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SYSTEMATIC REVIEW

The effect of temporary uterine artery ligation on blood loss during laparoscopic myomectomy: A systematic review and meta-analysis

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Abstract

Introduction: The effectiveness of temporary uterine artery ligation (TUAL) in reducing blood loss during laparoscopic myomectomy (LM) is uncertain, despite increased use as an adjunct to improve surgical safety. This study aims to evaluate the safety and efficacy of TUAL in LM for the management of uterine myomas.

Material and Methods: We conducted a systematic review and meta-analysis of comparative studies evaluating LM with and without TUAL. Electronic databases were searched up to October 7, 2024. Eligible studies were randomized controlled trials or observational comparative studies published in English that reported at least one primary outcome. The primary outcomes were intraoperative estimated blood loss and perioperative change in hemoglobin. Secondary outcomes included operative time, number and size of myomas removed, length of hospital stay, recurrence, and complication rates. Data extraction and analysis were performed using a random-effects model. This review was registered prospectively with PROSPERO (CRD42024595684).

Results: Seven studies met the inclusion criteria, comprising five randomized controlled trials and two retrospective case–control studies, with a total of 857 women (352 undergoing LM with TUAL and 505 undergoing LM alone). TUAL was associated with a reduction in intraoperative estimated blood loss (mean difference [MD]: −84.7 mL; 95% CI: −89.0; −80.0) and postoperative reduction in hemoglobin level (MD: −0.4 g/dL; 95% CI: −0.7; −0.2) compared with LM without TUAL. However, TUAL was associated with increased operative time (MD: 16.5 min; 95% CI: 3.4; 29.6).

Conclusions: TUAL appears to be a possible adjunct to LM for selected patients in the management of uterine myomas. Our study demonstrated that TUAL with LM could

Abbreviations: BMI, body mass index; LM, laparoscopic myomectomy; MD, mean difference; RCT, randomized controlled trial; TUAL, temporary uterine artery ligation; UAL, uterine artery ligation.

be associated with a reduction in estimated blood loss, despite an increase in operative time. Nonetheless, further studies with a larger sample size and long-term follow-up, as well as stratification of outcomes based on ligation technique, are warranted to elucidate the benefits of TUAL.

KEYWORDS
intraoperative bleeding, laparoscopic myomectomy, meta-analysis, myomas, temporary uterine artery ligation, TUAL

1 | INTRODUCTION

Uterine myomas, benign mesenchymal tumors, affect over 70% of women worldwide.[1,2] Their growth is associated with smooth muscle proliferation and enhanced vascularization.[3] Myoma symptoms can include heavy menstrual bleeding, abdominal pain, and infertility, though many patients remain asymptomatic. For individuals planning for pregnancy, uterine-sparing treatments such as hormonal therapies are the first-line approach. Alternatives include uterine artery embolization and MRI-guided therapies with 20% and 30.5% recurrence rates, respectively, and surgical intervention may be warranted for patients with disease refractory to medical management.[4–6] Myomectomy remains the most effective method to treat uterine myomas, achieving symptom improvement in approximately 80% of cases.[7,8] Nevertheless, the existing literature demonstrated that myomectomy is associated with risks, including intraoperative and postoperative bleeding as well as adhesion formation.[9,10]

Laparoscopic myomectomy (LM) has gained popularity over recent decades for the management of selected uterine myomas, largely due to concerns associated with open myomectomy, including increased intraoperative blood loss, higher blood transfusion requirements, and longer hospital stays. To further reduce the bleeding risk, uterine artery ligation (UAL) has emerged as an adjunct approach during myomectomy. UAL during LM can be temporary or permanent and involves occluding the artery with clamps, catheters, coagulation, sutures, or clips, with the equipment choice based on resource availability and surgeon preference.[11] Temporary uterine artery ligation (TUAL) provides a reversible blockage of the uterine artery to limit intraoperative blood loss, with normal uterine perfusion restored once the procedure is completed.[6] Some studies have reported additional potential benefits of UAL including reduction in residual myoma size and a lower risk of recurrence; however, the current evidence is limited, and further research is needed to draw a unanimous conclusion.[12]

Despite TUAL appearing to be an effective approach for reducing intraoperative blood loss in LM, debate continues over bleeding risk in laparoscopic approaches with and without UAL.[6] Moreover, existing meta-analyses have primarily compared UAL with pharmacologic treatments. Many have also combined open and laparoscopic myomectomy or included permanent ligation, without performing subgroup analyses by surgical approach.[6,13–14] Therefore, this study aims to evaluate the safety and efficacy of LM with TUAL compared with no ligation control in the management of uterine myomas and provide insights to guide clinical decision-making.

Key message

Temporary uterine artery ligation is a possible adjunct to laparoscopic myomectomy, reducing estimated intraoperative blood loss despite longer operative time. Further studies with larger cohorts, extended follow-up, and technique-based stratification are needed to better clarify its benefits.

2 | MATERIAL AND METHODS

2.1 | Search strategy and data sources

In compliance with the Preferred Reporting Items for Systematic Reviews and Meta-analyses guidelines, a comprehensive search of several electronic databases from each database's inception to 7th of October 2024 was conducted. The databases included Ovid MEDLINE, Embase, CINAHL, and The Cochrane Library. An experienced librarian developed and implemented the search strategy with input from the study's principal investigator. Controlled vocabulary supplemented with keywords was used to search for studies investigating the use of TUAL in LM. The search strategy is summarized in Appendix S1. The Preferred Reporting Items for Systematic Reviews and Meta-analyses checklist can be found in Appendix S2. This review was registered prospectively with PROSPERO (CRD42024595684).

2.2 | Eligibility criteria and quality assessment

The following inclusion criteria had to be met by eligible randomized controlled trials, retrospective or prospective studies: (1) be written in the English language; (2) a comparative study evaluating the use

of TUAL treatment against no ligation controls in women undergoing LM; (3) report on at least one of the following outcomes: estimated blood loss or change in hemoglobin perioperatively. Case reports, case series, abstracts, conference abstracts, and studies with overlapping patient data were excluded. Three independent assessors (M.M.W., Z.Y.Z., O.M.) conducted article screening and data extraction utilizing the Covidence software (Covidence.org, Software Development, Melbourne, Victoria, Australia). Any disagreements were adjudicated (N.E.B.) and discussed with co-authors as necessary. The methodological quality of each study was assessed independently by two authors (Z.Y.Z. and O.M.) using the Risk Of Bias In Non-randomized Studies—of Interventions and the Risk of Bias 2 Tools.[15,16] Differences were resolved by a third author (N.E.B.). Results of the quality assessment of all included studies are shown in Figure 2A,B.

2.3 | Data extraction

The following outcomes were extracted: estimated blood loss, change in hemoglobin pre- and post-operatively, operative time, length of hospital stay, number of myomas, size of myomas, recurrence rate, symptom resolution, and complications. Transvaginal/transabdominal ultrasound and/or Magnetic Resonance Imaging were utilized preoperatively for evaluation of the number and size of myomas.

2.4 | Defining uterine artery ligation

In this study, TUAL is defined as a procedure that includes only temporary uterine artery ligation, whereas UAL includes both temporary and permanent uterine artery ligation. Our included studies reduced the blood flow to the uterus by performing TUAL during the LM; however, the tools used varied. Hiratsuka et al.[6] employed multifilament sutures to ligate the uterine arteries. Three studies used titanium clips.[17–19] Kwon et al.[20] and Vercellino et al.[21] both applied vascular clips to the uterine arteries. Kim et al.[22] used bulldog clamps and occluded not only the uterine arteries but also the utero-ovarian arterial anastomoses at the utero-ovarian pedicle. In all included studies, the uterine artery was temporarily ligated near its origin from the internal iliac artery.[6,17–22] Access to this site was achieved via three distinct retroperitoneal approaches, chosen based on anatomical considerations and surgeon preference. The posterior approach, most commonly reported, involved a retroperitoneal incision above the ureter, followed by lateralization of the ureter and TUAL.[19,21–22] The lateral approach involved identifying the infundibulopelvic ligament and incising the pelvic parietal peritoneum.[19,20] The anterior approach entailed visualization of the bladder and an incision in the peritoneum to trace the uterine artery to its origin.[19] In two studies, the uterine arteries were isolated from the anterior branch of the internal iliac artery by retrograde tracking of the umbilical ligament.[6,18]

2.5 | Statistical analysis

Pooled means and proportions of our data were analyzed using an inverse variance method for continuous data, which assigns the weight of each study based on its variance. For dichotomous data, the pooled means and proportions of our data were analyzed using the Mantel–Haenszel method, which assigns the weight of each study based on its variance. A direct comparison between the two techniques was conducted by assessing studies that reported outcomes of both treatments (two-arm analysis). The heterogeneity of effect size estimates across the studies was quantified using the Q statistic and I^2. The random-effects model was used in accordance with Cochrane guidelines, and a leave-one-out sensitivity analysis was subsequently performed to assess the robustness of the results. If mean and standard deviation were unavailable, the median was converted to a mean using the formulas from the Cochrane Handbook for Systematic Reviews of Interventions. Data analysis was performed using RevMan© software version 5.4 (Review Manager (RevMan©) [Computer program]). The Cochrane Collaboration, 2020, Copenhagen, Denmark.

3 | RESULTS

3.1 | Study selection and patient characteristics

A comprehensive search of electronic databases initially yielded 405 studies. After removing duplicates, the abstracts were screened according to predefined inclusion and exclusion criteria, resulting in 23 full-text articles considered suitable for further assessment. Ultimately, seven studies, encompassing 857 women, met the criteria and were included in this meta-analysis.[6,17–22] Comprehensive details of the study selection process can be found in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Flowchart (Figure 1). Out of the seven studies included, five were randomized controlled trials (RCTs),[17–19,21–22] and two were retrospective case–control studies.[6,20] Out of 857 women undergoing laparoscopic myomectomy, 352 underwent TUAL, and 505 were controls that did not receive ligation.[6,17–22] The age of the study participants ranged from 20 to 49 years.[6,17–22] Additionally, five studies reported on their patients' preoperative body mass index (BMI), with a mean of $22.4 \pm 3.3\,kg/m^2$.[6,17–19,22] These demographics and patient characteristics are reported in Table 1.

3.2 | Risk of bias

Figure 2A,B illustrates an overview of the quality of the included studies. Five randomized controlled trials were evaluated using the Risk of Bias 2 tool.[17–19,21–22] Jin et al.[18] and Vercellino et al.[21] were classified as having a low risk of bias, while Ji et al.,[17] Kim et al.,[22] and Moratalla-Bartolomé et al.[19] had a moderate risk of bias. The two non-randomized controlled trials were evaluated using the

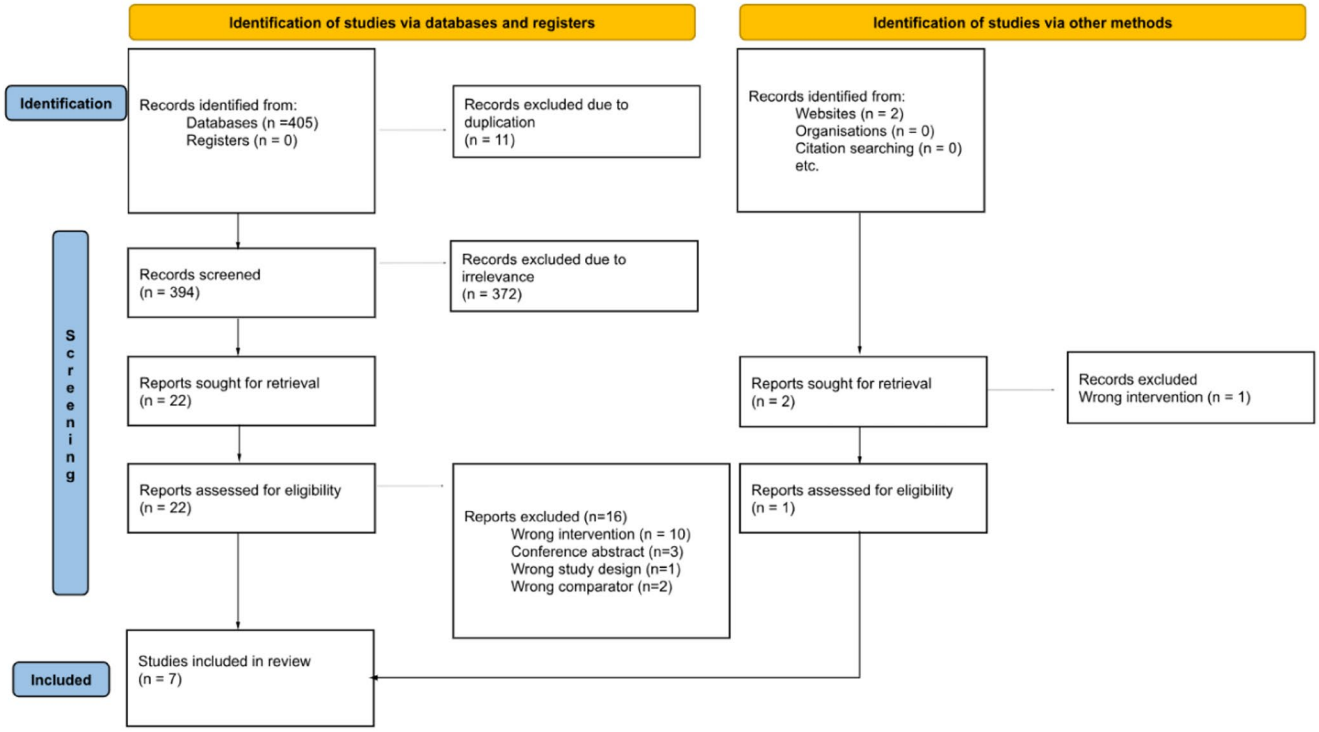

FIGURE 1 Preferred reporting items for systematic reviews and meta-analyses flow chart.

Non-randomized Studies—of Interventions Tool and were both determined to have a moderate risk of bias.[6,20] The biases in the non-RCTs were attributed to confounding, deviations from intended interventions, bias in the measurement of outcomes, and bias in the selection of the reported results.[6,20] Nonetheless, all the studies were retained as their cohorts appeared representative with adequate exposure and outcome ascertainment, and the studies provided clear reports of their intended interventions, outcome measures, and had low levels of missing data. The GRADE assessment was used to assess the certainty of evidence for the effect of TUAL on intraoperative estimated blood loss. Given the study characteristics, including risk of bias, heterogeneity, and imprecision, the result was rated as moderate certainty, indicating that the true effect is likely close to the estimated effect. The GRADE assessment can be found in Appendix S3.

3.3 | Primary outcomes

Change in hemoglobin level was measured in three studies.[19,21–22] TUAL had a smaller reduction in hemoglobin level than no ligation controls (MD: −0.4 g/dL; 95% CI: −0.7, −0.2; $\tau^2 = 0.01$ I^2: 17%). Six studies reported estimated blood loss.[6,17–20,22] TUAL had less estimated blood loss than no ligation controls (MD: −84.7 mL; 95% CI: −89.0, −80.4; $\tau^2 = 0.00$ I^2: 0%). Subgroup analysis with only RCTs has shown similar results (MD: −85.8 mL; 95% CI: −92.8, −78.7; $\tau^2 = 16.1$ I^2: 30%).[17–19,22] All the primary outcomes are summarized in Figure 3.

3.4 | Secondary outcomes

The duration of surgery was recorded in all studies.[6,17–22] TUAL had a longer operative time than no ligation controls (MD: 16.5 min; 95% CI: 3.4, 29.6; $\tau^2 = 267.0$ I^2: 86%). Subgroup analysis carried out on studies only using clips for ligation has shown no difference in operative time between groups (MD: 13.7 min; 95% CI: −1.8, 29.3; $\tau^2 = 273.3$ I^2: 88%).[17–21] Length of hospital stay was assessed in four studies,[19–22] demonstrating no difference between groups (MD: −0.01 days; 95% CI: −0.1, 0.1; $\tau^2 = 0.00$ I^2: 0%). Three studies reported on the number of myomas,[6,20,22] with a mean of 2.8 ± 2.6, and all studies[6,17–22] reported on myoma size, which ranged from 5.6 to 7.8 cm in the TUAL group and 5 to 7 cm in the controls. Pooled analysis showed no statistically significant differences for myoma number (MD: 0.2; 95% CI: −0.1, 0.6; $\tau^2 = 0.00$ I^2: 0%) and size (MD: 0.3 cm; 95% CI: −0.1, 0.6; $\tau^2 = 0.1$ I^2: 37%). Three studies evaluated recurrence rates[17,18,20] and symptom resolution,[17,18,22] which demonstrated similar outcomes between the groups (OR: 0.9; 95% CI: 0.4, 1.7; $\tau^2 = 0.00$ I^2: 0%) and (OR: 1.0; 95% CI: 0.5, 1.7; $\tau^2 = 0.00$ I^2: 0%).

Perioperative complications were evaluated in the included studies.[17,21–22] Three studies reported on intraoperative intestinal injury, with one incidence (0.7%) in the TUAL group, whereas no incidents were reported in the no ligation control. Incidence of infection was assessed in three studies[17,18,21] reporting two cases (0.9%) in the TUAL group and none in the control. Blood transfusion[17,18,22] was assessed in three studies, reporting one case in the intervention group (0.7%) and three in the control group (1.9%). All the secondary outcomes and subgroup analyses are summarized in Figures 4 and 5. All sensitivity

TABLE 1 Baseline characteristics.

Author	Year	Study type	Uterine artery ligation and comparator	Country	Sample size	Overall age (year ± SD)	Preoperative BMI (kg/m^2)	Myoma size (cm ± SD)	Number of myomas (n ± SD)
Hiratsuka et al.	2022	Retrospective case–control study	*TUAL*: Multifilament sutures *Control*: No UAL *Both*: Vasopressin injected into the myometrium	Japan	*Total*: 264 *TUAL*: 52 *Control*: 212	37.2 ± 4.8	21.9 ± 3.5	*Overall*: 6.1 ± 2.1 *TUAL*: 6.5 ± 2.0 *Control*: 6 ± 2.1	*Overall*: 3.2 ± 2.9 *TUAL*: 3.6 ± 3 *Control*: 3.2 ± 2.9
Ji et al.	2017	RCT	*TUAL*: Titanium clips *Control*: No UAL	China	*Total*: 64 *TUAL*: 33 *Control*: 31	31.5 ± 6.6	23.2 ± 2.4	*Overall*: 6.8 ± 1.9 *TUAL*: 6.7 ± 2.2 *Control*: 6.9 ± 1.6	NR
Jin et al.	2019	RCT	*TUAL*: Titanium clips *Control*: No UAL *Both*: 6 U vasopressin injected into the myometrium	China	*Total*: 132 *TUAL*: 67 *Control*: 65	38.3 ± 6.7	22.3 ± 2.8	*Overall*: 7.1 ± 1.9 *TUAL*: 7.2 ± 1.8 *Control*: 7.0 ± 2.0	NR
Kim et al.	2019	RCT	*TUAL*: Bulldog clamps (bilateral uterine and utero-ovarian arteries) *Control*: No UAL	Korea	*Total*: 62 *TUAL*: 31 *Control*: 31	39.8 ± 5.7	22.9 ± 3.3	*Overall*: 6.9 ± 1.6 *TUAL*: 7.1 ± 1.6 *Control*: 6.6 ± 1.6	Overall: 2.95 ± 2.1 *TUAL*: 3.3 ± 2.2 Control: 2.6 ± 2.0
Kwon et al.	2013	Retrospective case–control study	*TUAL*: Vascular clips *Control*: No UAL	Korea	*Total*: 89 TUAL: 49 Control: 40	43.2 ± 6.0	NR	*Overall*: 5.9 ± 1.7 *TUAL*: 5.6 ± 1.5 *Control*: 6.2 ± 1.9	*Overall*:1.7 ± 1.0 *TUAL*: 1.8 ± 1.0 *Control*: 1.6 ± 1.0
Moratalla-Bartolomé et al.	2024	RCT	*TUAL*: Endoclips *Control*: No UAL	Spain	*Total*: 80 *TUAL*: 40 *Control*: 40	37.5 ± 3.7	23.0 ± 3.8	*Overall*: 7.6 ± 2.3 *TUAL*: 7.8 ± 2.5 *Control*: 7.5 ± 2.0	NR
Vercellino et al.	2012	RCT	*TUAL*: Vascular clips *Control*: No UAL	Germany	*Total*: 166 *TUAL*: 80 *Control*: 86	38.8 ± 6.8	NR	*Overall*: 5.3 ± 1.3 *TUAL*: 5.6 ± 1.5 *Control*: 5.0 ± 1.0	NR

Abbreviations: BMI, body mass index; cm, centimeter; NR, not reported; RCT, randomized control trial; SD, standard deviation; TUAL, temporary uterine artery ligation; U, units.

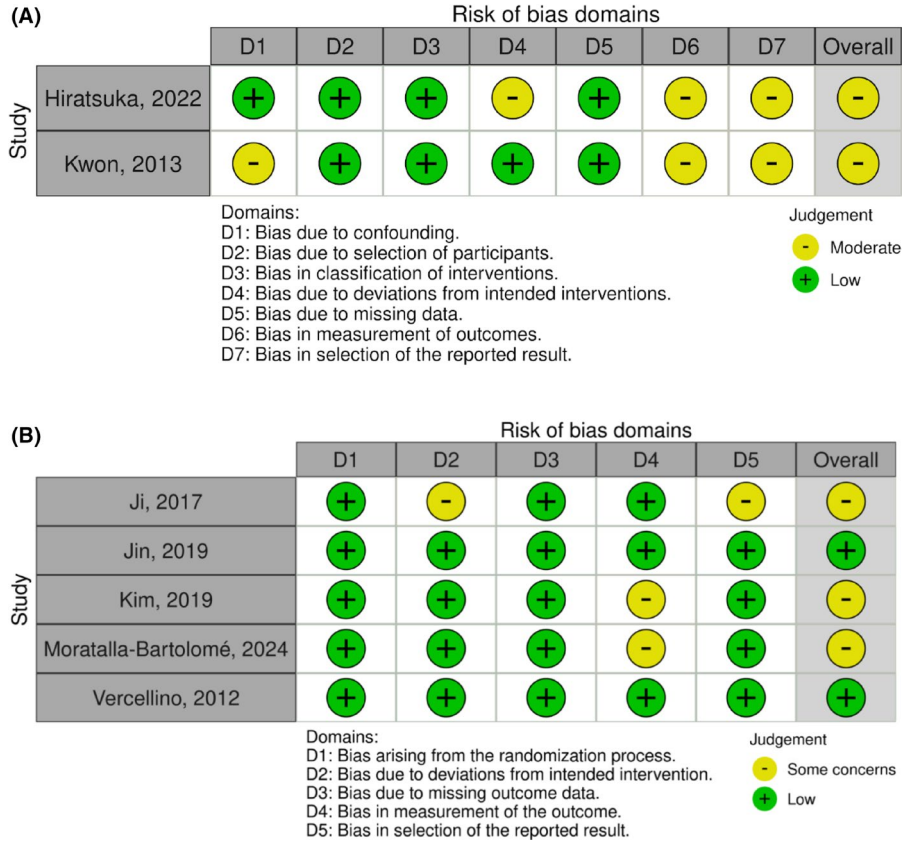

FIGURE 2 (A) Non-randomized studies—of interventions tool for non-RCT traffic light plot. (B) Risk of Bias 2 tool for RCT traffic light plot.

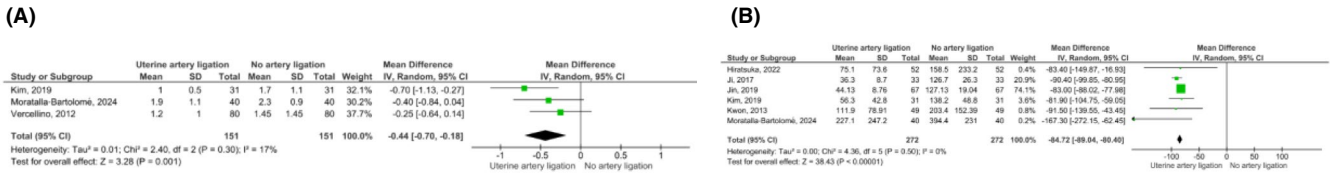

FIGURE 3 Primary outcomes. (A) Reduction in hemoglobin level (g/dL). (B) Estimated blood loss (mL).

analyses of the included results are summarized in Figures S1–S7, which show no differences from the reported outcomes.

4 | DISCUSSION

TUAL is increasingly used as an adjunct during LM for the management of uterine myomas to reduce intraoperative bleeding. This meta-analysis, to our knowledge, is the first to examine TUAL in LM, focusing solely on its effects on blood loss, hemoglobin changes, and other perioperative outcomes without comparing it with the pharmacological occlusion approach. Our analysis demonstrated that TUAL reduces estimated intraoperative blood loss, with a mean difference of 84.7 mL compared with controls. Subgroup analysis of four RCTs supported this effect, showing a mean reduction of 85.8 mL in the intervention group. In addition to limiting hemorrhage, TUAL was associated with an increase in operative time of 16.5 min, while no differences were observed in length of hospital stay or perioperative complications.

Mechanical occlusion techniques are widely used to control intraoperative bleeding during LM, with their success largely dependent on the surgeon's expertise.[20] Laparoscopic permanent uterine artery ligation can be performed using bipolar coagulation with suture ligation, or permanent placement of titanium surgical clips.[19] Conversely, temporary clipping is a non-invasive method that enhances visualization and efficiency, without compromising ovarian function and reducing the need for extensive coagulation, potentially lowering the risk of adhesions.[10,17,19] Other transient mechanical techniques include clamps, temporary sutures, or endoscopic vascular clips made of other metals, which provide a transient arterial blockage and a clearer surgical field to minimize thermal damage to the myometrium.[20] A potential risk of TUAL could be delayed hemorrhage, where initial arterial closure reduces bleeding but may lead to secondary bleeding upon reversal of TUAL. A recent study

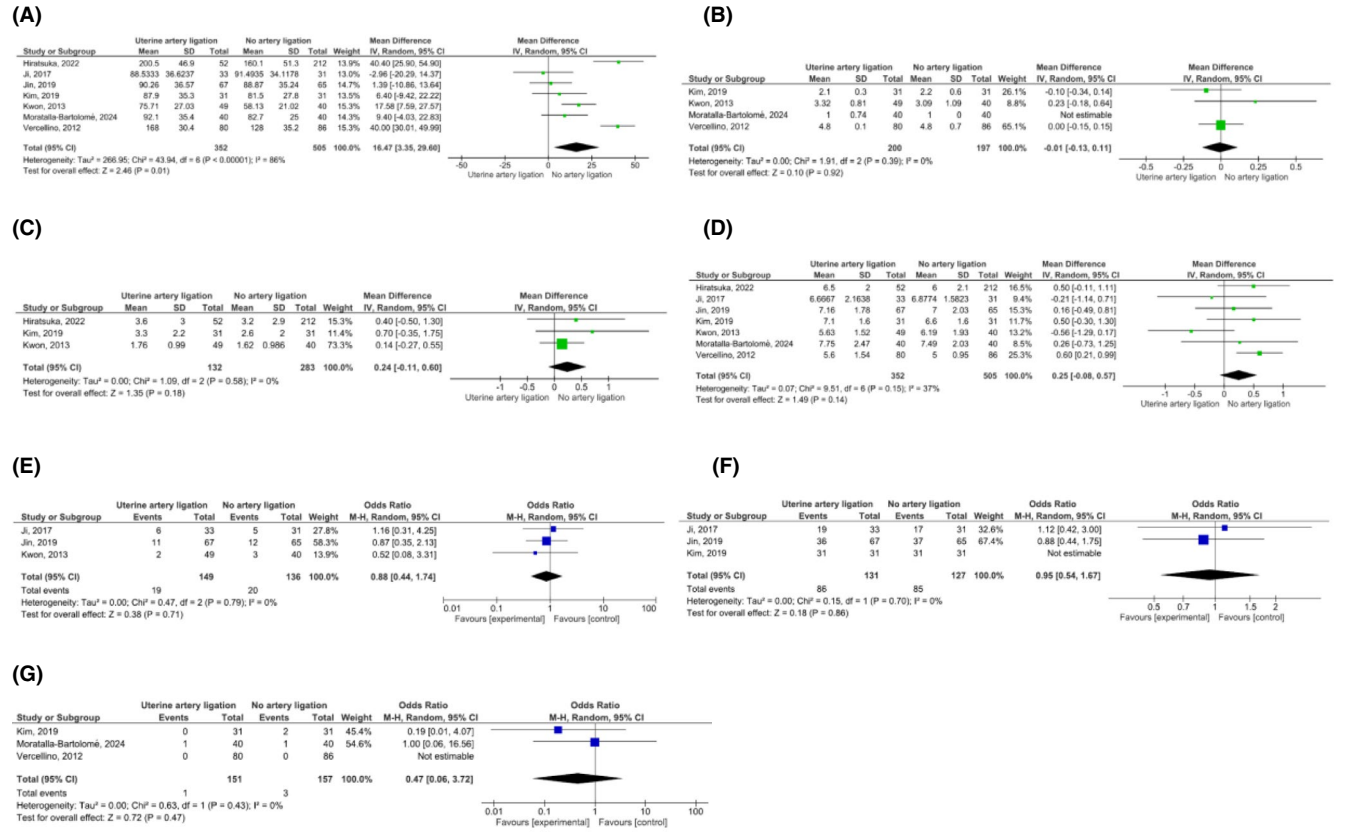

FIGURE 4 Secondary outcomes. (A) Duration of surgery (min). (B) Length of hospital stay (days). (C) Number of myomas. (D) Size of myomas (cm). (E) Recurrence rate. (F) Symptom resolution. (G) Blood transfusion.

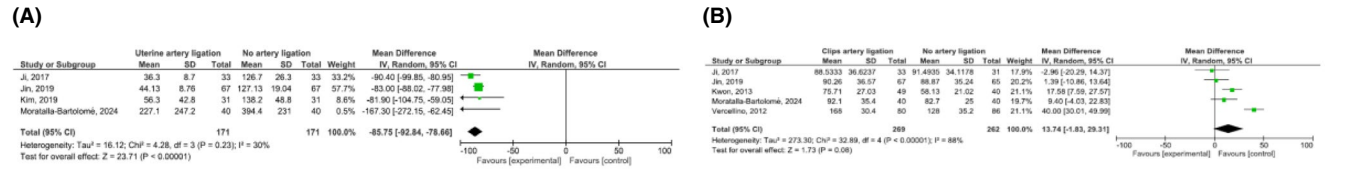

FIGURE 5 Subgroup analysis. (A) Blood loss (mL) excluding non-RCTs. (B) Duration of surgery (min) in UAL using clips.

investigated different surgical techniques, including TUAL for hysterectomy, concluding that the posterior approach to UAL was faster than both the anterior and lateral approaches, demonstrating greater efficiency, with no reported cases of vascular injury or vaginal bleeding.[23] Another has shown that the retroperitoneal UAL approach improves efficiency and safety by allowing near-perpendicular access, reducing estimated blood loss, and minimizing ureteral injury. Major complications were rare (1.8%), and failure occurred in 29%, mainly due to enlarged or distorted uteri and higher BMI.[24] Despite reassuring findings in the literature, wide confidence intervals in our analysis and limited reporting highlight uncertainty, and the true risk of hemorrhage, transfusion, infection, or visceral injury remains unclear. Taken together, these data suggest that TUAL shows promise and warrants further prospective evaluation to clarify complication rates across different techniques and patient populations.

LM offers advantages over other surgical approaches, including shorter recovery, less postoperative pain, a lower risk of anemia, adhesions, and heavy postoperative bleeding.[10,17,20] TUAL can help control intraoperative blood loss during LM, particularly in patients with larger or multiple myomas, by providing short-term vascular occlusion while preserving uterine and ovarian perfusion. Our meta-analysis observed a reduction in estimated blood loss, which was consistent with the existing meta-analysis.[25] Its effectiveness depends on factors such as myoma size, number, and location.[19] This technique can be performed using methods similar to those employed in total laparoscopic hysterectomy without requiring additional equipment.[10] Rapid restoration of blood flow after the procedure helps prevent ischemic damage and supports tissue healing.[26] Uterine artery occlusion, permanent or temporary, has long been used to control bleeding. Tranoulis et al.[27] (permanent UAL) and Sanders et al.[11] (laparoscopic and abdominal myomectomy) demonstrated its effectiveness. Mechanical occlusion techniques are widely used to control intraoperative bleeding during LM, providing a reversible approach that improves visualization, reduces the need for coagulation,

and minimizes thermal injury as well as adhesion formation.[10,17,19–20] In the literature, complications of TUAL are described as occasional, including ureteric or bladder injury, which may occur when managing difficult vascular pedicles. However, these risks can be minimized by ligating the uterine artery at its vascular origin.[28] Additionally, postoperative bleeding and broad ligament hematoma remain potential concerns, particularly with temporary occlusion, which may predispose to delayed hemorrhage after reperfusion.[14] In this analysis, only three included studies reported hemorrhagic outcomes, and no significant differences were observed in the pooled analysis.[17,21–22] Therefore, the limited reporting restricts definitive conclusions regarding the true impact of TUAL on hemorrhagic risk.

Achieving hemostasis during laparoscopy remains challenging, especially when myomas are large (>8 cm) or multiple, as uterine reconstruction becomes technically demanding.[17] While some experts recommend laparotomy for myomas larger than 8–10 cm or when removing more than three, many minimally invasive surgeons continue to perform laparoscopy, emphasizing the need for improved hemostatic control. The decision ultimately depends on the surgeon's expertise and individual factors.[20,22] However, even small differences in myoma size could still contribute to variability in blood loss, representing potential residual confounding. Other key predictors, such as BMI or preoperative hormonal therapy (e.g., Gonadotropin-Releasing Hormone agonists), were inconsistently reported across studies, limiting fully adjusted comparisons. Future investigations should account for these factors to better evaluate the impact of TUAL on estimated blood loss and recurrence. Although differences in myoma size and number were not considerable in this study, they could have affected blood loss, providing a rationale for future investigations into LM with TUAL based on these factors. Therefore, paying closer attention to myoma sizes and numbers in future studies would help avoid confounding and enable more accurate comparisons between techniques.

One concern with TUAL is its potential impact on operative time. Across studies, TUAL was associated with a mean increase of 16.5 min compared with the controls. Despite the substantial heterogeneity among included studies, likely reflecting differences in surgical technique and surgeon experience, this finding cannot be overlooked. Five of the seven studies used endoscopic clips, with four reporting titanium clips. In a subgroup analysis of the clip studies, the mean operative time was 13.7 min, but heterogeneity increased slightly from 86% to 88%. This suggests that variations in surgeon experience, rather than the method of temporary occlusion itself, may have contributed to longer operative times. Overall, six of the seven studies reported longer surgery with TUAL, likely due to the additional steps required for laparoscopic control of the uterine artery. However, this increase was generally modest and may be similar to the time required for hemostatic control using other techniques, given the highly vascularized nature of myomas and the need for meticulous bleeding management. Literature on the subject seems to be divided, and while some reports suggest an increased operation time of approximately 40 min,[10] others indicate no difference between groups.[17,22] Moreover, a study reported that experienced surgeons could manage the TUAL procedure with only a 10–20 min extension.[19] Despite these discrepancies, it remains pertinent to highlight that temporary vascular occlusion does not compromise ovarian blood supply or function.[18] Unlike permanent uterine artery occlusion, which may be associated with increased risks of postpartum hemorrhage, preterm delivery, caesarean section, and malpresentation,[19] Our findings highlight the need to consider variables such as surgeon experience and UAL complexity, especially near the bladder and ureter. While longer surgical times may occur initially due to the learning curve, this gap likely decreases with experience.

Beyond its impact on blood loss, this meta-analysis found no difference in myoma recurrence rates between TUAL and control groups.[17,18,20] Some studies have reported lower recurrence with UAL, which may be due to ischemic changes restricting the growth of smaller myomas.[29–31] However, the short duration of temporary occlusion may be insufficient to induce apoptosis or affect regrowth, as evidenced by Ji et al., who reported no significant difference in recurrence at 2-year follow-up ($p = 0.83$).[17] Furthermore, some authors argue that symptoms may return because very small or hidden myomas are sometimes missed during laparoscopy. They suggest that this, rather than a failure of UAL itself, may explain the recurrence.[19,30–31] Permanent UAL reduces blood supply to the myoma capsule, promoting necrosis and potentially lowering recurrence rates, while temporary methods allow reperfusion, which may lessen this benefit.[19] Additional factors, such as age (<40 years), hormonal exposure, BMI, insulin resistance, and preoperative hormone therapy, may also contribute to recurrence risk, regardless of the surgical technique.[32] Further studies are needed to examine the relationship between these factors and myoma recurrence.

A key strength of this study is its comprehensive analysis of TUAL in LM, providing new insights into its role in reducing intraoperative blood loss. The findings align with previous literature, reinforcing evidence for the benefits of vascular occlusion in achieving effective hemostasis during myomectomy. According to the GRADE assessment, the certainty of evidence for reduced blood loss with TUAL was rated as moderate, reflecting generally consistent findings tempered by heterogeneity, risk of bias, and imprecision.

Several limitations should be noted. Heterogeneity across the included studies may introduce selection and information biases. While five of the studies were RCTs, two were retrospective, increasing the risk of confounding. Heterogeneity remained high even in RCT-only analysis, likely reflecting differences in surgical protocols and techniques.

Methodological variability further complicated direct comparisons. Although all studies followed similar steps for UAL, differences in ligation duration, materials (clips, clamps, or sutures), and definitions of successful ligation varied across studies, potentially introducing observer bias. Additionally, there was considerable heterogeneity among the included studies regarding operative time, likely attributable to variability in ligation technique and surgeons' expertise. Due to the small number of included

studies (<10), assessment of publication bias using funnel plots was not performed.

Reporting secondary outcomes was also limited. Hemorrhage, a key measure of hemostatic effectiveness, was reported in only three studies, and fewer than half provided detailed information on complications such as vessel injuries. Other outcomes, including infection, bladder and intestinal injuries, fertility, and recurrence, were inconsistently reported, restricting interpretation. Residual confounding related to myoma size, BMI, and inconsistent stratification by myoma number may further influence both operative time and blood loss, limiting generalizability.

5 | CONCLUSION

TUAL appears to be a possible adjunct to LM for selected patients in the management of uterine myomas. Our study demonstrated that TUAL with LM could be associated with a reduction in estimated blood loss, despite an increase in operative time. However, the procedure can be technically challenging. Its safety and effectiveness could depend on experience and may not be generalizable to all operators. Further studies with a larger sample size and long-term follow-up, as well as stratification of outcomes based on ligation technique, are warranted to elucidate the benefits of TUAL.

AUTHOR CONTRIBUTIONS

Systematic review conception: M.M.W., F.A.M.A., N.E.B., H.N., C.A.T. Screening: M.M.W., Z.Y.Z., O.M., N.E.B. Extraction: M.M.W., Z.Y.Z., O.M., N.E.B. Statistical analyses: M.M.W., N.E.B. Drafted manuscript: All. Editing and final approval: All.

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CONFLICT OF INTEREST STATEMENT

All authors declare that they have no conflicts of interest to disclose.

DATA AVAILABILITY STATEMENT

The data set used for this meta-analysis can be shared upon request.

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REFERENCES

1. Yang Q, Ciebiera M, Bariani MV, et al. Comprehensive review of uterine fibroids: developmental origin, pathogenesis, and treatment. *Endocr Rev*. 2022;43(4):678-719.
2. De La Cruz MSD, Buchanan EM. Uterine fibroids: diagnosis and treatment. *Am Fam Physician*. 2017;95(2):100-107.
3. Fleischer R, Weston GC, Vollenhoven BJ, Rogers PAW. Pathophysiology of fibroid disease: angiogenesis and regulation of smooth muscle proliferation. *Best Pract Res Clin Obstet Gynaecol*. 2008;22(4):603-614.
4. Muzii L, Galati G, Mercurio A, et al. Presurgical treatment of uterine myomas with the GnRH-antagonist relugolix in combination therapy: an observational study. *Sci Rep*. 2024;14:22481.
5. Giuliani E, As-Sanie S, Marsh EE. Epidemiology and management of uterine fibroids. *Int J Gynaecol Obstet*. 2020;149(1):3-9.
6. Hiratsuka D, Isono W, Tsuchiya A, Okamura A, Fujimoto A, Nishii O. The effect of temporary uterine artery ligation on laparoscopic myomectomy to reduce intraoperative blood loss: a retrospective case-control study. *Eur J Obstet Gynecol Reprod Biol X*. 2022;15(8):100162.
7. Chen I, Lisonkova S, Joseph KS, Williams C, Yong P, Allaire C. Laparoscopic versus abdominal myomectomy: practice patterns and health care use in British Columbia. *J Obstet Gynaecol Can*. 2014;36(9):817-821.
8. Altgassen C, Kuss S, Berger U, Löning M, Diedrich K, Schneider A. Complications in laparoscopic myomectomy. *J Minim Invasive Gynecol*. 2006;20(4):614-618.
9. Donnez J, Dolmans M. Uterine fibroid management: from the present to the future. *Hum Reprod Update*. 2016;22(6):665-686.
10. Barseghyan M, Chae-Kim J, Catherino WH. The efficacy of medical management of leiomyoma-associated heavy menstrual bleeding: a mini review. *F S Rep*. 2023;5(1):4-8.
11. Alborzi S, Ghannadan E, Alborzi S, Alborzi M. A comparison of combined laparoscopic uterine artery ligation and myomectomy versus laparoscopic myomectomy in treatment of symptomatic myoma. *Fertil Steril*. 2009;92(2):742-747.
12. Sinha R, Sundaram M, Mahajan C, Raje S, Kadam P, Rao G. Laparoscopic myomectomy with uterine artery ligation: review article and comparative analysis. *J Gynecol Endosc Surg*. 2011;2(1):3-10.
13. Sanders AP, Norris S, Tulandi T, Murji A. Reproductive outcomes following uterine artery occlusion at the time of myomectomy: systematic review and meta-analysis. *J Obstet Gynaecol Can*. 2020;42(6):787-797.
14. Sanders AP, Chan WV, Tang J, Murji A. Surgical outcomes after uterine artery occlusion at the time of myomectomy: systematic review and meta-analysis. *Fertil Steril*. 2019;111(4):816-827.
15. Sterne JA, Hernán MA, Reeves BC, et al. ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. *BMJ*. 2016;355:i4919. doi:10.1136/bmj.i4919
16. Sterne JAC, Savović J, Page MJ, et al. RoB 2: a revised tool for assessing risk of bias in randomised trials. *BMJ*. 2019;366:l4898. doi:10.1136/bmj.l4898
17. Ji L, Jin L, Hu M. Laparoscopic myomectomy with temporary bilateral uterine artery occlusion compared with traditional surgery for uterine myomas: blood loss and recurrence. *Eur J Obstet Gynecol Reprod Biol*. 2018;25:434-439.
18. Jin L, Ji L, Shao M, Hu M. Laparoscopic myomectomy with temporary bilateral uterine artery and utero-ovarian vessels occlusion compared with traditional surgery for uterine fibroids: blood loss and recurrence. *J Minim Invasive Gynecol*. 2019;84:548-554.
19. Moratalla-Bartolome E, Lazaro-de-la-Fuente J, Lopez-Carrasco I, et al. Surgical impact of bilateral transient occlusion of uterine and utero-ovarian arteries during laparoscopic myomectomy. *J Minim Invasive Gynecol*. 2024;14:7044.
20. Kwon YS, Jung DY, Lee SH, Ahn JW, Roh HJ, Im KS. Transient occlusion of uterine arteries with endoscopic vascular clip preceding laparoscopic myomectomy. *J Minim Invasive Gynecol*. 2013;23:679-683.
21. Vercellino G, Erdemoglu E, Joe A, et al. Laparoscopic temporary clipping of uterine artery during laparoscopic myomectomy. *Arch Gynecol Obstet*. 2012;286:1181-1186.

22. Kim HC, Song T. Temporary simultaneous two-arterial occlusion for reducing operative blood loss during laparoscopic myomectomy: a randomized controlled trial. *J Minim Invasive Gynecol*. 2019;33:2114-2120.
23. El-Minawi A, El-shenoufy H, Hussein A, et al. Effect of bilateral uterine artery ligation on blood loss during total laparoscopic hysterectomy. *Front Med*. 2025;12:1577904. doi:10.3389/fmed.2025.1577904
24. Choi HJ, Kim MS, Kim T-J. Uterine artery ligation at its origin following retroperitoneal space development decreases blood loss during single-port total laparoscopic hysterectomy. *Taiwanese Journal of Obstetrics and Gynecology*. 2020;59:262-268. doi:10.1016/j.tjog.2020.01.015
25. Sordia-Piñeyro MO, Sordia-Hernández LH, Morales-Martínez FA, et al. Efficacy of medical and surgical interventions to reduce blood loss during laparoscopic myomectomy: a systematic review and meta-analysis. *Int J Gynaecol Obstet*. 2025;171:1168-1179.
26. Mara M, Kubinova K, Maskova J, Horak P, Belsan T, Kuzel D. Uterine artery embolization versus laparoscopic uterine artery occlusion: the outcomes of a prospective, nonrandomized clinical trial. *Fertil Steril*. 2012;35:1041-1052.
27. Tranoulis A, Georgiou D, Alazzam M, Borley J. Combined laparoscopic uterine artery occlusion and myomectomy versus laparoscopic myomectomy: a direct-comparison meta-analysis of short- and long-term outcomes in women with symptomatic leiomyomas. *J Minim Invasive Gynecol*. 2019;26:826-837.
28. Jan H, Ghai V. The approach to uterine artery ligation. *Semin Intervent Radiol*. 2019;26:S22. doi:10.1016/j.jmig.2019.09.517
29. Bae JH, Chong GO, Seong WJ, Hong DG, Lee YS. Benefit of uterine artery ligation in laparoscopic myomectomy. *Fertil Steril*. 2011;95:775-778.
30. Chang KM, Chen MJ, Lee MH, Huang YD, Chen CS. Fertility and pregnancy outcomes after uterine artery occlusion with or without myomectomy. *Taiwan J Obstet Gynecol*. 2012;51:331-335.
31. Akbaba E, Kilicci C. Clinical results of uterine artery ligation in myomectomy. *J Obstet Gynaecol Res*. 2023;94:498-505.
32. Yang Q, Madueke-Laveaux OS, Cun H, et al. Comprehensive review of uterine leiomyosarcoma: pathogenesis, diagnosis, prognosis, and targeted therapy. *Cells*. 2024;13(13):1106. doi:10.3390/cells13131106

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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