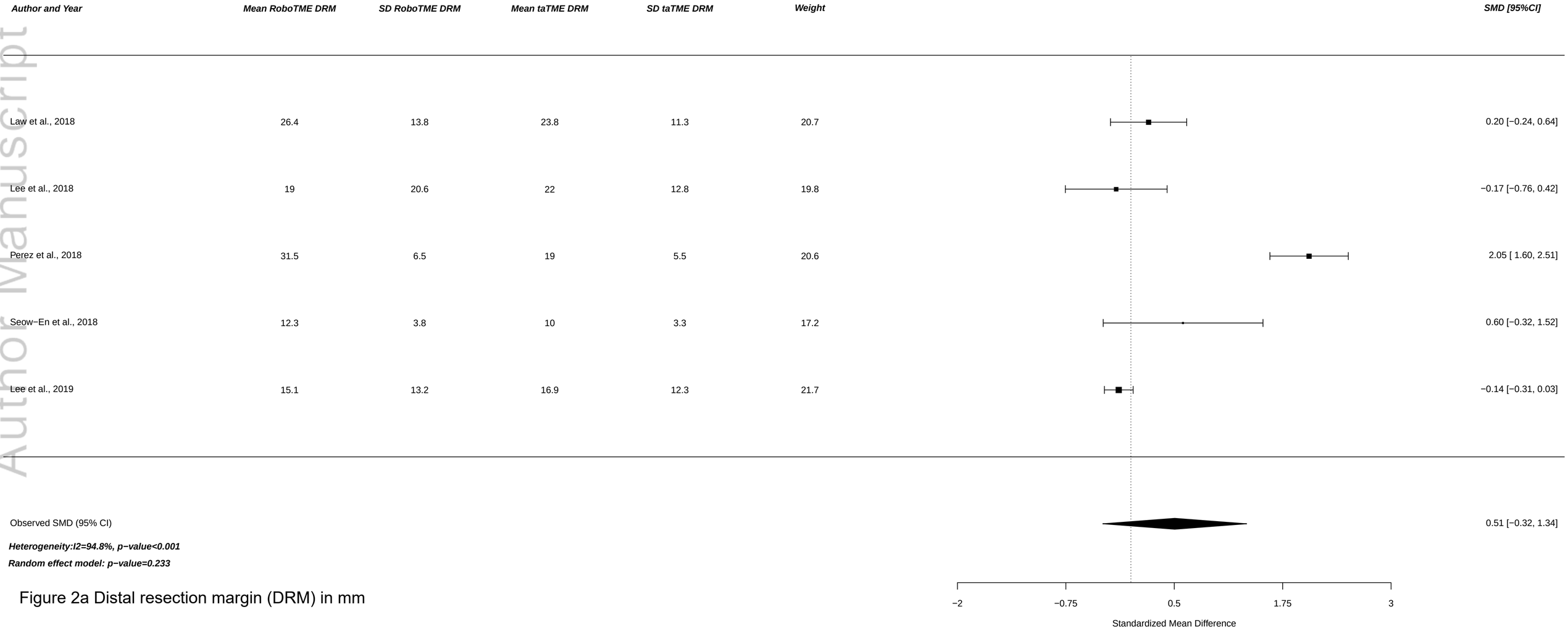



Figure 2a Distal resection margin (DRM) in mm

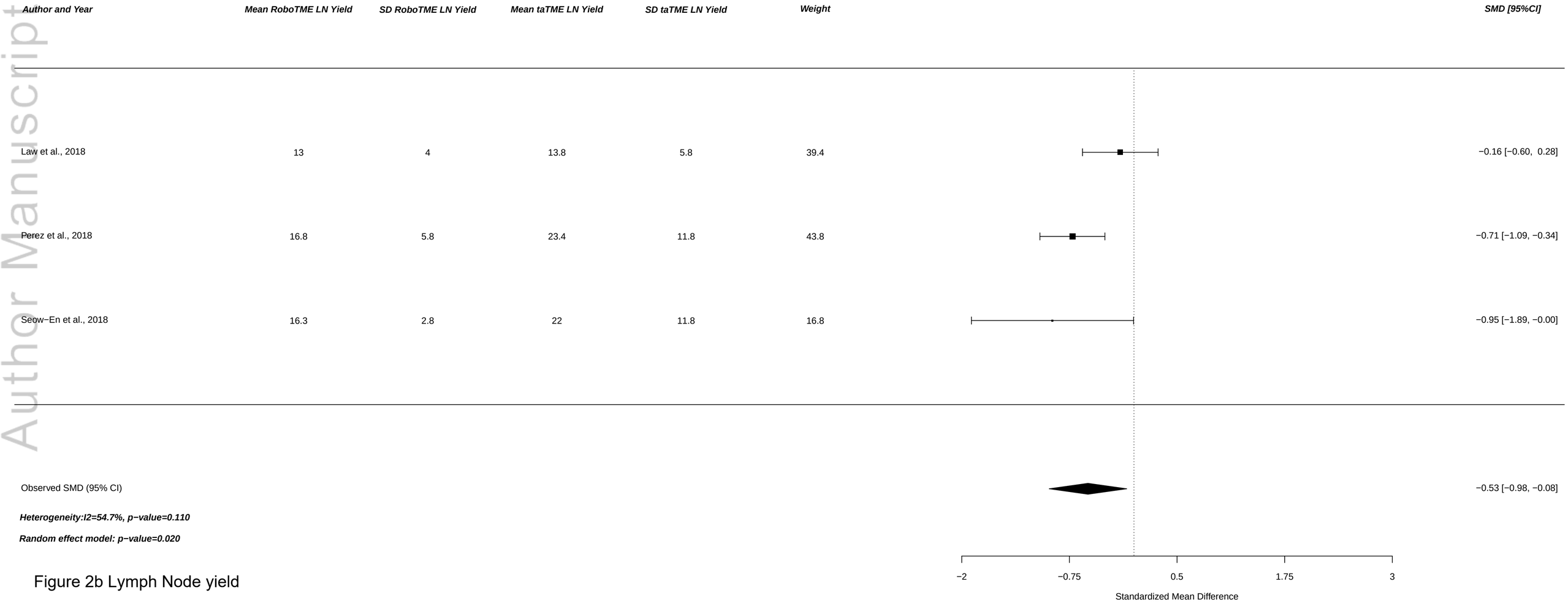



Figure 2b Lymph Node yield

| *Author and Year* | *RoboTME OC+ve* | *RoboTME OC−ve* | *taTME OC+ve* | *taTME OC−ve* | *Weight* | *Odds Ratio [95%CI]* |
|---|---|---|---|---|---|---|
| Law et al., 2018 | 22 | 18 | 12 | 28 | 17.2 | 2.85 [1.14, 7.15] |
| Perez et al., 2018 | 39 | 21 | 38 | 17 | 44.1 | 0.83 [0.38, 1.81] |
| Seow−En et al., 2018 | 7 | 14 | 6 | 0.5 | 19.4 | 0.04 [0.00, 0.86] |
| Lee et al., 2019 | 7 | 363 | 5 | 221 | 19.3 | 0.85 [0.27, 2.72] |
| ***Total*** | ***71 (15.3)*** | ***416 (84.7%)*** | ***61 (18.6%)*** | ***266.5 (81.4%)*** | ***100%*** | |
| Pooled Odds Ratio | | | | | | 1.03 [0.63, 1.68] |

***Heterogeneity:I2=68.2%, p−value=0.024***

***Cochran−Mantel−Haenszel Test: p−value=0.989***

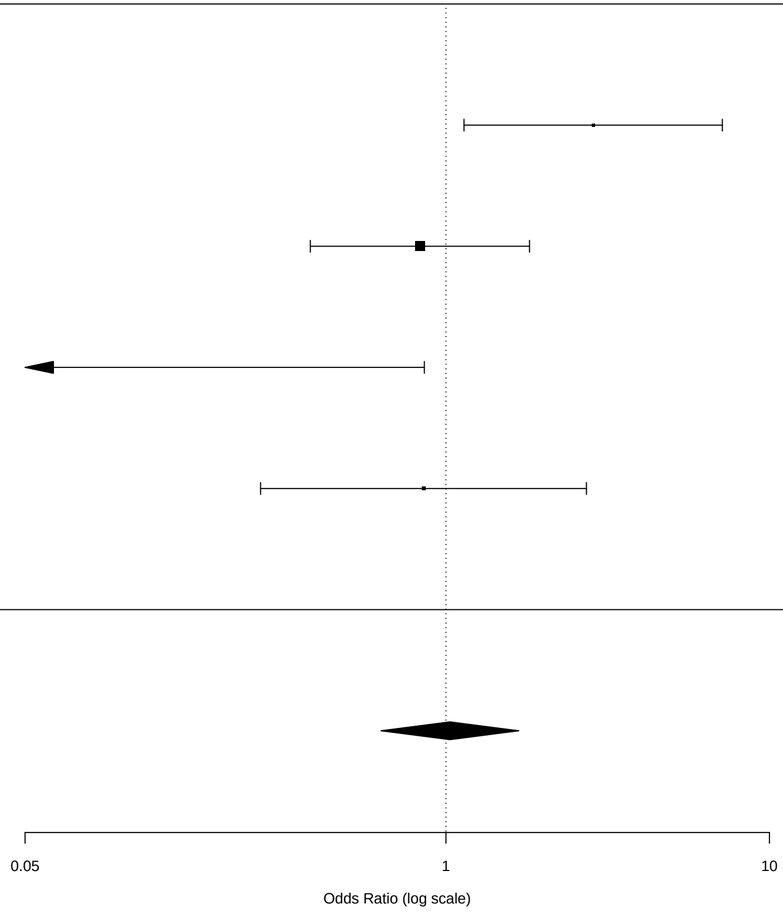



Figure 3a Overall complication rate

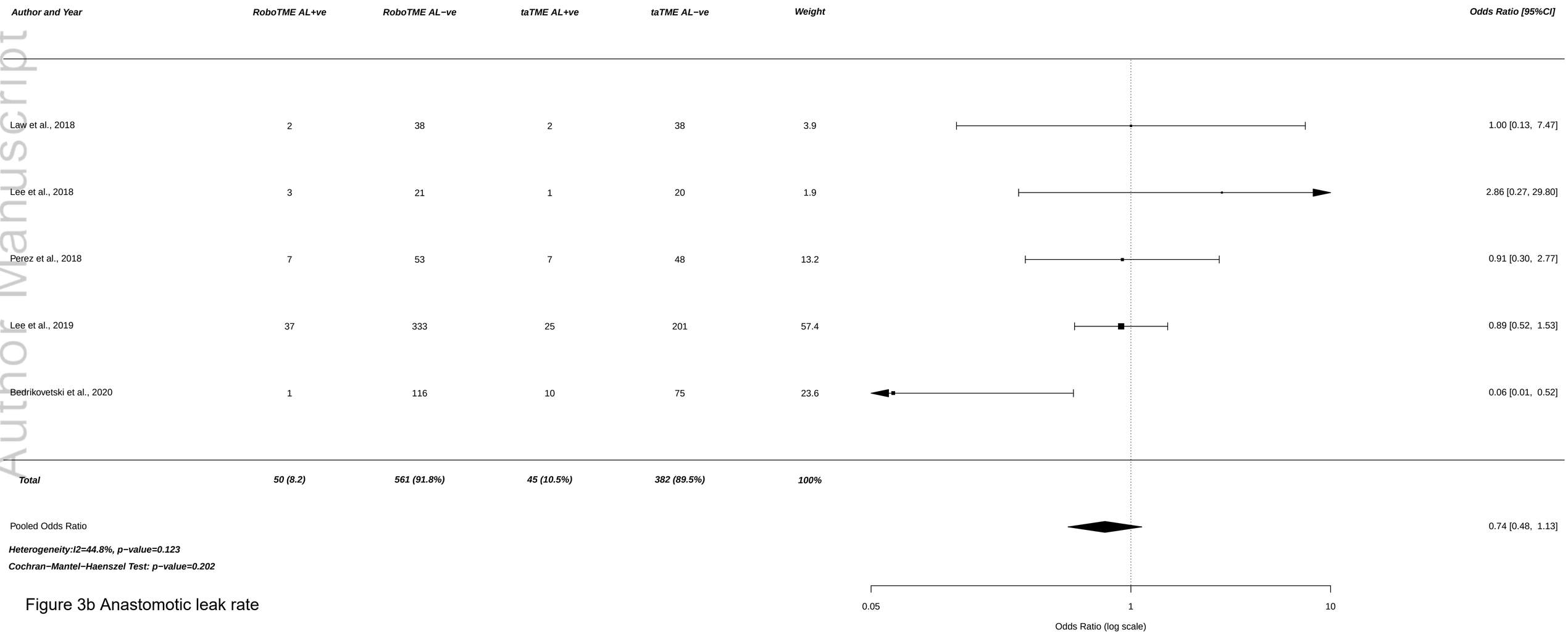



Figure 3b Anastomotic leak rate

| *Author and Year* | *RoboTME WI+ve* | *RoboTME WI−ve* | *taTME WI+ve* | *taTME WI−ve* | *Weight* | *Odds Ratio [95%CI]* |
|---|---|---|---|---|---|---|
| Lee et al., 2018 | 5 | 19 | 10 | 11 | 70.5 | 0.29 [0.08, 1.07] |
| Perez et al., 2018 | 2 | 58 | 2 | 53 | 16.8 | 0.91 [0.12, 6.72] |
| Seow−En et al., 2018 | 0.5 | 20.5 | 1 | 5 | 12.7 | 0.12 [0.00, 4.17] |
| ***Total*** | ***7.5 (7.1)*** | ***97.5 (92.9%)*** | ***13 (15.9%)*** | ***69 (84.1%)*** | ***100%*** | |
| Pooled Odds Ratio | | | | | | 0.37 [0.13, 1.04] |

***Heterogeneity:I2=0.00%, p−value=0.521***

***Cochran−Mantel−Haenszel Test: p−value=0.094***

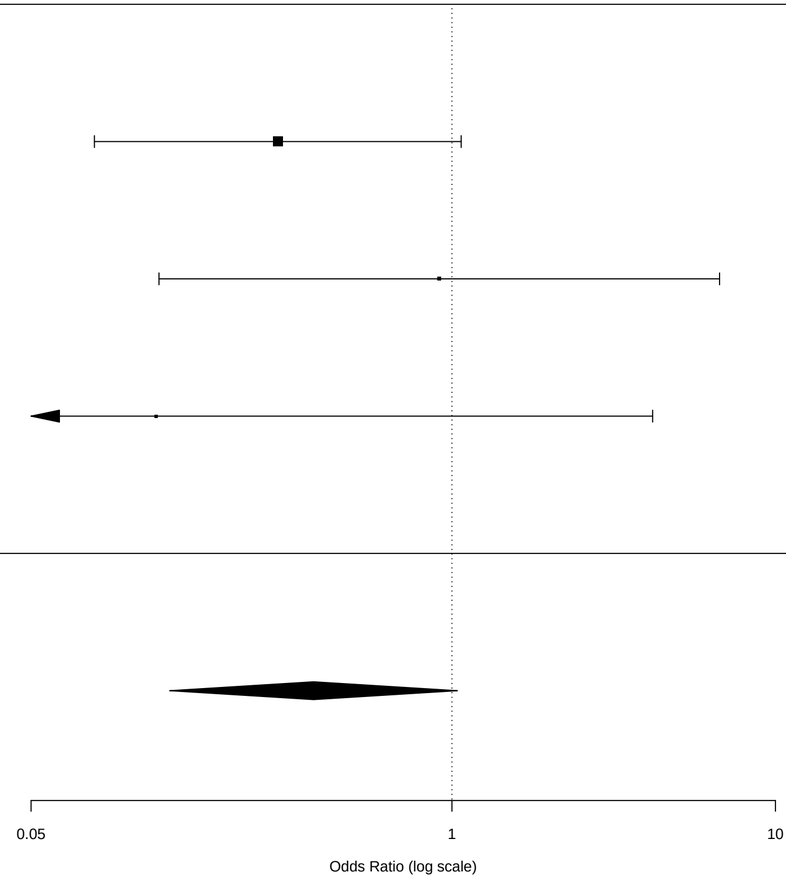



Figure 4a Wound infection rates

| *Author and Year* | *RoboTME Ileus+ve* | *RoboTME Ileus−ve* | *taTME Ileus+ve* | *taTME Ileus−ve* | *Weight* | *Odds Ratio [95%CI]* |
|---|---|---|---|---|---|---|
| Lee et al., 2018 | 1 | 23 | 0.5 | 20.5 | 1.1 | 1.78 [0.06, 55.96] |
| Lee et al., 2019 | 49 | 321 | 25 | 201 | 57.3 | 1.23 [0.73, 2.05] |
| Bedrikovetski et al., 2020 | 13 | 104 | 19 | 66 | 41.6 | 0.43 [0.20, 0.94] |
| ***Total*** | ***63 (12.3%)*** | ***448 (87.7%)*** | ***44.5 (`3.4%)*** | ***287.5 (86.6%)*** | ***100%*** | |
| Pooled Odds Ratio | | | | | | 0.90 [0.60, 1.37] |

***Heterogeneity:I2=59.9%, p−value=0.082***

***Cochran−Mantel−Haenszel Test: p−value=0.707***

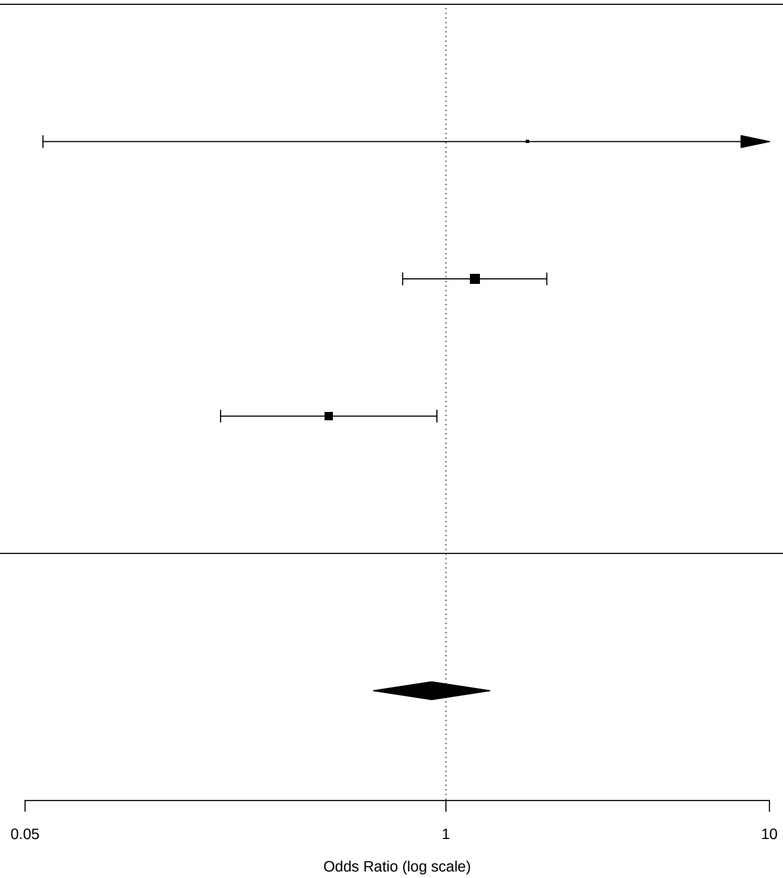



Figure 4b Post op ileus rates

| Author and Year | Mean RoboTME OT | SD RoboTME OT | Mean taTME OT | SD taTME OT | Weight | SMD [95%CI] |
|---|---|---|---|---|---|---|
| Law et al., 2018 | 327.1 | 91.3 | 287.6 | 71.3 | 29.2 | 0.48 [ 0.03, 0.92] |
| Lee et al., 2018 | 252 | 77.3 | 267 | 77.6 | 23.9 | −0.19 [−0.78, 0.40] |
| Perez et al., 2018 | 306 | 95 | 333.8 | 112.5 | 32.1 | −0.27 [−0.63, 0.10] |
| Seow−En et al., 2018 | 135.7 | 25 | 120.3 | 9 | 14.8 | 0.66 [−0.27, 1.58] |
| Observed SMD (95% CI) | | | | | | 0.11 [−0.34, 0.55] |

***Heterogeneity:I2=63.9%, p−value=0.034***

***Random effect model: p−value=0.642***

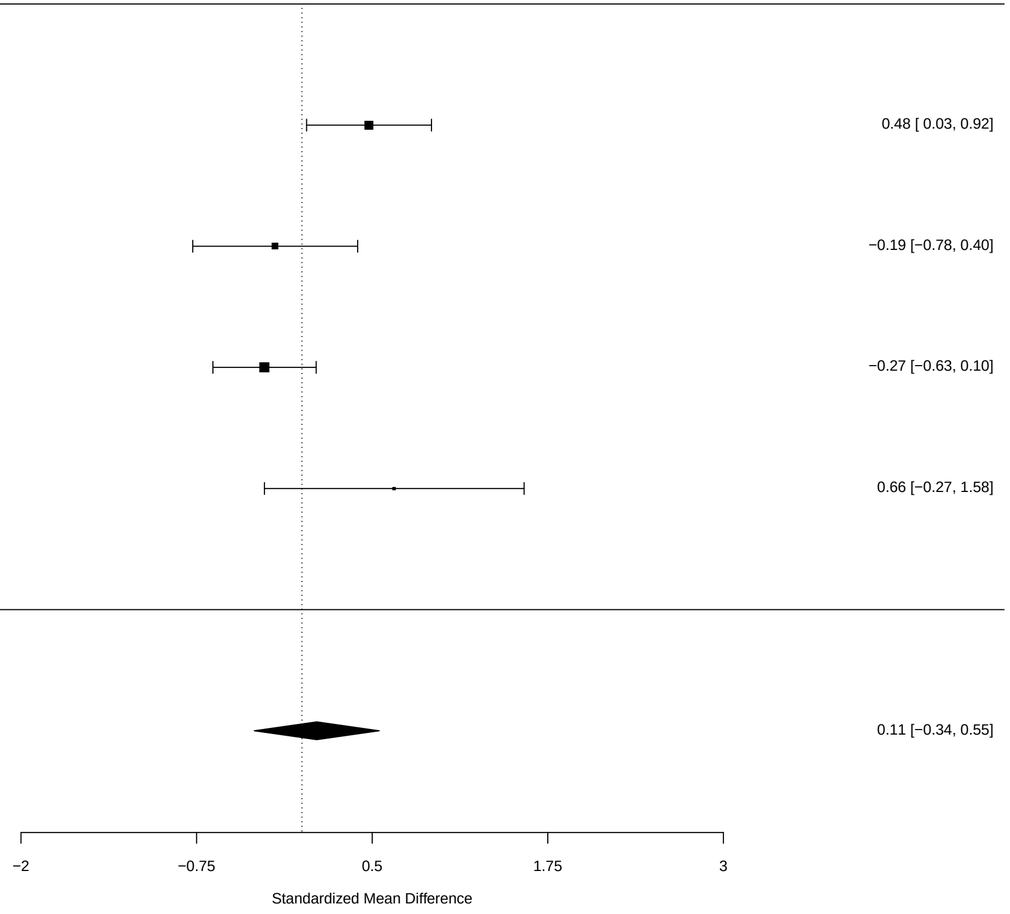



Figure 5 Operative time in minutes