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REVIEW

Can ventral TAPP achieve favorable outcomes in minimally invasive ventral hernia repair? A systematic review and meta-analysis

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Abstract

Purpose The concept of the transabdominal preperitoneal (TAPP) was transferred from the inguinal hernia repair to be adopted in minimally invasive ventral hernia repair (VHR) and since then it has been gaining popularity. However, there are minimal data supporting the ventral TAPP (vTAPP) technique which may lead to reticence in the adoption of this approach. The aim of this meta-analysis was to evaluate the outcomes of patients who received minimally invasive vTAPP for VHR.

Study design A systematic search was performed of PubMed, Science Direct, Google Scholar and Cochrane Library until July 2022. We selected studies that compared the vTAPP technique with any of other minimally invasive techniques. A meta-analysis was done for the outcomes of perioperative characteristics and postoperative parameters.

Results A total of 9 studies (1429 patients) were identified. vTAPP was associated with considerable benefit when compared to IPOM. vTAPP was less painful (MD = − 1.01; 95% CI [− 1.39, − 0.64], $p < 0.00001$), of reduced average cost (MD = − 457.10; 95% CI [− 457.27, − 456.92], $p < 0.00001$) and decreased SSI (OR = 0.29; 95% [0.09, 0.96], $p = 0.04$). On the other hand, the vTAPP approach consumed less operative time (MD: − 31.01, 95% CI [− 33.50, − 28.51]), $p < 0.00001$) and shorter hospital stay than the e-TEP approach.

Conclusion vTAPP appears to be safe and effective procedure for VHR, superior or similar to other minimally invasive techniques for perioperative characteristics and short-term outcomes.

Keywords Ventral hernia repair · Trans-Abdominal PrePeritoneal (TAPP) · Minimally invasive surgery

Introduction

Ventral hernia repair (VHR) is one of the most common operations performed worldwide. Open sublay operation has long been the highly frequented procedure [1]. The introduction of minimally invasive techniques has allowed to reduce septic complications and hospital stay. Laparascopic intraperitoneal onlay mesh (IPOM) repair was the most commonly used method. However, several possible complications due to the interaction of the mesh with the visceral organs such as adhesion formation and enterocutaneous fistula can occur after IPOM repair [2]. This eventually led surgeons to focus attention in other mesh placements. Other minimally invasive extraperitoneal mesh placement procedures have been slowly growing as possible safer alternatives to IPOM. The concept of the transabdominal preperitoneal (TAPP) and extraperitoneal approach (TEP) was transferred from the inguinal hernia repair to be adopted in minimally invasive VHR.

Ventral TAPP (vTAPP) repair has multiple following benefits: eliminating the need for mesh fixation causing less chronic pain, less bowel abdominal adhesions due to the position of the mesh extraperitoneally and lower cost due to the use of a non-coated mesh [3]. A meta-analysis of 11 studies found that there were no statistically significant differences between minimally invasive intraperitoneal and extraperitoneal mesh placement for short-term results [1]. However, this analysis included comparisons that combined enhanced view TEP (e-TEP) and vTAPP procedures.

According to the International Endohernia Society (IEHS) guidelines, both laparoscopic pre-peritoneal and

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retro muscular techniques are feasible options for the treatment of small- and medium-sized ventral hernias [4, 5]. Therefore, these procedures have been criticized for the necessity of extensive dissection and demanding steep learning curve [1]. A systematic review and meta-analysis reported the feasibility and safety of the e-TEP approach for minimally invasive VHR [6]. However, there are minimal data supporting the vTAPP technique which may lead to reticence in the adoption of vTAPP. To the best of our knowledge, this is the first systematic review and meta-analysis aims to evaluate the outcomes of patients who received minimally invasive vTAPP for VHR.

Thus, the objective of the present study was to summarize and ascertain the safety, short-term and perioperative outcomes of vTAPP compared to other procedures for the treatment of ventral hernias.

Methods

Review design and registration

The systematic review was conducted and reported according to the Cochrane Handbook of Systematic Reviews and Interventions, the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) and assessing the Methodological Quality of Systematic Reviews (AMSTAR) guidelines [7, 8]. A priori protocol was published in PROSPERO (ID: CRD42022330518).

Criteria of eligibility

To be included, trials were required to meet the following PICOs criteria.

P (patients)

Adult patients who underwent minimally invasive elective VHR were included. All medial, lateral ventral or incisional hernias were included in this study.

No restrictions were placed on any study comparator group (such as operative technique, hernia size and type of mesh).

I (intervention) and C (control)

We included all studies that compared the vTAPP technique with any of other minimally invasive techniques. Trials were included irrespective of the surgical approach (robotic or laparoscopic approach) and mesh positioning (the preperitoneal space versus intraperitoneal mesh placement or the retro-rectus space).

Articles that not clearly describe preperitoneal space dissection or not presenting results separately for the vTAPP technique were excluded.

O (outcome)

The primary outcome of the study was to review the safety of vTAPP technique for VHR. These include perioperative characteristics (operative time, intra operative complications and conversion rate) and postoperative parameters (surgical site infection (SSI), seroma, hematoma and recurrence). The secondary outcomes focused on post-operative pain, cost and quality of life.

S (study type)

All available studies (RCTs and cohort studies) that directly compared vTAPP versus other minimally invasive techniques for VHR were eligible for inclusion. Case series with fewer than 10 patients were excluded.

Search strategy

The online databases of PubMed, Science Direct, Google Scholar and Cochrane Library were searched combining keywords and using Boolean operators until July 2022. Combinations of the following search terms were used: ventral hernia, incisional hernia, umbilical hernia, abdominal wall, Spiegalian hernia, laparoscopic, robotic, laparoscopy, minimally invasive, preperitoneal, TAPP, trans abdominal preperitoneal and Preperitoneal Onlay Mesh Repair. Studies not published in English were excluded. The reference lists of retrieved studies were further screened to ensure that the search was as complete as possible.

When institutions published duplicate or overlapping data sets were detected, the largest report was selected.

Study selection and data collection

Two authors (MM and GHK) independently carried out the searches and articles were screened for relevance based on title and abstract. Full texts of potentially eligible publications were obtained. Data were extracted independently by MM and GHK. Disagreements were resolved through discussion as needed or by appeal to a senior author (KH).

Risk of bias and quality assessment

The quality of each enrolled study was evaluated independently by two authors (MM and GHK). The methodological quality of the selected studies was assessed using the modified Jadad scale according a maximum of eight points. Studies with a score equal to or higher than 4 indicate high quality [9]. Quality analysis of non-randomized was evaluated using the Methodological Index for Non-Randomized Studies (MINORS) index. High-quality studies were considered those that reached score ≥ 14 for comparative studies [10]. Any disagreement was resolved via discussion.

Statistical analysis

Measure of effect size: The odds ratio (OR) was used as the statistical measure for dichotomous outcomes with 95% confidence intervals (CIs) estimated using the Mantel–Haenszel method. All Results were presented in forest plots.

Assessment of heterogeneity: Between-study heterogeneity was assessed using the Cochrane Chisquare test (Q test) and the I^2 test. If the I^2 statistic was greater than 50%, heterogeneity was considered as significant, a random-effects model was used; otherwise a fixed-effects was performed.

Sensitivity analyses were performed if the I2 statistic was greater than 75%, by excluding the outlier articles and a new Forrest Plot was performed in a random model to evaluate the results.

All Statistical analysis were carried out using the Review Manager 5.1 (Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration, 2008).

Results

Search results

A total of 418 records were retrieved through database searching. After removing duplicates and screening title and abstract, a total of 29 full-text studies were assessed for full text screening. Of these, three were excluded because they included the same cohort of patients [11–13] and two compared vTAPP with open procedure [14, 15].

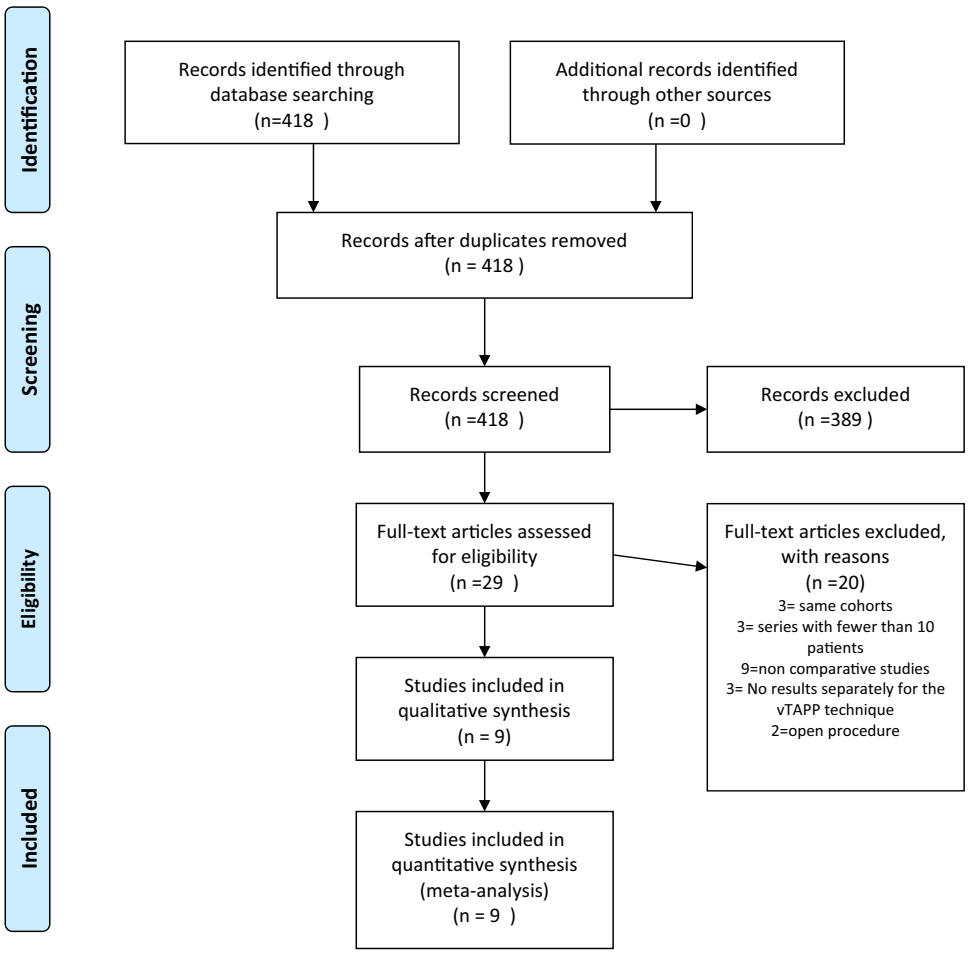

Fig. 1 PRISMA flowchart

Table 1 Baseline Characteristics of patients with minimally invasive ventral hernia repair

Author, year	Surgical procedure *n* (%)	Type of hernia, *n* (%)	Area of hernia defect (cm^2)	Follow (mo)	Outocme (mo)
Kudsi 2022 [19]	Robotic 506(100)	Ventral 333(65.8) Incisional 173(34.2)	9.6 (3.1–19.6)	36.1	A,B,C,D,E,F,G,H
Megas 2022 [2]	Laparoscopic 54 (100)	Epigastric 2 (3.7) Epigastric and umbilical 6 (11.1) Umbilical 31(57.4) Spigelian 1(1.8) Incisional 14(2.6)	TAPP: 2.98 ± .945 IPOM: 3.35 ± 1.17	TAPP: 14.7 ± 15.7 IPOM: 31.96 ± 27.57	A,B,D,EF,G,I,H,J
Sharbaugh 2021 [22]	Robotic 80(100)	Sub xiphoid 12(8.2) Epigastric 30(20.5) Umbilical 68(46.5) Infra umbilical 21(14.4) Suprapubic 7(4.8) Lateral 8(5.8)	7.01 ± 8.63	20.85	B,C,D,E,F
Baur 2021 [16]	Robotic 118(100)	Primary umbilical 63(56.2) Primary epigastric 23(20.5) Spigelian 3 (2.7) Incisional 23(20.5)	vTAPP: 8.8 ± 9.4 TEP: 20.1 ± 17.7	> 6 weeks	A,F,E,H,I,G
Donovan 2021 [17]	Laparoscopic 77(100)	Spigelian 77(100)	3.6 (1.8–7.1)	vTAPP31 (7–48) TEP 9 (1–22)	B,D,E,H
Ruiz 2019 [21]	Laparoscopic 59(100)	Incisional 47(80) Umbilical 2(3.4) Lumbar 2 (3.4) Spiegel 8(13.5)	2.91 ± 5.44	24	B,H
Kennedy 2018 [18]	Robotic 63 (100)	NM	IPOM 3.40 ± 1.51 vTAPP 3.98 ± 2.61	> 1 mo	A,B,C,D,E,F,F
Shetty 2015 [23]	Laparoscopic (100)	Primary umbilical or para-umbilical hernia	NM	32	A,B,D,E,F,G,H,I,J
Prasad 2011 [20]	Laparoscopic 279 (100)	Incisional hernia 195(70) Umbilical and Paraumbilical 68(24.3) Epigastric 9(3.2) Spigelian 6(2.1) Lumbar 1 (0.3)	vTAPP 30.8 ± 24.4 IPOM 29.9 ± 22.0	vTAPP22.7 ± 13.4 IPOM 22.5 ± 11.9	A,B,C,D,E,F,G,H,I,J

vTAPP ventral transabdominal preperitoneal repair, *IPOM* intraperitoneal onlay mesh repair, *TEP* total extraperitoneal repair, *NM* not mentioned, *A* operative time, *B* intra-operative complications, *C* conversion rate, *D* surgical site infection, *E* seroma, *F* hematoma, *G* hospital stay, *H* recurrence, *I* post-operative pain, *J* cost

Finally, nine full articles [2, 16–23] met the inclusion criteria and entered the meta-analysis model. The search and study selection history are summarized in the PRISMA flow diagram (Fig. 1).

Study characteristics

Within the nine studies included, two were prospective [20, 23] and seven were retrospective series [2, 15–19, 21, 22] (Table 1). Six studies [2, 18–20, 22, 23] considered comparison between vTAPP and IPOM, and four studies [16, 17, 19, 21] focused upon the comparison between vTAPP and e-TEP. Overall, 1429 patients were included in the analysis. Of these,

Table 2 Studies' details and quality assessment

Author, year	Country and study interval	Study methodology	Intervention, *n* (%)	MINORS score
Kudsi 2022 [19]	MA, USA 2013–2020	RC	vTAPP 156 IPOM 197 TEP 153	16
Megas 2022 [2]	Germany June 2014–August 2020	RC	vTAPP 27 IPOM 27	16
Sharbaugh 2021 [22]	NY, USA 2012–2016	RC	vTAPP 61 IPOM 19	15
Baur 2021 [16]	Switzerland 2018–2020	RC	vTAPP 88 TEP 30	14
Donovan 2021 [17]	IL, USA 2009–2018	RC	vTAPP 40 TEP 37	16
Ruiz 2019 [21]	Colombia 2015–2017	RC	vTAPP 41 TEP 18	14
Kennedy 2018 [18]	NY, USA 2014–2017	RC	vTAPP 36 IPOM 27	15
Shetty 2015 [23]	Manipal,India 2008–2013	PC	vTAPP 34 IPOM 59	14
Prasad 2011 [20]	Kolkata, India 2005–2009	PC	vTAPP 68 IPOM 211	16

RC retrospective cohort, *PC* prospective cohort, *vTAPP* ventral transabdominal preperitoneal repair, *IPOM* intraperitoneal onlay mesh repair, *TEP* total extraperitoneal repair

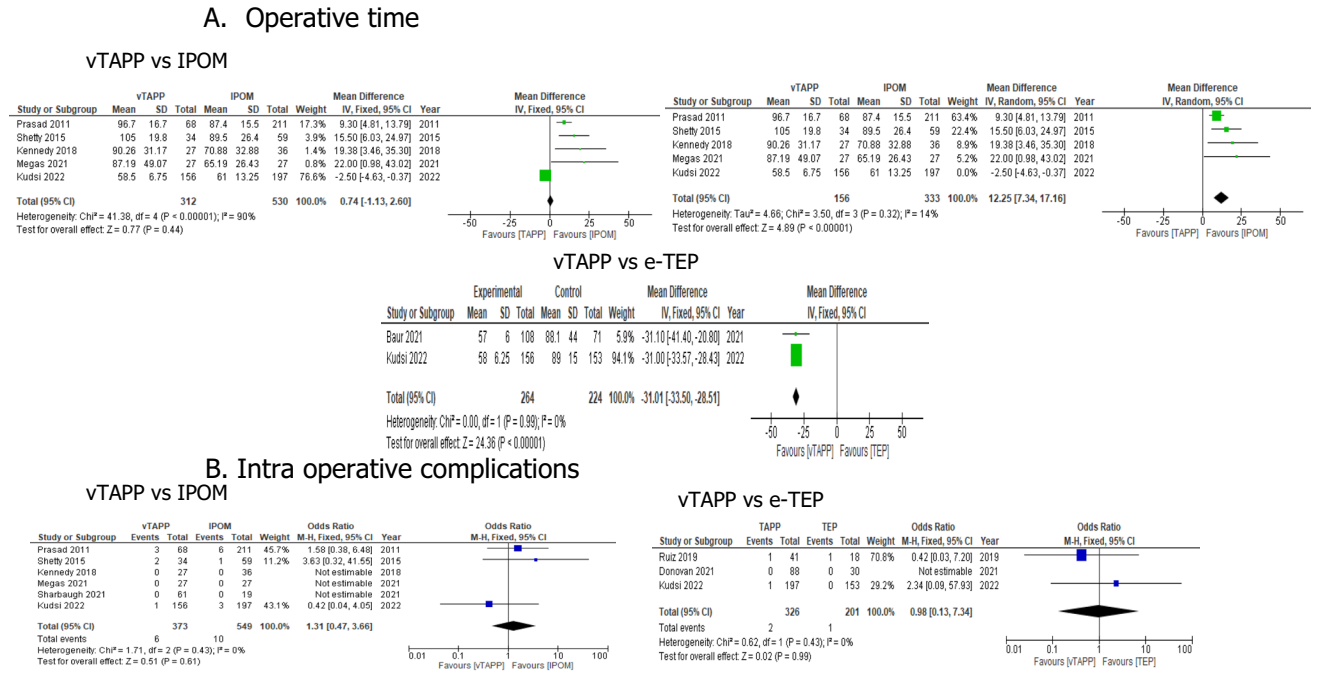

Fig. 2 Perioperative characteristics

651 (45.6%) underwent vTAPP, 540 (37.8%) IPOM and 238 (16.6%) e-TEP. Baseline characteristics of patients included in the studies are provided in Table 1. There was variability in the follow-up periods: some studies reported up to 5 years of follow-up and others reported one month outcomes. Table 2 presents the quality assessment of the included studies according to MINORS criteria.

Perioperative characteristics (Fig. 2)

Operative time

The operative time was reported in six studies. Five studies compared vTAPP to IPOM [2, 19, 20, 23], and two studies compared vTAPP to e-TEP [16, 19].

Trials comparing vTAPP with e-TEP documented a significantly shorter operative time after vTAPP repair (MD: − 31.01, 95% CI [− 33.50, − 28.51]), $p < 0.00001$, $I^2 = 0\%$). There was no significant difference between vTAPP and IPOM (MD: 0.74, 95% CI [− 1.13, 2.60]), $p = 0.44$, $I^2 = 90\%$). A sensitivity test was then performed, which showed an outlier study [19].

If data of this study were excluded, a significantly shorter operative time was found for IPOM repair with low heterogeneity (MD = 12.25; 95% CI [7.34, 17.16], $p < 0.00001$, $I^2 = 14\%$).

Intra operative complications

Summarizing all the included studies, we found an incidence of 8 in 502 (1.6%) intraoperative complications in vTAPP repair versus an incidence of 10 in 549 (1.8%) in IPOM repair and 1 in 201 (0.5%) e-TEP repair. Meta-analysis of these study results showed no significant difference between vTAPP vs IPOM (OR = 1.31; 95% CI [0.47, 3.66], $p = 0.61$; $I^2 = 0\%$) and vTAPP vs e-TEP (OR = 0.98; 95% CI [0.13, 7.34], $p = 0{,}99$, $I^2 = 0\%$).

Conversion rate

A total of four studies [18–20, 22] reported conversion rates. All these studies reported that patients did not experience any conversion in vTAPP, IPOM and e-TEP repairs. Thus meta-analysis was not feasible.

Postoperative parameters (Fig. 3)

Surgical site infection

The results of the studies [2, 17–20, 22, 23] that included information about SSI indicate that vTAPP repair result in a cumulative incidence of 4 of 413 (1%) cases vs 12 of 549 (2.1%) in IPOM repair and 1 of 190 (0.52%) in e-TEP repair. We found that there was no statistically significant difference between patients who received vTAPP repair versus e-TEP technique (OR = 2.94; 95% CI [0.46, 18.86], $p = 0.26$; $I^2 = 0\%$).

However, the comparison of the vTAPP repair with IPOM showed a lower incidence of SSI after vTAPP with significant difference (OR = 0.29; 95% [0.09, 0.96], $p = 0.04$; $I^2 = 0\%$.

Seroma

Eight studies [2, 16–20, 22, 23] provided data on seroma rates between patients receiving vTAPP, IPOM and e-TEP repair. There was no statistically significant difference in the postoperative incidence of seroma between vTAPP vs IPOM repair (17 of 373 [4.5%] vs 32 of 549 [5.8%]), OR = 0.88; 95% CI [0.47, 1. 65], $p = 0.69$; $I^2 = 0\%$) and vTAPP vs e-TEP repair (26 of 284 [9.1%] vs 17 of 220 [7.7%]), OR = 0.90; 95% CI [0.47, 1.75], $p = 0.76$; $I^2 = 21\%$).

Hematoma

Seven studies [2, 16, 18–20, 22, 23] evaluated hematoma as a complication. The results of these studies indicated that vTAPP repair resulted in fewer hematoma incidence when compared IPOM repair (5 of 373 [1.3%] vs 10 of 549 [1.82%]) and e-TEP repair (5 of 244 [2%] vs 5 of 183 [2.7%]). However, these reductions of hematoma rates did not reach statistical significance ($p = 0.38$ and $p = 0.32$, respectively).

Hospital stay

Data concerning hospital stay were reported in four studies [2, 16, 20, 23]. Only one study reported data after vTAPP and e-TEP repair. Hospital stay was significantly shorter in the vTAPP group than in the e-TEP group (1.5 ± 0.6 vs. $2.7 \pm$ days, $p < 0.001$) [16].

The comparison of vTAPP repair with IPOM repair included three studies [2, 20, 23] and showed shorter hospital stay after vTAPP repair. This reduction did not reach statistical significance (MR = − 0.04; 95% CI [− 0.19, 0.11]), $p = 0.62$). There was very high heterogeneity between the included studies ($I^2 = 82\%$).This result was strongly influenced by the study of Prasad et al. [20]. If these data are excluded, a significantly shorter hospital stay found for the vTAPP repair (MR = − 0.51; 95% CI [− 0.83, − 0.19], $p = 0.002$, $I^2 = 0\%$).

Recurrence

The incidence of hernia recurrence was documented in eight studies [2, 16–21, 23]. Summarizing the available data,

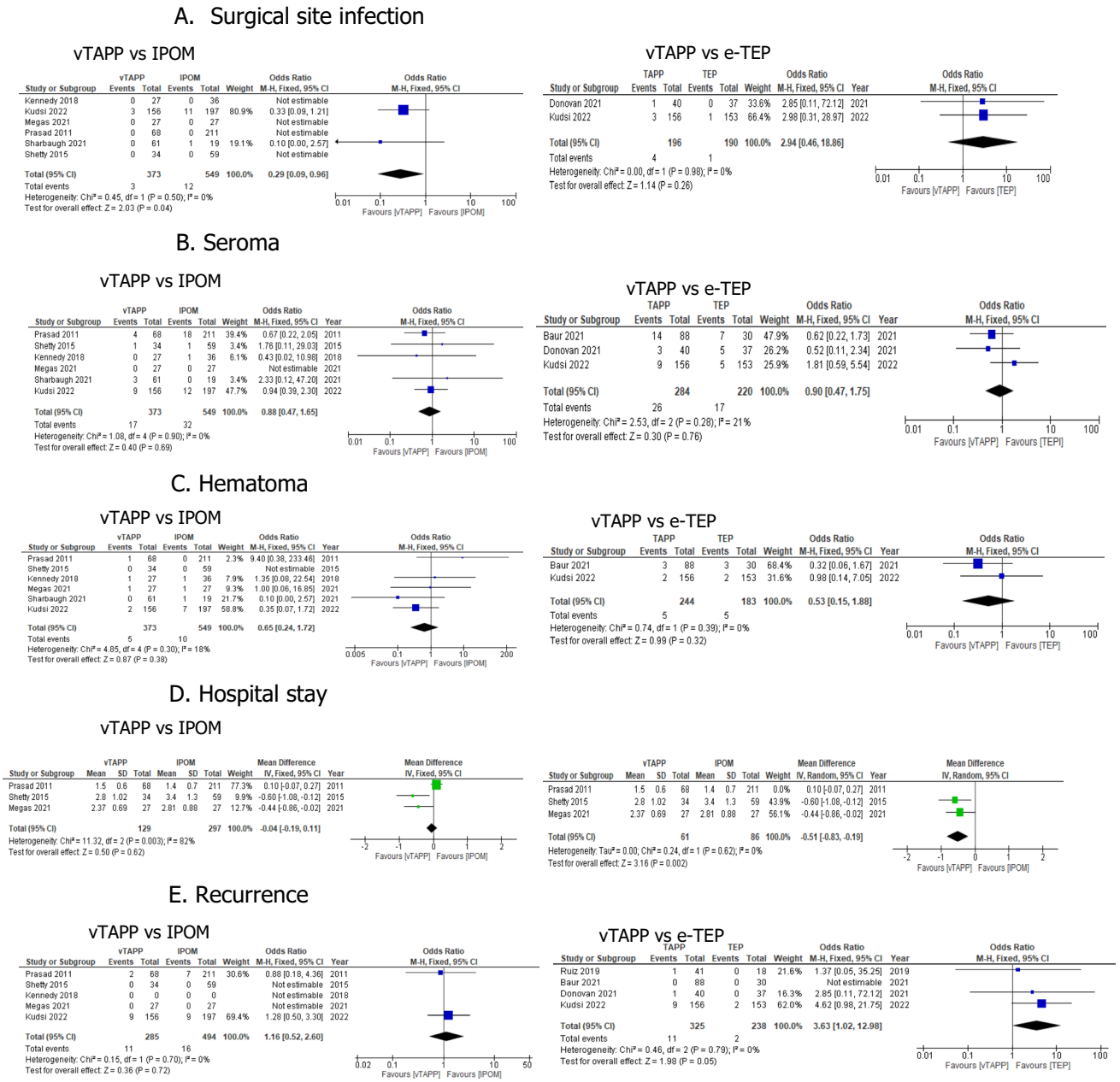

Fig. 3 Postoperative parameters

vTAPP repair resulted in a cumulative incidence of 22 of 610 (3.6%) cases vs 16 of 494 (3.2%) in IPOM repair and 2 of 238 (0.8%) in e-TEP repair. Meta-analysis of these study results showed no significant difference between vTAPP and IPOM (OR = 0.88; 95% CI [0.18, 4.36], $p = 0.88$) and vTAPP and e-TEP repair (OR = 3.63; 95% CI [1.02, 12.98], $p = 0.05$, $I^2 = 0\%$).

Secondary outcomes (Fig. 4)

Post-operative pain

Two studies [2, 23] assessed the Visual Analogue Scale obtained on the first day after surgery (VAS 24 h). A comparison with IPOM showed that vTAPP had significantly lower VAS 24 h (MD = − 1.66; 95% CI [− 2.16, − 1.16], $p < 0.00001$, $I^2 = 96\%$). In addition, only two studies [20, 23] compared chronic pain between vTAPP and IPOM repairs.

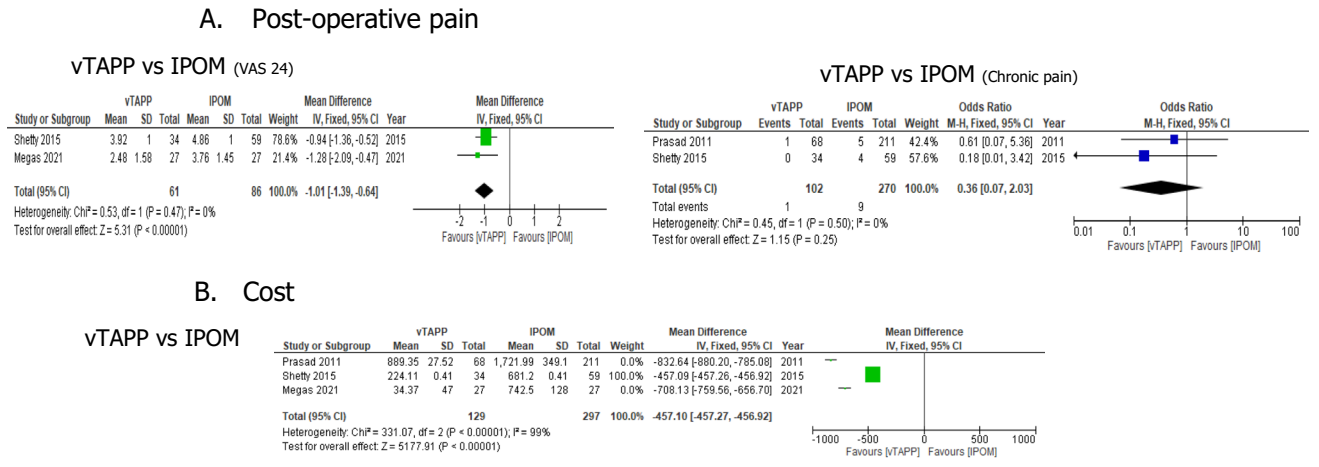

Fig. 4 Secondary outcomes

There was no significant difference (MD = 0.36; 95% CI [0.07, 2.03], $p = 0.25$, $I^2 = 0\%$).

Cost

Only three studies [2, 20, 23] reported the cost analysis, comparing vTAPP repair to IPOM repair. To account for the varying values of currencies across countries, cost was converted and adjusted to US dollars based on the mean exchange rate of the year of publication. vTAPP was associated with much significant lower costs compared to IPOM (MD = − 457.10; 95% CI [− 457.27, − 456.92], $p < 0.00001$, $I^2 = 96\%$). A sensitivity analysis could not be performed.

Quality of life

None of the included studies reported data on quality of life. Thus meta-analysis was not feasible.

Discussion

According to our meta-analysis, vTAPP appears to be safe in terms of perioperative and post-operative outcomes. The cumulative rate of intraoperative complications was 1.6%.

SSI, seroma and hematoma formation rarely occur and recurrence rates were low.

vTAPP was associated with considerable benefit when compared to IPOM. vTAPP was less painful, with reduced average cost and decreased wound morbidity. On the other hand, the vTAPP approach had less operative time-consuming and shorter hospital stay than the e-TEP approach.

Despite several recent advances in the practice of minimally invasive hernia surgery, the ideal approach for the VHR remains debatable [22]. Based on the present data, vTAPP was found to be a promising alternative to the surgeon's armamentarium for VHR.

vTAPP was first described by Chowbey [24] and Hilling [25]. Since then, it has been gaining popularity.

For this technique, the preperitoneal space was incised in a lengthwise manner, 6–7 cm away from the defect and dissected circumferentially within a margin of 5–6 cm in all directions to create space for adequate mesh. Then, the mesh was fixed onto the abdominal and the peritoneal flap was closed [13, 26].

In an experimental study in a VH swine mode, Graf et al. [27] demonstrated that preperitoneal mesh placement induced more fibrous than intra peritoneal palcement due to the both sides contact enhancing the strength of the mesh. However, the authors showed that the perperitoneal technique requires more time than IPOM, as vTAPP necessitates technically laborious dissection to free the preperitoneal space. The lack of popularization of this technique may be related to this reason [28].

Nevertheless, our study did not find a significant difference in the operative time between vTAPP and IPOM. The data on operative time were highly heterogeneous across the different studies ($p < 0.00001$, $I^2 = 90\%$). In most studies, the operating time was significantly longer in vTAPP group. If data of the study of Kudsi et al. [19] were excluded, a significantly shorter operative time was found for IPOM repair with low heterogeneity. Kudsi et al. published the largest series with 7-year experience. We suspect that, with increasing experience with vTAPP, surgeon can recognize appropriate layers more rapidly and the operation time will become shorter.

The same authors produced a learning curve to evaluate operative time of robotic vTAPP. Patients were divided into three phases using cumulative sum analysis. They showed a reduction of 11 min per phase with a significant reduction in peritoneal tears from 63 to 11% after 46 cases [29].

On the other hand, the vTAPP approach was associated with a significantly shorter operative time and hospital stay than the e-TEP approach. This may be due to the fact that e-TEP requires more operative time, prior to developing the retromuscular plane necessary for mesh placement. Consenquently, surgeons can take advantage of a large retromuscular flap that provides ample space for larger mesh sizes.

In the included studies [16, 19], we found several important differences between two groups' intraoperative variables. Baur et al. [16] and Kudsi et al.[19] reported an average hernia defect area and mesh size significantly larger in the e-TEP group than the vTAPP group (8.8 vs 20.1 cm^2, $p < 0.001$; 107.8 vs 205.5 cm^2, $p < 0.001$ and 3.1 vs 15.1 cm^2, $p < 0.001$; 113 vs 225 cm^2, $p < 0.001$, respectively). Thus, criticisms of the vTAPP repair include the technical difficulty of the lateral dissection needed to create a larger space and treat large defect sizes.

Kudsi et al. [19] presented the outcomes of 664 robotic VHR. Most defects (88.5%) were < 4 cm in the vTAPP group and 28.8% in the e-TEP group. The authors concluded that vTAPP should be an option for small to medium size hernias.

These findings coincide with the results of Li et al., showing that the optimal indication for the preperitoneal route is small and medium primary umbilical and epigastric hernias [30].

Postoperative wound events represent the most common surgery-related complications in VHR. Our study showed that IPOM, vTAPP and e-TEP were associated with similar results in term of postoperative SSI, hematoma and seroma. These results are in accordance with the meta-analysis by Yeow et al. showing no differences comparing intraperitoneal versus extraperitoneal mesh in minimally invasive VHR. In our analysis, we found that the most common complication with the vTAPP approach was seromas (43 of 657 (6.5%)). There are several reasons associated with the formation of seroma [31]. Prasad et al. showed that partial dissection of the sac after vTAPP repair may lead to seroma occurrence. Conservative management with compression bandage at the hernia repair site 5 days postoperatively was sufficient.

In terms of postoperative pain, we found a significant difference in the postoperative pain scores between the vTAPP and IPOM groups. This pain reduction is due to the need for more extensive fixation of the mesh using tacks or sutures after IPOM repair.

Limited number of tackers is usually sufficient for TAPP repair, as the mesh is confined between the posterior fascia and peritoneum. A study by Shetty et al. [23] of 120 patients after minimally invasive VHR showed that the average number of tacks was 8–10 in the vTAPP group vs 15–25 in the IPOM group. According to Megas et al. [2], no securing mesh sutures are necessary after vTAPP as in the TAPP technique for inguinal repair.

The main advantage of vTAPP is that it allows the use of a polypropylene mesh which is less expensive. A previous study [20] suggested that IPOM is associated with much higher overall cost of surgery including fixating devices, mesh cost, operation theatre charge and hospital stay compared to vTAPP ($1752.3 ± 355.7 vs $903.6 ± 28, respectively). For all these reasons, Megas et al. [2] stated that vTAPP would be suitable for a day-surgery procedure and could become the gold standard for minimally invasive VHR in the future.

This study has several limitations. We included only cohort studies with low methodology and risk of bias as no randomized controlled trials have been conducted on this topic. Furthermore, there was substantial heterogeneity regarding the hernia aetiology including primary and incisional hernia, hernia size and surgical techniques. In our analysis, the hernia repair was performed using a laparoscopic or robotic approach. The introduction of robotic platform facilitates suturing and optimizes some manoeuvres, which may lead to a shorter operative time and ameliorate outcomes. In addition, it should be taken into account the difference in the duration of post-operative follow-up. For this reason, recurrence rates have been underestimated in most studies. Moreover, the quality of life after ventral hernia repair has been developed and used to be an important parameter to assess the effectiveness of therapeutic interventions. Due to the lack of data, an analysis of the quality of life was not possible.

Despite these limitations, the present study provides an objective summary of evidence of vTAPP for VHR that could be useful in guiding surgical recommendations.

In conclusion, vTAPP appears to be safe and effective procedure for VHR. Our study showed that vTAPP has several advantages. Decreased hospital stay, lower rates of wound events and reduced pain and average cost could favour this approach for VHR compared to other minimally invasive techniques in selected patients with small to medium size hernias. Randomized controlled trials with long-term follow-up should be conducted to validate these results and evaluate long-term outcomes.

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Declarations

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval No Ethical Approval required as this research project is a systematic review of previous studies.

Human and animal rights and informed consent This article does not contain any studies directly involving human participants or animals, as it is a review of data already collected and publicated.

Data availability The data that support the findings of this study are available from the corresponding author, [MM], upon reasonable request.

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