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Outcomes of Minimally Invasive Management of Tubo-Ovarian Abscess: A Systematic Review

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Abstract

Objective: To compare the success rate, complications, and hospital length-of-stay (LOS) of three modalities of minimally invasive management of tubo-ovarian abscesses (TOA): laparoscopy, ultrasound-guided drainage and computerized tomography (CT)-guided drainage.

Data Sources: Electronic-based search in Pubmed, EMBASE, Ovid MEDLINE, Google Scholar, and Cochrane Central Register of Controlled Trials, using the following medical subject heading (MeSH) terms: "minimally invasive surgical procedures, drainage, abscess, tubo-ovarian, ovarian diseases, and fallopian tube diseases."

Methods of Study Selection: Of the 831 articles in the initial results, 10 studies were eligible for inclusion in our systematic review.

Results: A total of 975 patients were included in our study; 107 (11%) had laparoscopic drainage procedures, and 406 (42%) had image-guided (US or CT) drainage of TOA. Image-guided TOA drainage had higher success rates (90 - 100%), when compared with laparoscopic drainage (89 -96%), and the use of antibiotic treatment alone (65 – 83%). Patients treated with image-guided drainage had no complications (for up to 6-months of follow-up) and shorter lengths of hospital stay (0-3 days on average) compared to laparoscopic drainage (5-12 days) or conservative management with antibiotics alone (7- 9 days).

Conclusion: Although conservative management of TOAs with antibiotics alone remains first-line, our review indicates that better outcomes in the management of TOA were achieved via minimally invasive approach compared to conservative treatment with antibiotics only. Of the minimally invasive techniques, image-guided drainage of TOAs provided the highest success rates, lowest complications, and the shortest hospital stays compared to laparoscopy. The low magnitude of evidence in the included studies, calls for further randomized trials. Review: This systematic review was registered in the International Prospective Register of Systematic Review (PROSPERO register, http://www.crd.york.ac.uk/PROSPERO;CRD 42020170345).

Introduction

Tubo-ovarian abscess (TOA), a complication of pelvic inflammatory disease (PID), can be severe and life-threatening[1]. TOA could be gastrointestinal or postoperative in origin and sometimes a surgical emergency. Management of TOAs with antimicrobials is usually the first line of therapy, with success rates of about 70%[2,3]. However, abscesses larger than 10 cm have greater than 60% chance of requiring surgery in addition to antimicrobials, when compared to smaller abscesses[3]. Laparoscopy, transvaginal ultrasound (US), and computerized tomography (CT)-guided drainage are established minimally invasive modalities in the management of TOAs[2–4]. Although there is a paucity of data comparing all three minimally invasive modalities, laparoscopy has been considered the surgical technique of choice because it offers the gynecologic surgeon accuracy in diagnosis, while simultaneously allowing treatment with low complication rates in the appropriate patient population [2,5–8]. A systematic review may provide insight into the comparative safety and effectiveness of the three modalities of management. This systematic review aims to review minimally invasive management of TOA looking at outcomes. We aim to compare laparoscopic, US-guided, and CT-guided drainage of TOA in three primary outcomes - success rate, complications, and post-procedure hospital length-of-stay (LOS).

Methods

Literature Search Strategy

We retrieved articles from PubMed, Ovid MEDLINE, Ovid EMBASE, Google Scholar, and Cochrane Central Register of Controlled Trials, using the medical subject heading (MeSH) descriptors: "Minimally Invasive Surgical Procedures" OR "Drainage" AND "Abscess" OR "Tubo ovarian" OR "Ovarian diseases" OR "Fallopian tube diseases." References were downloaded into Covidence, a web-based platform that streamlines the production of the systematic review, including Cochrane review. The initial search was for all human subject studies, all publications in English as the primary language and later limited to publications from January 1990 up to 10th March 2020.

Study Eligibility

Our systematic review followed the suggestions of the Preferred Reporting Items for Systematic Reviews and Meta-Analysis statement[9,10], and was registered in the International Prospective Register of Systematic Review (PROSPERO register, http://www.crd.york.ac.uk/PROSPERO;CRD 42020170345). The primary objective of the present investigation was to compare the success rate, complications, and post-procedure hospital LOS for three modalities of minimally invasive management of TOA: laparoscopy, US-guided drainage, and CT-guided drainage.

The inclusion criteria were 1) cohort studies or clinical trials in patients with no age restriction, 2) studies that described pelvic inflammatory disease/TOA complexes of gynecologic origin 3) studies published in the last 30 years, 4) studies published in English as the first language, 5) studies with >10 patients, 6) studies that recorded outcomes for at least one of the following minimally invasive interventions for TOA: laparoscopy, ultrasound-guided drainage, and CT- guided drainage. We excluded case studies, reports or series, video reports, studies of non-gynecological abscesses (e.g., appendicitis), and studies describing pre-existing postoperative pelvic abscesses within 30 days of surgery. Studies that did not state the imaging or surgical modalities of drainage and studies that did not document the etiology or cause of abscess as gynecologic were also excluded.

Study selection and Data extraction

The primary authors executed the search strategies in collaboration with the university librarian (L.H). For preliminary review, authors (O.G., M.M., S.K., and M.C.) met to evaluate titles, abstracts, study design, and methodology. All authors critically reviewed each article using a standardized form. Abstracts deemed ineligible by all authors were omitted from review. If there was a disagreement about an article, all authors reviewed it again and came back to discuss using established criteria to accept or reject. A total of 10 studies representing 975 patients aged 11-86 years, met selection criteria. Tables 1 and 2 summarize details of the design, population, strengths, weakness, and critical appraisal of included studies. All patients received broad-spectrum antibiotics.

We extracted the following data from articles that met inclusion criteria: study design, mean patient age, minimally invasive procedure type, average abscess size, average post-procedure length-of-hospital-stay, procedure complication, and success rate. Methodological quality assessment to evaluate the risk of bias in each study was performed by all four authors (O.G., M.M., S.K., M.C.) using the Grading of Recommendations, Assessment, Development and Evaluation (GRADE)[11] and the American College of Obstetricians and Gynecologists (ACOG) guidelines [12]. ACOG guidelines categorize evidence in three recommendation levels: A (good and consistent evidence typically from clinical trials), B (limited or inconsistent evidence from retrospective studies), and Level C (consensus and expert opinion). We rigorously assessed each study's PICOS question, risk of bias, precision, consistency, directness, and publication bias to assign GRADE levels of evidence (Appendix 1).

Results

Our initial search identified 831 citations. We eliminated duplicate entries, resulting in 711 unique full-text articles. We screened the titles, abstracts and methods sections, and excluded 601 records for the following mutually exclusive reasons: did not report data on any outcome of interest such as hospital length-of-stay, success rates, or complications; did not report on any minimally invasive surgical method (laparoscopy or image-guided techniques); was a review article, case-report, case-series, or video report; or full English text was unavailable. We completed full-text reviews on the remaining 110 studies, further excluding 47 articles that were not published in the last 30 years, did not document the etiology or cause of abscess, or did not state the imaging or surgical modalities of drainage. Fifty-three articles were further excluded because they did not report on pelvic inflammatory disease/TOA complexes of gynecologic origin, had a sample size <10 patients or described pre-existing postoperative pelvic abscesses within 30 days of surgery. Overall, 10 articles met our inclusion criteria and were incorporated into our final analysis, as detailed in Fig. 1. Our study cohort included 975 patients: 107 (11%) had laparoscopic drainage procedures, 357 (37%) had US-guided drainage, and 49 (5%) had initial CT-guided drainage of TOA. Average abscess size for patients who underwent minimally-invasive procedures ranged from 4.32 to 8.5 cm but was inconsistently reported (Table 2). The three primary outcome measures we sought to compare across studies were (1) success rate, defined as a complete response to treatment not requiring a repeat intervention, no conversion-to-laparotomy within the same hospital admission, no secondary intervention during the follow-up period, and successful long-term outcomes from surgery, (2) complications, defined as an intraoperative or postoperative injury to an internal organ except genital organs or wound infection, and (3) post-procedure length-of-hospital-stay. Measuring direct surgical outcomes is by far the most robust method of simultaneously assessing the impact of the surgery on the patient's quality of life and the hospital's distribution of care[13]. Table 1 summarizes study characteristics and risk of bias.

Success rate

Successful TOA drainage refers to a complete response to treatment that does not require a repeat intervention, no conversion to laparotomy within the same hospital admission, no secondary intervention during the follow-up period, and successful long-term outcomes from surgery. Image-guided aspiration of TOAs with CT or transvaginal US had better success rates than laparoscopy (Table 3). Caspi et al.[14] reported 100% success of transvaginal US-drainage followed by local intracavitary antibiotic irrigation. Teisala et al.[15] found that all patients who had transvaginal US drainage did not require a repeat intervention after a 1-month follow-up. Aboulghar et al. [16] similarly noted that all patients who underwent transvaginal US-drainage were symptom-free after six months of follow up and did not require further intervention. For Goharkhay et al.[17], 100% of the US-drained TOAs showed complete response to treatment with no required secondary intervention, compared to 58% of the antibiotics-only treatment group. Of the 42%, antibiotics-only treated cases that failed response, 90% received salvage image-guided drainage and showed a complete clinical response after this secondary intervention. In comparison, the other 10% that did not receive salvage image-guided drainage needed a total hysterectomy.

In addition, To et al.[18] described that 97.6% of the patients who underwent image-guided drainage (either CT- or US-drainage) had a complete response. In contrast, only 83.3% of those in the antibiotics-only treatment arm had complete success. Of note, 22.6% of the patients in the antibiotic-only group were readmitted for similar disease compared to 9.8% readmission rate in the image-guided drainage group[18]. Perez-Medina et al.[19] also reported a 90% favorable short-term response in patients who only had transvaginal US-drainage of TOAs compared to a 65% favorable response for those who received only antibiotics group. After a 1-month follow up, 94% of patients in the US-drainage group, in contrast to 77% patients in the antibiotics-only group had complete treatment response, with no persistent pain, no adnexal masses, and no need for further intervention[19]. Likewise, Gjelland and colleagues[20] found that 93.4% of patients who were administered antibiotics and subsequent transvaginal US-drainage had successful recoveries, with 62.3% of them reporting a complete resolution of their pain within 48 hours of the first drainage[20]. Interestingly, their research produced such a high success rate. There was no relapse of TOA after a 3-year follow-up in 100% of their participants that they suggest that this regimen should be considered a first-line procedure[20].

Among the laparoscopic studies, Buchweitz et al.[21] were the first to compare fertility-preserving (organ-preserving) laparoscopic drainage of TOA to non-fertility preserving (organ-ablative, or non-organ-preserving laparoscopy with salpingectomy and oophorectomy) management. In their study, 96% of the patients in the organ-preserving laparoscopic drainage group were not readmitted for pelvic pain. In comparison, 89% of patients in the non-organ preserving drainage group were not readmitted for pelvic pain within two weeks after discharge[21]. In terms of long-term fertility success rates, 19% of the organ-preserving group achieved live births, whereas only 4% of the non-organ-preserving group achieved live births. The total laparoscopic conversion-to-laparotomy rate documented by Buchweitz and colleagues was 1.67%[21].

Complications

Intraoperative and postoperative complications significantly predict postsurgical morbidity. On the whole, image-guided drainage techniques had fewer complications than laparoscopy (Table 4). Impressively, Gjelland et al.[20] reported no major procedure-related complications, such as bowel perforation or bleeding, in any of the 302 patients who underwent transvaginal US drainage. Aboulghar et al.[16], Caspi et al.[14] Goharkhay et al.[17], and Teisala et al.[15] did not report any complications in image-guided drainage procedures.

On the contrary, Buchweitz et al.[21] recorded significant complications with the non-organ-preserving laparoscopy compared to organ-preserving drainage ($p < .05$). Remarkably, 51% of the patients who underwent non-organ-preserving laparoscopic drainage had complications such as bowel injury with secondary laparotomy (1), serosal lesions (4), lesions of the greater omentum (2), lacerated collaterals of the internal iliac artery bowel obstruction (2), thrombosis of the upper and lower legs (2), and fever higher than 38˚C for more than 2 days (1) . In contrast, no operative complications or serious systemic sequelae were found in the organ-preserving laparoscopic-drainage group[21].

Yang et al.[5] recorded a 10% complication rate with laporoscopy. Complications were defined as injury to an internal organ except genital organs and/or wound infection after surgery. Similarly, Doganay et al.[22] reported 7% organ injury with laparoscopic drainage.

Average Hospital Length-of-Stay

Hospital length-of-stay (LOS) often serves as a proxy measure for clinical outcomes. There is substantial evidence to show that reducing LOS improves financial, operational, and clinical outcomes[23]. Most surgical procedures are moving towards same-day discharge to decrease the costs of care for a patient and minimize hospital-acquired infections[13]. The mean length of hospital stay for TOA patients receiving minimally-invasive interventions ranged from 0 to 13.3 days (Table 5).

Aboulghar et al.[16] recorded same-day discharge in 40% of the patients undergoing transvaginal US drainage; the other 60% were discharged in 1-3 days. For Caspi et al.[14], mean transvaginal US drainage-to-discharge time was 3.1 days. Perez-Medina et al.[19] recorded mean transvaginal US drainage-to-discharge time as 3.9 days compared to 9.1 days for the group of patients managed with only antibiotics ($p < 0.001$). Similarly, Goharkhay et al.[17] found that image-guided drainage (US- and CT-) had significantly shorter mean post-surgical hospital stay (4.5 days) compared to conservative antibiotic treatment (7.0 days, $p < .001$). Surprisingly To et al.[18] discovered that patients who received image-guided (CT or US) drainage had more extended hospital stays on average (13.3 days) compared to 7.4 days for the antibiotics-only group ($p < .01$). It is important to note that patients in this study were on antibiotics alone for extended days before the minimally invasive technique was introduced. The authors note that time from treatment to discharge was similar in both groups: 7.4 days for antibiotics- only versus 6.7 days in the image-guided group, p=.52). Therefore, the increased LOS is likely due to a delay in initiating drainage since the majority of image-guided drainages were salvage procedures[18].

Doganay et al.[22] reported average hospital LOS for laparoscopies to be 2 days, laparotomies averaging 7.4 days, and antibiotic-only treatment averaging 11 days. Yang et al. [19], also showed a marked decrease in hospital LOS with laparoscopy (5.4 days) (p<.001). Furthermore, Buchweitz et al.[21] discovered that the organ-preserving laparoscopic TOA drainage group had a shorter hospital LOS on average than the non-organ-preserving cohort (11.9 versus 12.5 days, respectively).

Discussion

The algorithm for the management of TOAs remains broad, as options range from conservative management with antibiotics for smaller abscesses, to a combination of antibiotics and minimally invasive drainage, for larger abscesses[21]. There is evidence in literature that antibiotic therapy alone is often insufficient due to the anaerobic nature of the abscess and inability of antibiotics to concentrate in the abscess cavity[16]. Therefore, the removal of the abscess via drainage in addition to antibiotics is needed in most cases. To our knowledge, there is no standard comparison of the surgical outcomes of all minimally invasive modalities in literature. Laparoscopic drainage of TOAs may be preferred as the minimally invasive surgical technique of choice for draining TOAs[4,5]. One key advantage of laparoscopy is its utility in diagnosis, as it allows for removal of necrotic tissue, and sample acquisition for pathology[1,6]. While there is evidence that laparoscopic intervention is highly effective if done early in the course of TOA management[6,8], clinicians must be mindful of the risks of anesthesia and other potential risks to fertility for patients who have not yet completed their families[5,24].

Our systematic review brings into question first-line management of TOAs with antibiotics-only laparoscopy for the drainage of TOAs. Advances in technology and the availability of interventional radiology have made image-guided TOA drainage approaches, namely US and CT, the preferred modalities in the drainage of TOA. Our systematic review documents that image-guided drainage is a safe and effective primary or secondary treatment of TOAs, and is less traumatic than laparoscopy [17]. In the authors' opinion, image-guided drainage techniques with concomitant antibiotics should be considered first line if readily available as they yield 90-100% success rates, lower complications, and shorter hospital stays[14–20]. If laparoscopy is considered first-line for minimally-invasive management, then Buchweitz et al. [21] illustrate that fertility-preserving or organ-preserving techniques (without salpingectomy or oophorectomy) can achieve similarly favorable outcomes to image-guided drainage.

A limitation of our study is that all the studies except one are retrospective studies. Most of the reviewed articles were low-quality studies, with small sample sizes limiting the magnitude of effect. According to the GRADE criteria[11], 2 of our studies were Very Low Quality[14,16], 2 were graded Low Quality[15,22], and the other 6 were scored as Moderate Quality[5,17–21]. Majority of the studies included patients treated for TOAs more than ten years prior to the preparation of this manuscript. Significant advances in the equipment and technique of laparoscopic and image-guided drainage of TOA have developed in the interim. With this understanding, we are aware that the current outcomes of each technique may differ from the observations of our systematic review. Additionally, the heterogeneity of study design restricted adequate comparison of all minimally invasive methods. In particular, the CT-only drainage sample size was small compared to transvaginal US studies with higher quality and higher magnitude of evidence. Across the studies, our three main outcome variables of interest (success rate, complications, and hospital length-of-stay) were not consistently reported, thereby limiting our Interpretation or ability to do a pooled meta-analyses of our specific outcomes. For example, some studies included patients who received early intervention within 24 hours of hospital admission; others looked at delayed interventions 48-72 hours after admission, managed with antibiotics. One of the points highlighted by the systemic review is the need for an algorithm in the management of TOA. Although the antibiotics administered were relatively uniform, and most followed the Centers for Diseases Control and Prevention (CDC) guidelines, there was no uniformity regarding when to offer image-guided drainage or laparoscopy. Of note, the conversion rate to laparotomy was not a consistently reported outcome. The post-procedure follow-up time in all of the studies ranged from 1 month to 3 years; therefore, long-term success rates after 3 years could not be determined. Some of the TOA patients in the antibiotic only arm were switched to minimally invasive methods when they were not clinically improving. Therefore, the period for improvement on antibiotics alone before the intervention was not standard and varied from 0 to 6 days between studies[14,17,18].

Furthermore, the choice of patients and minimally invasive intervention after antibiotic treatment failure was not well-documented in all studies, therefore one must be wary of a possible selection bias affecting our comparison of outcomes between all surgical modalities. Due to the quality of the papers, sample sizes, and the low magnitude of effect, the authors acknowledge that we can only draw preliminary associations. Since none of the studies compared image-guided drainage to laparoscopic management, further research for head-to-head comparison is warranted. Our limitations underscore the need for large-scale studies on this topic.

As the first of its kind to systematically review the outcomes for minimally-invasive management of TOAs, our study's strength is our broad literature search and final review of studies from many countries, thus representing universal approaches to minimally-invasive TOA management. By adhering to our strict inclusion and exclusion criteria, we focused our review on gynecology related TOAs, thereby minimizing the risk of other pelvic abscess etiologies confounding our analysis.

Conclusion

Minimally invasive management of TOAs achieves more favorable outcomes than conservative treatment with antibiotics alone[5,14–22]. Our preliminary review findings reveal that image-guided draining techniques should be the first-line minimally invasive treatment for TOAs[14–20]. Laparoscopy should only be considered if antibiotics and image-guided techniques are not effective. This topic is of considerable importance to the gynecologic surgeon, given the difficulty in managing TOA's and the morbidity of the condition.There is a critical need for higher-powered studies comparing outcomes for all TOA treatment modalities. Research in this domain will be important in determining the standard of care for TOA patients and guiding gynecologic surgeons on managing TOAs based on patient characteristics, surgical skills, and technology availability.

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Appendix 1. GRADE and ACOG scoring

First Author	Year	Population (N)	Intervention	Comparison group	Outcome	Study design	GRADE scoring	ACOG
Aboulghar [16]	1995	15 patients with acute PID-TOA	US-guided transvaginal drainage	None	6 outpatients, 9 LOS 1-3 days	Retrospective Cohort Study	1/5 = very low quality	B
Buchweitz[21]	2002	60 Patients with TOA	laparoscopy – organ-preserving (25)	Laparoscopy – organ-ablative (35)	18/35 ablative had complications, 0/25 aspiration	Retrospective Cohort Study	3/5 = moderate quality	B
Caspi[14]	1996	10 patients with TOA-PID	US-guided + Antibiotics	None	100% success	Retrospective Cohort Study	1/5 = very low quality	B
Doganay[22]	2011	184 Patients with TOA	Laparotomy (122)	Antibiotics-only group and laparoscopy	25.4% complications in laparotomy, 7.1% complication in laparoscopy	Retrospective Cohort Study	2/5 = low quality	B
Gjelland[20]	2005	302 Patients with TOA	US-guided drainage	None	93.4% successful, no major complications, 20/302 had treatment failures	Retrospective Cohort Study	4/5 = moderate quality	B
Goharkhay[17]	2007	58 patients with TOA	50 Antibiotics	8 US or CT-guided	29/50 success with Antibiotics, 8/8 drain success with no complications	Retrospective Cohort Study	3/5 = moderate quality	B
Perez-Medina[19]	1996	40 women with TOA	US-guided	Antibiotics-only	90% success, no complications	Randomized Control Trial	3/5 = moderate quality	B
Teisala [15]	1990	10 patients with severe PID	US-guided drainage	None	100% success, no complications	Retrospective Cohort Study	2/5 = low quality	B
To[18]	2014	240 patients with TOA	CT-guided drainage	Antibiotics-only	CT hospital stay longer than Antibiotics, 16.1% Antibiotics req surgery, just 2.4% CT required	Retrospective Cohort Study	3/5 = moderate quality	B

					follow-up surgery (failure rate higher)			
Yang[5]	2002	56 patients with TOA	19 laparoscopy	37 laparotomy	10.5% laparoscopy complications, 32.4% laparotomy complications	Retrospective Cohort Study	3/5 = moderate quality	B

*Authors rated quality of evidence using the GRADE (Grading of Recommendations, Assessment, Development and Evaluations) criteria. Evidence from randomized controlled trials automatically started at high quality, and evidence from observational data started at low quality. The certainty in evidence was increased or decreased based on 5 criteria: risk of bias, imprecision, inconsistency, indirectness, and publication bias. The authors also rated the quality of evidence using ACOG guidelines: A = randomized control trial; B = retrospective chart review; C = expert opinion/ case series.

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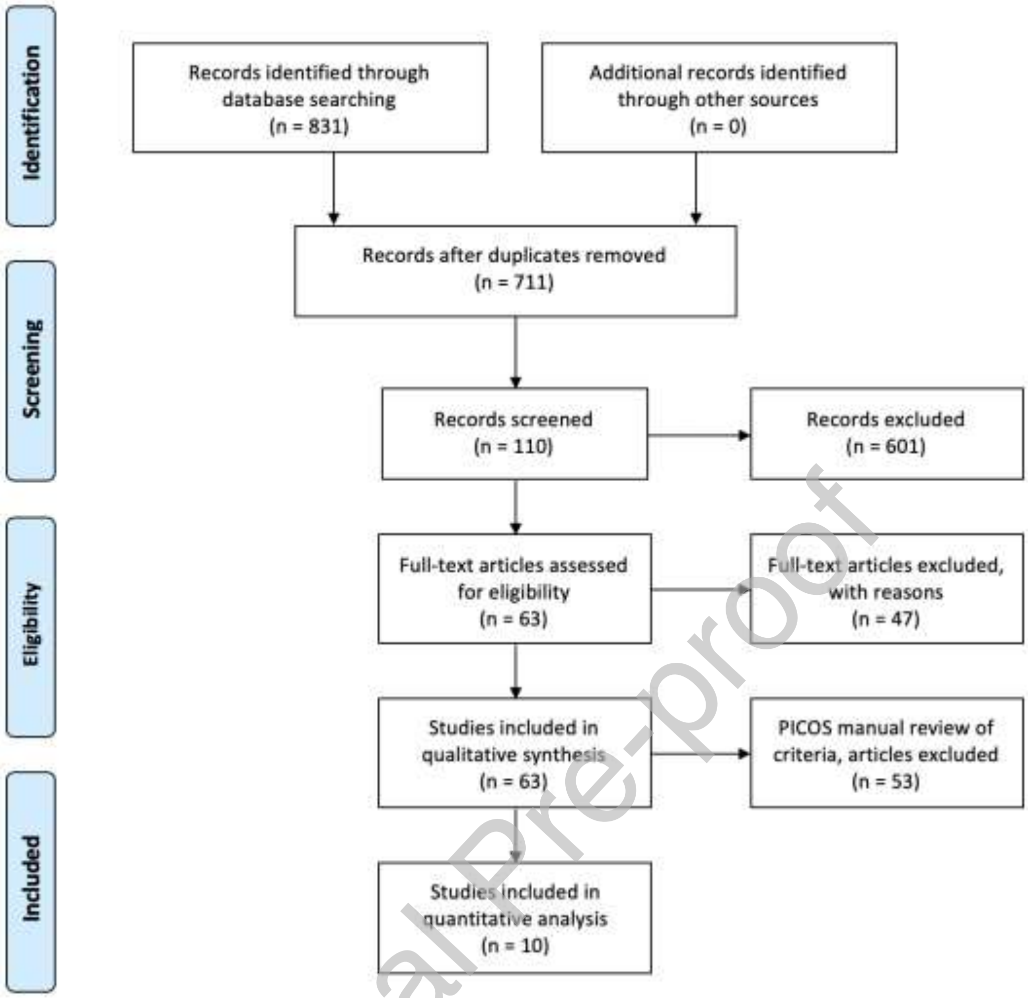

Figure 1. PRISMA 2009 Flow Diagram

Table 1. Risk of bias assessment using GRADE system and ACOG guidelines

First Author [Reference]	Year of Publication	Country	Study design	Study Period	Level of Recommendation (GRADE System)	Level of Evidence (ACOG Guidelines)
Teisala [15]	1990	Finland	Retrospective Cohort Study	1988	LQ	B
Aboulghar [16]	1995	Egypt	Retrospective Cohort Study	1988 - 1993	VLQ	B
Caspi [14]	1996	Israel	Retrospective Cohort Study	1990 - 1994	VLQ	B
Perez-Medina [19]	1996	Spain	Randomized Control Trial	1989 - 1992	MQ	B
Buchweitz [21]	2002	Germany	Retrospective Cohort Study	1994 - 1998	MQ	B
Yang [5]	2002	China	Retrospective Cohort Study	1992 - 2000	MQ	B
Gjelland [20]	2005	Norway	Retrospective Cohort Study	1986 - 2003	MQ	B
Goharkhay [17]	2007	USA	Retrospective Cohort Study	1999 - 2001	MQ	B
Doganay [22]	2011	Turkey	Retrospective Cohort Study	2001 - 2008	LQ	B
To [18]	2014	USA	Retrospective Cohort Study	2012 - 2014	MQ	B

*ACOG = American College of Obstetricians and Gynecologists; GRADE = Grading of Recommendations, Assessment, Development, and Evaluation; VLQ=Very Low Quality; LQ = Low Quality; MQ = Moderate Quality.

Table 2. Studies Characteristics

First Author [Reference]	Sample Size, N	Drainage Intervention (n)	Mean Age(range)	Mean Abscess Diameter, cm
Teisala [15]	10	Transvaginal US-guided (10)	33 (22 – 46)	n/a
Aboulghar [16]	15	Transvaginal US-guided	28.5 ± 7.2 (23-37)	6.73 ± 1.61 (4-9.5)
Caspi [14]	10	Transabdominal US-guided (2)	36 (22-52)	5.5 (3.6 - 7.8)
		Transvaginal US-guided (8)	n/a	
Perez-Medina [19]	40	Antibiotics only (20)	27.4 (16-49)	5.8
		US-guided (20)	29.1 (16-49)	6.3
Buchweitz [21]	60	Organ-Preserving Laparoscopy(25)	30.6 (23-37)	n/a
		Organ-Ablative Laparoscopy(35)	39.5 (33-46)	
Yang [5]	56	Laparotomy (37)	36.19 ± 9.42	n/a
		Laparoscopy (19)	37.74 ± 7.58	
Gjelland [20]	302	Transvaginal US-guided	40.1 (15-86)	7.7 (3.0 - 15.0)

Goharkhay [17]	58	Antibiotics only (50)	31.7 (16-61)	n/a
		US- or CT-guided (8)	32.5 (18-44)	
Doganay [22]	184	Laparotomy (122)	43.07	6.48
		Abx only (34)	27.04	3.68
		Laparoscopy (28)	33.08	4.32
To [18]	240	Antibiotics only (199)	32.7 ± 0.7 (11-49)	5.9 ± 2.6
		CT-guided (41)	32.2 9 ± 1.8 (11-49)	8.5 ± 3.6

[a]Mean total volume of abscess, as estimated by sonographic imaging, is reported as 143.8 mL (Abx group) and 157.1 mL (drainage group).

Table 3. Success Rates

First Author [Reference]	Sample Size, N	Drainage Intervention (n)	Average Length of follow-up after intervention (N)	Success rate, %
Teisala [15]	10	Transvaginal US-guided (10)	1 month follow-up	100
Aboulghar [16]	15	Transvaginal US-guided	6 month follow-up	100
Caspi [14]	10	Transabdominal US-guided (2)	6 month follow-up	100
		Transvaginal US-guided (8)		100
Perez-Medina [19]	40	Antibiotics only (20)	1 month follow-up	65
		US-guided (20)		90
Buchweitz [21]	60	Organ-Preserving Laparoscopy(25)	n/a	96
		Organ-Ablative Laparoscopy(35)	n/a	89
Yang [5]	56	Laparotomy (37)	n/a	n/a
		Laparoscopy (19)	n/a	n/a
Gjelland [20]	302	Transvaginal US-guided	3 year follow-up	93.4

Goharkhay [17]	58	Abx only (50)	n/a	58
		US- or CT-guided (8)	n/a	100
Doganay [22]	184	Antibiotics only (34)	1 year follow-up (34)	n/a
		Laparotomy (122)	n/a	n/a
		Laparoscopy (28)	n/a	n/a
To [18]	240	Antibiotics only (199)	10 ± 2.7 years (120)	83.3
		CT-guided (41)	8.5 ± 3.1 years (30)	97.6

Table 4. Complications

First Author [Reference]	Sample Size, N	Drainage Intervention (n)	Complication Rate, %	Commonly Reported Complications, (N)
Teisala [15]	10	Transvaginal US-guided (10)	0	None
Aboulghar [16]	15	Transvaginal US-guided	0	None
Caspi [14]	10	Transabdominal US-guided (2)	0	None
		Transvaginal US-guided (8)	0	None
Buchweitz [21]	60	Organ-Preserving Laparoscopy(25)	0	No operative complications; post-operative admission (1)
		Organ-Ablative Laparoscopy(35)	51.4	Intestinal perforation requiring subsequent laparotomy (1); serosal lesion (4); lesion of the greater omentum (2); lacerated collaterals of internal iliac artery (2); bowel obstruction (2); thrombosis of lower leg(1);

				thrombosis of upper leg (1); postoperative fever higher than 38˚C for 2 days.
Yang [5]	56	Laparotomy (37)	32.4	Injury to an internal organ except genital organs and/or wound infection after surgery (12)
		Laparoscopy (19)	10.5	Injury to an internal organ except genital organs and/or wound infection after surgery (2)
Gjelland [20]	302	Transvaginal US-guided	0	None
Goharkhay [17]	58	Abx only (50)	n/a	n/a
		US- or CT-guided (8)	0	None
Doganay [22]	184	Antibiotics only (34)	n/a	n/a
		Laparotomy (122)	14	Bowel injury (8), Ureteral injury (6), Morbidity related to abdominal

		incision (6)
		Bowel injury (2)
Laparoscopy (28)	7	

Table 5. Average Hospital Length-of-Stay

First Author [Reference]	Sample Size, N	Drainage Intervention (n)	Average hospital LOS, days, (N), [range]
Aboulghar [16]	15	Transvaginal US-guided	0 (6) 1-3 (9)
Caspi [14]	10	Transabdominal US-guided (2) Transvaginal US-guided (8)	3.1 [2-12]
Perez-Medina [19]	40	Antibiotics only (20)	9.1 [5-16]
		Transvaginal US-guided (20)	3.9 [2-8]
Buchweitz [21]	60	Organ-Preserving Laparoscopy(25) Organ-Ablative Laparoscopy(35)	11.9 12.5

Yang [5]**	56	Laparotomy (37)	8.92 ± 2.59
		Laparoscopy (19)	5.37 ± 1.38
Goharkhay [17]**	58	Abx only (50)	7 [4-16]
		US- or CT-guided (8)	4.5 [4-8]
Doganay [22]	184	Antibiotics only (34)	11.06
		Laparotomy (122)	7.43
		Laparoscopy (28)	2.07
To [18]*	240	Antibiotics only (199)	7.4 ± 6.1
		CT-guided (41)	13.3 ± 8.9

**p<.01, **p<.001*