REVIEW

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Diagnosis, management and outcomes of incarceration or intussusception of Fallopian tubes following uterine perforation after vacuum aspiration or dilatation and curettage of the uterine cavity: a systematic review of the literature

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ABSTRACT

Background: Dilation and curettage and vacuum aspiration are frequently performed gynaecological procedures used to treat uterine pathology. This procedure carries a risk of uterine perforation, which can lead to injury of abdominal organs and, rarely, to fallopian tubes.

Objectives: To evaluate symptoms and diagnostic signs and to propose the most appropriate management for the intussusception and incarceration of fallopian tubes following uterine aspiration and curettage.

Methods: We screened three major databases (Medline, Scopus, Google Scholar) from 2000 to May 2024. Our review examined tubal incarceration, causes, management, symptoms, parity, diagnosis timelines, visceral injury, and surgical complications. The methodological quality of the included studies was assessed using the JBI Critical Appraisal Checklist for case reports.

Main Outcome Measures: Diagnostic methods, complications and management of tubal incarceration following uterine perforation.

Results: We identified 24 papers, all of which were case reports or case series. In our analysis, tubal incarceration was observed in 25 of 26 cases (96.2%) and in 2 of which (7.7%) it was associated with the entrapment of the infundibulopelvic ligament. In 1 of 26 cases (3.8%) intussusception of the fallopian tube was observed. The most frequently manifested symptoms were abdominopelvic pain, vaginal bleeding, vaginal discharge and amenorrhoea. The mean time to diagnosis was 15.4 months, with transvaginal ultrasound being the primary diagnostic tool, followed by hysteroscopy and diagnostic laparoscopy.

Conclusions: Diagnosing this condition should involve a detailed medical history, a comprehensive clinical examination, and imaging evaluations. If instrumental investigations are negative but suspicion remains, hysteroscopy and/or laparoscopy may be necessary.

What is New? Tubal incarceration complicating uterine perforation can be managed using hysteroscopy and laparoscopy.

Keywords: Fallopian tubes incarceration, intussusception, aspiration, curettage, uterine perforation, systematic review

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Introduction

The risk of perforation during gynaecological procedures ranges from 0.1% to 4%. The highest risk is associated with postpartum procedures (4%), followed by operative hysteroscopies (1%), and the lowest risk is seen in diagnostic hysteroscopies or procedures involving premenopausal patients (0.1%-0.5%).[1] Hysteroscopic procedures generally present a lower risk of perforation and accidental organ damage compared to dilation and curettage (D&C) procedures, due to the greater control provided by direct vision.[1]

D&C is one of the most common gynaecological procedures for the investigation of abnormal uterine bleeding, which nowadays has been replaced with procedures that are more accurate. Nevertheless, vacuum evacuation and curettage remains the standard to remove pregnancy tissue during a first-trimester abortion or miscarriage or post-partum retention of material, despite its highly invasive nature.[2] In contrast, for heavy menstrual bleeding or abnormal uterine bleeding, a hysteroscopic approach, whether "office" or operative, is currently recommended to identify the underlying cause, as it offers superior diagnostic and therapeutic accuracy compared to "blind" procedures like D&C.[3]

It is well-known that any intrauterine procedure, from a simple aspiration to a more complex curettage, carries a risk of uterine perforation.[1] While most perforations can be managed without additional interventions and typically do not result in significant morbidity, serious complications can occur. These include sepsis, haemorrhage, poor reproductive and obstetric outcomes, or injuries to the small intestines, bladder, rectum, appendix, and, rarely, the fallopian tubes, potentially leading to death.[1,4]

In this literature review, we have collected all cases published since inception concerning fallopian tube incarceration following intrauterine procedures. Our goal is to highlight suspicious symptoms and diagnostic signs and to propose the most appropriate management strategies. We have defined tubal incarcerations as cases in which the tube, or a portion of it, become trapped inside the uterus through a breach created by D&C or suction with a cannula during vacuum aspiration. Additionally, we have included cases of tubal intussusception, where one segment of the tube slips inside another, leading to its entrapment.

Methods

This research was approved by the Institutional Review Board of the Institute for Maternal and Child Health IRCCS Burlo Garofolo (RC 08/2022). A literature search was conducted in May 2024 using various combinations of the following terms: "Tubal incarceration," "Tubal incarceration and uterine perforation," and "Tubal incarceration after vacuum aspiration dilatation and curettage." All cases published in the literature in any language until May 2024 were sourced from Google Scholar, PUBMED, and Scopus.

In our review, we evaluated cases of tubal incarceration, including their causes, management, symptoms, parity, diagnosis timelines, visceral injuries, previous gynaecological surgeries, and complications. Articles that were not relevant to the topic were excluded. All identified studies were examined for year, citation, title, authors, abstract, and full text. Duplicates were identified through manual screening performed by two researchers (C.R. and G.S.) and subsequently removed. The review followed PRISMA guidelines.[5]

The PRISMA flow diagram illustrating the selection process is provided in Figure 1. For the eligibility process, two authors (C.R. and G.S.) independently screened the titles and abstracts of all non-duplicated papers and excluded those not pertinent to the topic. The same two authors independently reviewed the full texts of papers that passed the initial screening and identified those to be included in the review. Discrepancies were resolved by consensus.

Due to the rarity of this condition, the included studies are all case reports. Consequently, we present the data in a descriptive manner. The methodological quality of the included studies was assessed using the JBI Critical Appraisal Checklist for case reports (Supplementary Table 1).

Results

After the literature search, we identified 24 articles comprising 26 cases (Table 1).[6-36] Most of the cases occurred after vacuum aspiration (11/26, 42.3%), 7 of 26 cases (27%) after D&C, 3 of 26 cases (11.5%) after curettage only, 3 of 26 (11.5%) cases after the combination of vacuum aspiration and curettage and, finally, 2 of 26 (7.7%) cases after combination of dilatation and curettage and vacuum aspiration. In 25 of 26 cases (96.2%), incarceration of the distal part of either the right or left

fallopian tube was observed, of which in 2 cases (7.7%) tubal incarceration was associated with entrapment of the infundibulopelvic ligament, and in one of these two cases, the ipsilateral ovary was also involved. In 2 of 26 cases (7.7%) the avulsion of fimbrial part or distal part of the tube occurred, and the rest remained entrapped. In 1 of 26 cases (3.8%) a tubal intussusception was observed. No concurrent injuries to other visceral organs, such as the bowel, sigmoid colon, or omentum, were reported in any of the screened cases.

The most common indication for the surgeries that led to tubal incarceration, avulsion or intussusception was surgical evacuation of the uterine cavity, either after a miscarriage (AS) or for voluntary termination of pregnancy (TOP) (73%). This was followed by removal of retained placenta after delivery or an incomplete afterbirth phase (23.2%). In one case (3.8%), the removal of an intrauterine device using Pean's forceps led to tubal incarceration. The symptoms most frequently reported by patients included non-specific abdomino-pelvic pain (14/26, 54%), abnormal vaginal bleeding (8/26, 30.8%), vaginal discharge (5/26, 19.2%), secondary amenorrhoea (3/26 11.5%), secondary infertility (4/26, 15.4%) and postpartum haemorrhage (1/26, 3.8%). Two of 26 patients (7.7%) were completely asymptomatic (Table 2).

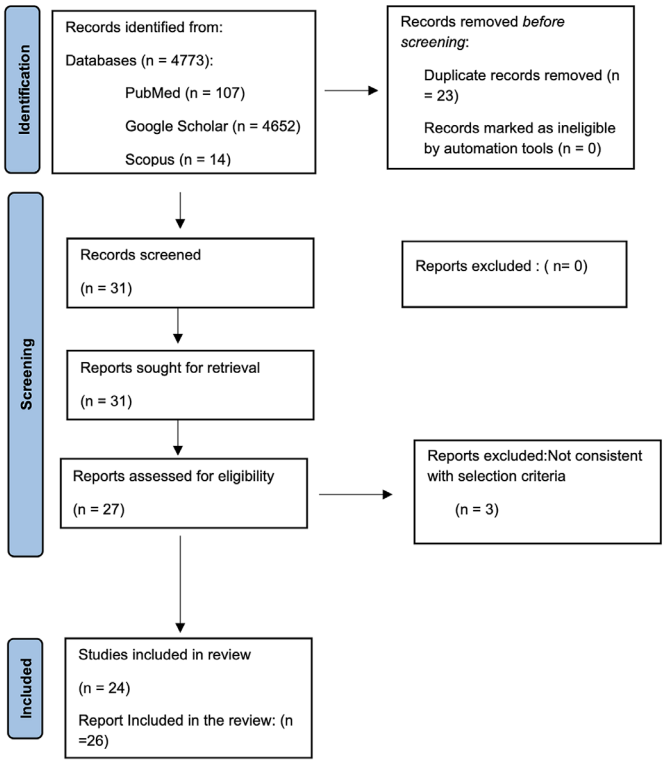

Figure 1. The PRISMA flow diagram of the selection process.

In our analysis, the mean time to diagnosis was 15.4 months, with a range from a few hours post-procedure to 5 years. In most cases, the suspected diagnosis was made using transvaginal ultrasound, followed by hysteroscopy and diagnostic laparoscopy. Magnetic resonance imaging (MRI) was used in 4 of 26 cases (15.3%) to complete the instrumental investigations, and computed tomography (CT) was used in 2 of 26 cases (7.7%).

Except for eight cases, laparoscopy was the approach of choice. In four cases (15.3%), the tube was extracted from the myometrium, which was subsequently sutured. In most cases (12 of 26, 46.1%), salpingectomy was necessary. In three cases, diagnostic hysteroscopy was performed concomitantly with laparoscopy. Except for one case of infection treated with antibiotics, there were no post-operative complications. Only one case presented with a life-threatening situation due to a postpartum haemorrhage of 2000 mL, which required the transfusion of 4 units of blood and fresh plasma, with no post-operative complications.

Two patients successfully delivered via caesarean section after laparoscopic correction of the tubal incarceration, and one patient was still pregnant without any related complications in the second trimester.

Discussion

Our review compiles cases of tubal damage following uterine perforation due to dilatation & curettage or vacuum aspiration. The analysis of the various cases reveals that the procedure most frequently associated with tubal damage is vacuum aspiration and the surgical indication is termination of pregnancy. Moreover, in most cases, the tube itself, entrapped in the myometrium, acts as a haemostatic agent, contributing to a delayed diagnosis, as the most common symptom is non-specific pelvic pain. Furthermore, as reported in our results, the incarceration of the tube is not accompanied by the incarceration of other abdominal organs, further reducing the presence of other suspicious signs or symptoms. The three most frequent symptoms are abdomino-pelvic pain (54%), abnormal vaginal bleeding (30.8%), vaginal discharge (19.2%) and they are aspecific and not directly related to a tubal pathology, leading to a mean time for the diagnosis of 15.4 months and to the low incidence reported in the literature.[22]

The data suggested the most significant risk factor for uterine perforation, accounting for approximately 95.6% of cases, was the surgeon's inexperience, especially when

Table 1. Reports of the literature.

Article/article type	Procedure	Tubal incarceration	Cause	Management	Visceral injury	Delayed diagnosis/ immediate diagnosis	Complication	Symptoms	Parity/uterine anomalies/ previous gynaecological surgeries
Steigrad and Margin[6], 1978	Vacuum aspiration and curettage	Yes, presented as uterine polyp extruded through the cervix	Postpartum haemorrhage after delivery	Twisted away from the vagina and after histological examination, LPT	No	After 10 months	No	Abnormal vaginal discharge, vaginal bleeding	G3P3, sterilised
Lapas and Todorov[7], 1987 Abstract	Dilatation and curettage + vacuum aspiration	Avulsion of right fallopian tube	Therapeutic abortion presence due to Rubeola antibodies in the serum	Emergency LPT, right horn suture with 3 haemostatic sutures	Round ligament	Immediately	No	Examination of vacuum-curettage specimen fragments of an abdominal suspected appendix	G1
Thomas[8], 2003	Vacuum aspiration	Yes	8-week gestation missed abortion	Hysteroscopy (resected as a polyp)	No	6 months	No	Secondary dysmenorrhea menometrorrhagia and lower back pain	G2P0, D&C for abortion 15 mo before
Deffieux et al.[9], 2007 Case report	Vacuum aspiration	Fallopian tube	Voluntary interruption of a first-trimester pregnancy	LPS: salpingectomy	No	5 years after vacuum aspiration/ US, MRI, laparoscopy, hysteroscopy (utero setto)	No	Intermittent abdominal pain	G1P0 (1 TOP)
Alanbay et al.[10], 2009 Case report	Dilatation and curettage	Tubal and distal part of the infundibulopelvic ligament herniation	First trimester due to early fetal loss	LPS, minilaparotom: gentle traction of the tubal complex. Hydropertubation of the tubes (bilateral passage)	No	2 years after curettage/ hysterosalphingography, diagnostic laparoscopy along with a diagnostic hysteroscopy	No	Secondary infertility	1G0P (1 AS)
Trio et al.[11], 2010 Case report	Vacuum aspiration	Incarceration of the left fallopian tube	Pregnancy termination (9 w)	LPS: during surgery, the tube was extracted from the uterine wall and the myometrial lesion was repaired using coagulation	No	Few days later/US, diagnostic laparoscopy	No	Pelvic pain and minimal vaginal bleeding	G1P0 (1 AS)
Ceccaldi et al.[35], 2011 Case report	Vacuum aspiration	Right fallopian tube	First-trimester surgical abortion	LPS: tube was extracted from the posterior wall of the uterus and repaired by neosalpingostomy	No	18 months after a surgical abortion/ hysterosalpingography, hysteroscopy, LPS	No	Secondary infertility	G5P2

Table 1. Continued

Article/article type	Procedure	Tubal incarceration	Cause	Management	Visceral injury	Delayed diagnosis/ immediate diagnosis	Complication	Symptoms	Parity/uterine anomalies/ previous gynaecological surgeries
Bharathan et al.[12], 2011 Case report	Vacuum aspiration	Fimbrial end of the right fallopian tube	Surgical termination of pregnancy at 6 w	Laparoscopy under hysteroscopic guidance	No	Three weeks following first procedure/US, followed by hysteroscopy and diagnostic laparoscopy	No	Persistent spasmodic pelvic pain	Multiparous
Damiani et al.[36], 2011 Case report, 2 cases	Vacuum aspiration	Tubal prolapse	Voluntary interruption of first-trimester pregnancy	Removed using a Pozzi Palmer forceps after insertion of a speculum	No	18 months after procedure/US, hysteroscopic (myoma misdiagnosed), histological examination	No	Secondary oligomenorrhea, lower abdominal pain and discomfort. Cramping abdominal pain, reflex pain in the right iliac fossa, deep dyspareunia, nausea and vomiting, diarrhoea, intermittent vaginal bleeding, vaginal discharge with an abnormal foul smell and colour that was either watery or bloody; and occasional febrile episodes	G5P2 (2 TOP, 1 AS, performed by dilation and suction curettage)
	Vacuum aspiration and curettage	Incarcerated distal part of the right fallopian tube	Post-partum retained material	LPS: salpingectomy + myometrium repaired	No	3 months after the delivery/US, hysteroscopic examination, biopsy, laparoscopic examination		Metrorrhagia on day 13 of puerperium, amenorrhea	G1P1
Nkwabong et al.[4], 2011 Case report	Vacuum aspiration	Incarceration of the distal part of the fallopian tube	Early foetal loss at 7 weeks 3 days	Emergency laparotomy: a left total salpingectomy (left fimbria and part of the ampulla were necrosed). The uterine cavity was curetted and the perforations closed with vicryl	No	Immediately	No	Painful aspiration and persistent pelvic pain, slight vaginal bleeding	G7P4 (4 PS 2 TOP)

Table 1. Continued

Article/article type	Procedure	Tubal incarceration	Cause	Management	Visceral injury	Delayed diagnosis/ immediate diagnosis	Complication	Symptoms	Parity/uterine anomalies/ previous gynaecological surgeries
Cremieu et al.[13], 2012	Dilatation and curettage	Right fallopian tube (posterior wall)	First trimester early foetal loss	Hysteroscopy 1st step (normal) and LPS 2nd step, salpingoscopy with blue, myometrial suture with monocryl 0	No	Unspecified, diagnostic sonosolpingography	No	Secondary infertility	G2P1, spontaneous pregnancy 3 months after, caesarean section 39 wks due to placenta accreta)
Kondo et al.[29], 2013 Case report	Curettage	Right fallopian tube	Post-partum retained placenta	LPS: right salpingectomy + uterine repair	No	11 months after uterus curettage/US, MRI, diagnostic laparoscopy	No	Pelvic pain (intermittent) and amenorrhea since vaginal delivery	G2P2
Guzel et al.[14], 2014	Dilatation and curettage	Yes	First-trimester Pregnancy loss	Hysteroscopy and LPS (preserved)	No	3 years	No	Secondary infertility	G3P1, previous caesarean section at 37 ws
Lin et al.[15], 2015 Case report	Dilatation and curettage	Fallopian tube	First-trimester pregnancy loss	Laparoscopy: salpingectomy with adhesiolysis + uteruss repair (histopathological examinations of the resected specimens demonstrated an ectopic pregnancy in the ampulla of the fallopian tube)	No	5 years/US, laparoscopy, hysteroscopy	No	5-year history of irregular menstruation and vaginal bleeding	G2P1 (1 TOP)
Chung and Cheung[16], 2015	Vacuum aspiration	Fimbrial part of right fallopian tube avulsed	Voluntary interruption of a 9 + 0 wk pregnancy	Repeat suction evacuation and laparoscopy. 1 cm perforation on caesarean scar	No	After 5 days	No	fallopian tube tissue shown on histological examination	G4P2, previous caesarean section
Camus et al.[33], 2017 Case report-video article	Dilatation and curettage	Fallopian tube incarceration	Non-evolving pregnancy at 8 w	LPS: tube extracted out of the uterine defect + uterus repair. Positive tubal patency test	No	9 months later/US, MRI, laparoscopy, hysteroscopy	No	abnormal vaginal discharge	G1P0 (1AS)

Table 1. Continued

Article/article type	Procedure	Tubal incarceration	Cause	Management	Visceral injury	Delayed diagnosis/ immediate diagnosis	Complication	Symptoms	Parity/uterine anomalies/ previous gynaecological surgeries
Dean et al.[23], 2017 Case report	Vacuum aspiration and curettage	Prolapse of the left fallopian tube and ovary into the uterine cavity and avulsion of the infundibulopelvic ligament	Elective surgical termination of pregnancy (TOP) at 19 w, followed by PPH (1500 cc)	Emergency LPS	No	Immediate diagnosis after PPH. Manual examination and ultrasound	Haemorrhagic Shock (2000 mL) with 4 units of blood transfusion and fresh frozen plasma	Postpartum haemorrhage	G5P2 (2 TOP), vaginal delivery, no previous PPH
Boujenah et al.[17], 2017 Letter to Editor	Vacuum aspiration	Intrauterine intussusception of the fallopian tube	Postpartum retained placenta 15 days after delivery	LPS: salpingectomy (because of severe ampullary damages) + uterus repair	No	9 months after vacuum aspiration/US (3D+ Doppler), MRI, hysteroscopy, LPS	No	Abdominal pain, spotting and amenorrhea	
Linton et al.[18], 2019 Case report	Dilatation and curettage + vacuum aspiration (7-mm rigid suction cannula)	Left fallopian tube	Voluntary pregnancy termination at 6 w + 5 d	Laparoscopy, using a standard entry, performed under general anaesthesia. Left salpingectomy, uterus repair and gentle suction curettage under direct laparoscopic visualization	No	In few hours/US	No	Increasing pain in her lower abdomen, nausea	G5P1 (1VB, 1CS, 2 ABS D&C)
Liu and Chi[19], 2021 Case report	Curettage	Right fallopian tube partly incarcerated in the uterine fundus	4 weeks postpartum after delivery for removal of retained placental membranes	LPS: neosalpingostomy and hysterography	No	3 years later curettage/diagnostic hysteroscopy (severe IUA), US (hydrosalpinx), hysteroscopy combined with laparoscopy	No	Amenorrhea and watery leucorrhoea	G2P1
Sedrati et al.[20], 2021	Dilatation and curettage	Yes	First-trimester pregnancy loss	Hysteroscopy and LPS (salpingectomy)	No	6 months	No	Pelvic pain	G1P0

Table 1. Continued

Article/article type	Procedure	Tubal incarceration	Cause	Management	Visceral injury	Delayed diagnosis/ immediate diagnosis	Complication	Symptoms	Parity/uterine anomalies/ previous gynaecological surgeries
Zhou et al.[26], 2021 2 case reports	Vacuum aspiration	A small part of the right ovary and most of the fallopian tube	Voluntary interruption of first trimester pregnancy	Bedside ultrasound (clinical suspicious if uterine rupture and surrounding tissue incarceration), extemporaneous histological examination of the tissue in vagina, exploratory LPT à chronic rupture in the anterior wall close to the fundus. Repair of rupture + right salpingectomy	No	2 years later after the delivery of 2nd child	No	A dark red growth approximately 7 mm × 2 mm × 2 cm in size, with moderate texture, was palpated in the vagina after the after-birth phase. Then, postpartum pain in the lower right abdomen, with noticeable tenderness and rebound pain	G3P2 (1AS with D&C)
	Vacuum aspiration	Fallopian tube	Voluntary interruption of first trimester pregnancy	Hysteroscopy with mass removal, no sign of perforation, placement of IUD à histological examination: fallopian tube		1 year		Severe dysmenorrhea, moderate vaginal discharge	G4P2 (2AS), IUD after 2nd AS removed for displacement after a year
Shu et al.[21], 2022	Curettage	Yes	Retained placenta after delivery	Hysteroscopy and LPS (salpingectomy)	No	2 months	No	Pelvic pain	G1P0
Wang et al.[31], 2022 Case report	Dilation and curettage	Fallopian tube incarceration	One month after term delivery due to space-occupying lesions	LPS: salpingectomy and oophorocystectomy (left ovarian mass concomitant) + repair of the uterus and ovary	No	3 years later/US (ovarian endometriosis cyst and endometrial polyps in the cavity misdiagnosed), hysteroscopy, LPS	No	Slight lower left abdominal pain	G1P0

LPT: Laparoscopic tubal surgery, LPS: Laparoscopic surgery, US: Ultrasound, MRI: Magnetic resonance imaging, D&C: Dilation and curettage, TOP: Termination of pregnancy, PPH: Postpartum haemorrhage, IUD: Intrauterine device, IUA: Intrauterine adhesions.

surgery (vacuum aspiration or dilatation and curettage) is performed after a miscarriage or for voluntary termination of pregnancy when the uterus is less resistant.[4,22-26]

Table 2. Frequency of symptoms.

Complaint	Number of cases	% of presentation
Abdominal/pelvic pain (non-specific)	14/26	54%
Abnormal vaginal bleeding (spotting, metrorrhagia, menorrhagia)	8/26	30.8%
Vaginal discharge	5/26	19.2%
Secondary infertility	4/26	15.4%
Secondary amenorrhoea	3/26	11.5%
Asymptomatic	2/26	7.7%
Post-partum hemorrage	1/26	3.8%

Transvaginal ultrasound is the first-line instrumental exam, with findings of a hyperechoic tubular structure in the myometrium or endometrial cavity, possibly associated with intra-pelvic free fluid, which is often misdiagnosed as an endometrial polyp, submucous myoma, or intrauterine adhesion.[27] 3D transvaginal ultrasound and color Doppler can assist in differential diagnosis.[28]

CT can be used in acute patients while, MRI can aid in challenging cases in stable patients where ultrasound and CT are not informative.[29,30] However, according to the data from our analysis, it may be quicker and less stressful for the patient to proceed directly with a diagnostic hysteroscopy, as suggested by Wang et al.[31] in order to obtain a bioptic diagnosis. Moreover, Boughizane et al.[32] and Camus et al.[33] recommended a combined approach with laparoscopy for the double diagnostic and therapeutic value of laparoscopy in these cases and for optimal tubal preservation.

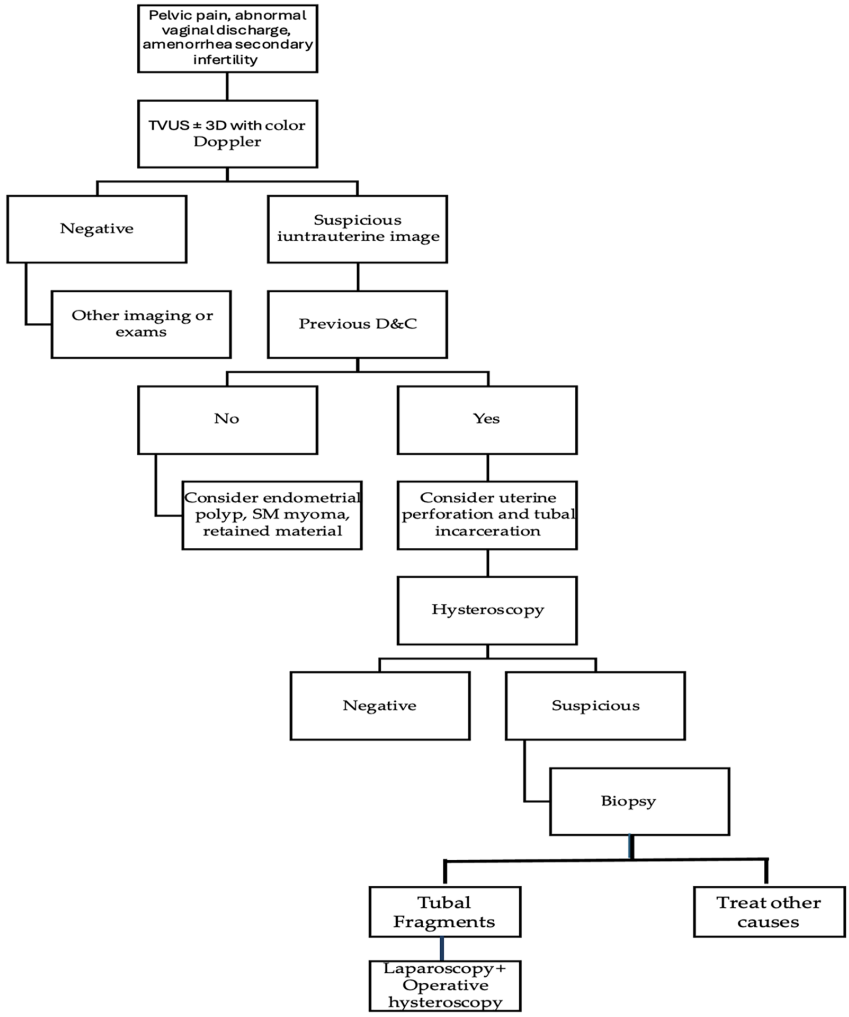

Figure 2. Diagnostic-therapeutic algorithm.
D&C: Dilation and curettage.

In most of our review cases, salpingectomy was performed after extracting the tube from the myometrium; if tubal preservation is affordable, it could be useful to perform chromo-salpingoscopy in order to verify tubal function. Dysfunction of the fallopian tubes is a leading cause of tubal infertility, with proximal tubal blockage accounting for about 26% of all infertility cases.[34] In addiction, with a view to future regnancies, suturing the myometrial breach is advisable even if it represents an area of minor resistance and tissue alteration, which may be susceptible to placentation issues or complications during manual placenta removal (2.7%).[4]

There are no specific guidelines on how to complete childbirth in these cases, with decisions made by the gynaecologist in consultation with the patient. Elective C-sections were performed in the cases described in this review. Ceccaldi et al.[35] suggested that large fundal myometrial defects and thin fibrosis may favour elective caesarean delivery. However, there is no absolute contraindication to vaginal delivery, though labour and delivery should be closely monitored to prevent uterine rupture.

Preventive strategies for uterine perforation include careful preoperative evaluation, appropriate instrumentation and techniques, and adequate training and experience of the surgeon.[23] Ultrasound guidance during surgical termination is supported to reduce procedure-related morbidity.[22] Damiani et al.[36] recommends using negative pressure not exceeding 500 mmHg (or 0.07 bar) during vacuum aspiration to reduce the risk of adjacent organ suction in case of uterine perforation.

The strength of this manuscript lies in the extensive literature review period, with the largest number of cases considered. All studies selected during the eligibility phase were manually compared to avoid overlapping cases. The methodological quality of the included studies was assessed using the JBI Critical Appraisal Checklist for case reports. Conversely, the main limitation is the inclusion of only case reports due to the rarity of this complication. For this reason, we aimed to gather data in order to provide clinical suspicion signs based on the patient's history, along with a diagnostic and management algorithm (Figure 2).

Conclusion

A thorough diagnosis of uterine perforation with secondary tubal damage requires a detailed medical history, a comprehensive clinical examination, and imaging evaluation. If instrumental investigations are negative but clinical suspicion remains, direct visualisation tools such as hysteroscopy and/or diagnostic laparoscopy may be necessary.

Given the rarity of this condition, there are no specific guidelines on how to manage this complication, considering that the majority of cases involve women of reproductive age, it is essential to preserve their reproductive function by assessing tubal integrity and function and preserving the myometrium as much as possible.

Footnotes

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Authorship Contributions

Conceptualization: G.S., G.R., M.B., Methodology: G.S., C.R., G.O, G.R., Software: C.R., G.O., Validation: G.S., L.N., M.L., G.Sca, Formal Analysis: G.S., C.R., M.B., Investigation: G.S., M.B., C.R., Data Curation: C.R., G.O., Writing-Original Draft Preparation: G.S., C.R., M.B., G.O., Writing-Review and Editing: G.S., M.B., G.R., Visualization: G.Sca, L.N., M.L., Supervision: G.R., G.Sca, Project Administration: G.S., G.R.

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Supplementary Table 1. https://l24.im/z7O2PI