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2

Ultrasound guidance in reproductive surgery

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A B S T R A C T

Ultrasound plays a key role in diagnosis and guidance in reproductive medicine and surgery. In the field of reproductive surgery, some of the interventions, especially intrauterine procedures, are regularly conducted without imaging guidance but instead performed based on clinical skills and experience alone. Operative real-time US provides concurrent visualisation of the structures, contents and planes and operating instruments and, therefore, has the potential to improve efficacy and safety of the operative interventions. Ultrasound should be used in our operating theatres more often to guide various intrauterine procedures to reduce the intra-operative risks and complications including uterine perforations and visceral injury. The use of ultrasound necessitates an additional assistant experienced in ultrasound in the theatre, but regular use of ultrasound improves the training opportunities of the trainees and clinicians.

Introduction

Ultrasound (US) is an essential tool in reproductive medicine primarily as a diagnostic tool, and its role has now been extended as a real-time guide during reproductive surgery. In the field of reproductive and other gynaecological surgeries, some of the interventions, especially intrauterine procedures, are regularly conducted without imaging guidance but instead are performed based on clinical skills (tactile sensation) and experience alone. Operative real-time US provides concurrent

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visualisation of the structures and contents and, therefore, has the potential to improve efficacy and safety of the operative interventions.

Application of intraoperative US will depend on good understanding of US features of normal female pelvic anatomy. The introduction of intraoperative US in obstetrics and gynaecology is still developing at a very slow pace, despite some available evidence that it will help to reduce complication rates. Even with endoscopic procedure such as hysteroscopy, the perforation rate or trauma is still high, and is quoted as 1.7% [1]. The use of US-controlled operative hysteroscopy will help reduce this known complication of uterine perforation and injury, especially in women with known intrauterine pathologic factors, thereby avoiding the use of unnecessary laparoscopy [2]. Further, the near simultaneous use of sophisticated endoscopic equipment and sensitive miniaturised US equipment has led to the introduction of intraoperative US monitoring for operative laparoscopy and hysteroscopy in gynaecologic surgery to further guide decision making [17].

US guidance in reproductive surgery has the potential to reduce operating time and to lower the potential morbidity. Performing blind intrauterine procedures such as surgical evacuation of uterus, intrauterine device placement in the presence of uterine abnormalities or complex cases under US guidance has the benefit of confirmation of completeness of the procedure and reduced risk of injury to uterus and internal visceral organs. In Assisted Reproduction Treatment, US has established its indispensable role in egg collection, which in the past was performed laparoscopically. Ultrasound guidance is also used in cases such as ovarian cyst aspiration, hydrosalpinx aspiration prior to *in vitro* fertilisation, embryo transfer (IVF-ET) and aspiration of ascitic fluid resulting from ovarian hyperstimulation syndrome.

Ultrasound-guided intrauterine surgery

Most commonly, abdominal US is used to guide hysteroscopic and intrauterine procedures. It is best to have moderately filled bladder to have a better view of the uterus and cervix. The abdominal probe is covered with a sterile sheath and is positioned to obtain a longitudinal view of the uterus. transvaginal and transrectal probes are only used if the abdominal US view is limited, but this may restrict the vaginal access and manipulation of instruments used for the procedure [18].

The US probe is positioned at the start of the procedure to provide a clear delineation of cervical canal, endometrial cavity, myometrial depth and boundaries [23] (Fig. 1). Bladder, if under filled, can be filled with sterile normal saline to optimise visualisation. Insertion of dilators, if cervical dilatation is required, is done under US guidance to ensure the dilatation follows the cervical canal and to minimise

Fig. 1. Abdominal scan demonstrating uterus including cervix in its longitudinal plane.

the risk of perforation or creation of a false passage. Once the procedure is commenced, the probe is dynamically manipulated to provide real-time images of the instruments especially at its distal or operative end, operative site, correct plane of dissection and myometrial thickness/depth.

Resection of uterine septum

Uterine septum, resulting from incomplete septal resorption during embryogenesis, is a protrusion of fibromuscular tissue from the fundal region into the uterine cavity, and it can be partial or complete. Although most women with uterine septum have normal reproductive function, some may be affected with adverse reproductive outcomes. Although randomised controlled trials on the efficacy and safety of surgical treatment of septum to improve reproductive outcomes are lacking, controlled studies have indicated that hysteroscopic septal resection reduces miscarriage rates and increases live birth rates. Based on the available evidence, the National Institute for Health and Care Excellence (NICE) has recommended that the evidence on the efficacy of hysteroscopic metroplasty of a uterine septum for recurrent miscarriage is adequate to support the use of this procedure, provided that normal arrangements are in place for clinical governance, consent and audit [3]. However, for the management of septum in primary infertility patients, current evidence on efficacy is inadequate, and this procedure should therefore only be performed with appropriate arrangements for clinical governance [4].

Hysteroscopic septal division is not free of complications, although the procedure is not particularly difficult in experienced hands. Some of the complications include incomplete resection of the septum and perforation of the uterus and uterine scarring. During hysteroscopic resection of uterine septum, it is difficult to perceive the depth despite it being done under direct vision, which provides only an estimate of where the fundus is and may result in either partial/incomplete resection or perforation of the uterus. Partial resection is known to cause recurrent miscarriage [5] and uterine rupture in mid trimester after over-zealous septal resection has been reported [6]. Preoperative preparation and measurement of the septal length using 3D US and subsequent live scanning during the procedure may improve the outcomes and safety of uterine septal resection. With US, an accurate measurement of the distances, including the thickness of the fundus just lateral to the base of the septum, may be obtained. Contemporaneous sonographic visualisation of the top of the fundus will confirm complete resection of the septum and avoid resecting into the myometrium without the subsequent risk of perforation and scarring. The procedure can be considered complete once both the ostia are simultaneously visualised and when the fundal myometrial thickness is 8–10 mm [7]. US guidance during the procedure has shown a trend towards lower perforation rates and is less expensive than laparoscopic guidance and, therefore, has been suggested as the optimal means of intra-operative guidance during hysteroscopic division of septum or adhesions [8].

Resection of uterine fibroids

Submucous fibroids can cause menstrual symptoms and are associated with adverse reproductive outcomes, including subfertility and miscarriage. Hysteroscopic resection of fibroids is the standard treatment for submucous myoma to improve menstrual symptoms and to optimise fertility. Although removal of type 0 fibroids (100% intracavitary) may not benefit from US guidance, removal of types 1 and 2 fibroids (<50% and >50% intramural components) may benefit from US guidance, as US allows identifying exact location of fibroids, the portion of fibroids protruding into the cavity, its intra-mural extension and myometrial free margin. The common intra-operative and immediate post-operative complications, when treating types 1 and 2 fibroids, are incomplete removal, perforation and fluid overload. Korkmazar et al. (2016) has described the technique of US-guided hysteroscopic resection of submucous fibroids with intramural component using cutting loop of monopolar or bipolar resectoscope [9]. The intracavitary component is excised by slicing from top to basal part and from back to front until reaching the plane of endometrial surface without causing undesired endometrial ablation. Once the cleavage plane between the fibroid and underlying myometrium with fibroid free myometrial thickness is identified, the intramural part of the myomas is excised using cavitation technique by slicing the tissue. Once the procedure is completed, the resectoscope is withdrawn back to the cervix, the uterine cavity is filled with distension media and then the margins of the uterus and fibroid are evaluated sono-hysterographically. A prospective multicentre study evaluating 64 women undergoing hysteroscopic resection of types 1 and 2 fibroids under US guidance has reported complete resection with no perforations. The authors concluded that US-guided hysteroscopy is a safe and effective method for resection of submucous fibroids with an intramural component [9].

Treatment of intra-uterine adhesions

Intra-uterine adhesions result from previous infection or uterine surgeries and manifest as hypomenorrhoea or amenorrhoea, infertility or recurrent miscarriage. Hysteroscopic division of adhesions is the treatment of choice to improve the symptoms. In moderate to severe cases, it is difficult to identify where to enter and which part of the uterine cavity is visualised while doing hysteroscopy. US guidance allows the accurate localisation of the instruments within the cervical canal and uterine cavity and visualisation of myometrial depth (Fig. 2). Abdominal US is used to guide the cervical dilatation process to ensure the dilator is pushed only along the line of cervical canal minimising the creation of false passage or myometrial or uterine perforation. During the procedure, the ultrasonographer is able to provide real-time feedback on the plane of dissection and myometrial thickness. A retrospective cohort review has reported a lower perforation rate and more cost-effectiveness for US-guided hysteroscopic adhesiolysis than those for laparoscopic guided or unguided hysteroscopy procedures [8].

Other hysteroscopic procedures

Removal of intrauterine devices (IUD) can be successfully done using US guidance if the attached thread is not visible on speculum examination (“lost thread”) [19]. The location of the IUD is first confirmed with transvaginal US (Fig. 3). Subsequently, an abdominal US examination with a full bladder is performed with the patient placed in lithotomy position. A longitudinal view of the uterus allows complete visualisation of the IUD. Speculum is then inserted in the vagina, visualising the cervix. Cervix may need to be steadied with tenaculum forceps, gentle traction on which allows the uterus to adopt neutral position, correcting the flexion and thus facilitating the extraction. Then, under abdominal US guidance, a fine grasping forceps such as Hartman crocodile forceps or even laparoscopic forceps or laparoscopic needle holder is introduced through the endocervical canal. The tip of the instrument is always kept under vision, grasping the vertical rod of the IUD between the jaws, forceps closed and IUD removed by gentle traction. It is important to maintain a sterile technique. The procedure is abandoned in case of intense pain or the patient's decision not to continue.

In cases where the IUD is adherent to the muscle or migrate into the muscle of the uterus, as shown in Fig. 3B, it is useful to push the stem of the IUD upwards to dislodge IUD and then withdraw reducing the pain experienced by the patient. This important step will help in a successful retrieval under US guidance.

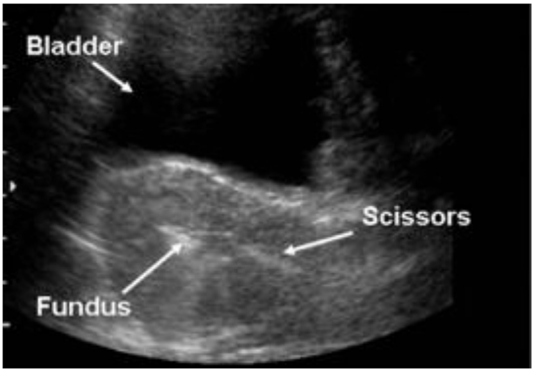

Fig. 2. Hysteroscopic uterine instrumentation demonstrating the tip of the scissors. Ultrasound guidance allows the accurate localisation of the instruments within the uterine cavity and visualisation of myometrial depth.

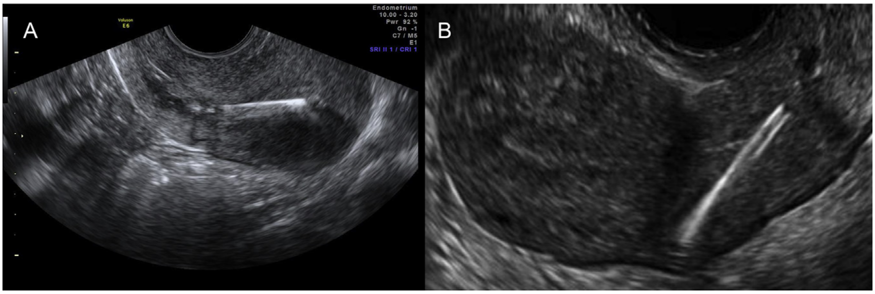

Fig. 3. Longitudinal view of uterus showing IUCD in correct position (A), displaced IUCD (B).

US guidance can be useful in hysteroscopic retrieval of foreign body embedded in myometrium (e.g.: bony fragments embedded following therapeutic abortion), when the foreign body is not evident by direct hysteroscopic vision [10]. In cases of haematometra associated with cervical stenosis or following endometrial ablation, concurrent US can be used to guide cervical dilatation and hysteroscopy-directed drainage of the uterine content [11]. Where resection of endometrial polyps is not possible employing traditional techniques under direct visualisation, US guidance may be employed in a similar way as when resection of leiomyomas is conducted.

Image-guided open surgery

Simultaneous use of sophisticated and sensitive US equipment has the potential for intraoperative US monitoring for operative laparoscopy and hysteroscopy in gynaecologic surgery to further guide decision making [17]. Miniaturised high-frequency transducers provide excellent resolution, which can be easily manoeuvred and has the potential to enhance surgical precision during intra-abdominal gynaecologic surgeries. The authors used a 7.5 MHz finger grip transvaginal US probe to monitor intra-abdominal reproductive surgery in women undergoing transabdominal myomectomy for multiple uterine myomas and uterine reconstruction or excision of obstructive uterine horns. This approach helped in placement of uterine incisions for surgical reconstruction and excision of obstructed horns for Mullerian abnormalities and in the identification and dissection of leiomyoma.

The technique of intraoperative US imaging described by authors consisted of placing the 7.5-MHz finger-grip probe into a sterile sleeve and drawing it onto the field for imaging. The probe was used by grasping it between the index and middle fingers. For those patients with uterine fibroids, a paediatric Foley catheter was inserted into the endometrial cavity and attached to a 30-mL syringe that was drawn onto the operative field for intraoperative sonohysterography. For myomectomy, the US probe was used to guide dissection of the fibroid and definition of the relationship of the fibroids to the endometrial cavity. It was particularly useful for size ranging from 3 to 5 cm. However, for fibroids greater than 5 cm, image quality was poor because of the poor penetration by the high-frequency probe. Intraoperative sonohysterography enabled better definition of the relationship of the uterine fibroids to the endometrial cavity both before and after resection. Intraoperative US is reported to be more efficient than palpation in detecting residual leiomyomata at the end of open myomectomy [23].

Surgical management of miscarriage

The management of miscarriage or termination of pregnancy is one of the commonest gynaecological operations performed both elective and emergency, as well office and hospital settings. The procedure can be done either medically or surgically, but even with medical management, surgical intervention may be necessary either to complete a failed procedure or resolve haemorrhagic complications. Surgical management of miscarriage is not without risks, and these include incomplete evacuation and, rarely, perforation of the uterus and the need to return to theatre. All these risks can be potentially minimised by the use of US during the process of surgical evacuation. US can aid in determining cervical orientation and guide the instrument along the cervical canal while dilating the cervix and introducing instruments into the uterine cavity. US helps to evaluate and continually visualise the size and direction of uterus, position of gestational sac inside the uterus, insertion and advancement of the instruments and completeness of the procedure.

With US-assisted procedure, the orientation of the uterus is confirmed and the location of the product of conception is ascertained. US will identify a whether the uterus is retroflexed or anteflexed and will help the operator to drop or elevate his or her hand to maintain a straight course to the axis of the uterus, hence avoiding perforation in the anterior or posterior wall of the uterus, which can potentially occur during the blind procedure. Once the procedure is finished, the completeness can be confirmed by US. US-guided procedure has the potential to reduce the risk of adhesion formation, as the procedure is performed with minimal trauma with the instruments (suction and curette) directed towards the product of conception and the procedure is stopped once the empty uterus is demonstrated on US scan. In contrast, the blind procedure may be associated with overzealous curettage to assure completeness of the procedure leading to subsequent damage of the endometrium. Randomised-controlled studies have reported US-guided surgical management of miscarriage has the advantage of reduced blood loss, less operating time and less chance of retained products of conception when compared to conventional blind procedure [12,20].

Caesarean scar ectopic pregnancy

CSP is a rare type of ectopic pregnancy in which the gestational sac is implanted in the scar caused by previous caesarean section (Fig. 4). Although two types of CSP –type 1 or endogenic and type 2 or exogenic- are described, management approach is the same. Type 1, or endogenic, CSP is where implantation occurs on the scar and the gestational sac grows towards the cervico-isthmic or uterine cavity, with the potential to reach a viable gestational age but with the risk of massive bleeding from the implantation site. Type 2, or exogenic, CSP occurs when the gestational sac is deeply embedded in the scar and the surrounding myometrium and grows towards the bladder. In exogenic types, a layer of myometrium may be seen between the gestational sac and the bladder at an earlier stage; this becomes thin and eventually disappears, with bulging of the gestational sac through the gap as the pregnancy progresses, thus carrying a greater risk of earlier rupture. In two-thirds of cases, the thickness of the scar may be less than 5 mm [13].

Although most women are present with slight vaginal bleeding and mild abdominal discomfort, some may be present with acute pain and profuse vaginal bleeding. Incidental diagnosis is sometimes made in asymptomatic women on routine early pregnancy scanning. Haemodynamic instability and collapse in a suspected CSP strongly indicate rupture with intra-abdominal bleeding. Given the potential for serious life-threatening complications, accurate and reliable diagnosis and appropriate management are crucial.

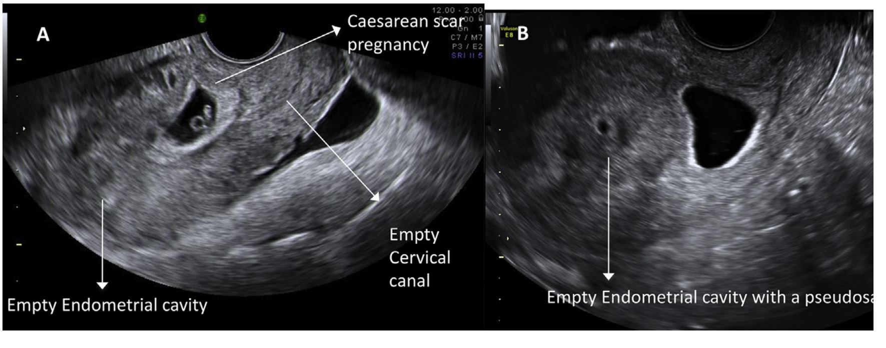

Fig. 4. Caesarean scar pregnancy- TV scan showing a pregnancy sac (with foetal pole and yolk sac) attached to caesarean scar. Triangular gestational sac in the lower uterine segment (A). Oval gestational sac with a pseudosac in the endometrial cavity (B).

Transvaginal US is the primary diagnostic modality with supplementation by transabdominal imaging, if required. Key to the diagnosis of CSP is a high index of suspicion followed by an US assessment demonstrating characteristic features.

US *diagnostic criteria* for diagnosing CSP are:

- Empty uterine cavity
- Empty cervical canal
- Gestational sac or solid mass of trophoblast located anteriorly at the level of the internal OS embedded at the site of the previous lower uterine segment caesarean section scar
- A triangular/round or oval-shaped gestational sac that fills the niche of the scar
- A thin or absent myometrial layer between the gestational sac and the bladder
- Discontinuity in the anterior wall of the uterus adjacent to the gestational sac
- Yolk sac, embryo and cardiac activity may or may not be present
- Evidence of prominent trophoblastic/placental circulation on colour flow Doppler examination
- Negative "sliding organ" sign (Gentle pressure with the transvaginal probe at the level of the internal OS may slide the gestational sac against the endocervical canal seen in inevitable miscarriage, with tissues loosely seen in the isthmal or cervical area; this is absent in CSP as the pregnancy sac is attached to the isthmal region)

Medical and surgical interventions, with or without additional haemostatic measures, should be considered in women with first trimester CSP. Although there are various medical and surgical options available, there is insufficient evidence to recommend any one specific intervention over another for CSP. However, the current literature supports a surgical rather than medical approach as the most effective option. Dilatation of cervix and evacuation under US guidance is suitable for symptomatic CSP and endogenic CSP with myometrial thickness of at least 2 mm thickness. Various techniques to reduce the bleeding during and after the procedure have been reported. Cervical cerclage applied prior to surgical evacuation and tied after the procedure is an effective method of reducing bleeding following evacuation. Other haemostatic techniques include the use of intrauterine Foley catheter inserted intra-/post-operatively and pre-operative uterine artery embolisation [13].

Abdominal US is done to obtain a sagittal view of the uterus, cervix and CSP in one plane if possible (Fig. 5). In our unit, we give 800 mcg misoprostol rectally in theatre immediately before starting the procedure. A cervical cerclage using a Mersilene tape is inserted but not tied at this stage. Dilatation of the cervix under US guidance is done so that the suction cannula can be inserted with ease. Suction evacuation of the decidua from the uterine cavity (to ensure the uterine cavity is emptied to reduce the risk of post-procedure bleeding) and then CSP is done under US guidance (Fig. 6). It is important to suction the CSP using a high suction pressure as quickly as possible as the blood loss is maximal during the procedure. Real-time US is utilised to ensure CSP tissue is completely removed. Once the procedure is completed, the Mersilene tape (cervical cerclage suture) is tied. The suture is then removed 2–4 days

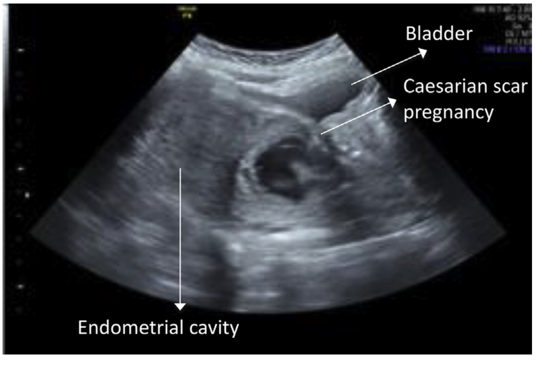

Fig. 5. Caesarean scar pregnancy on abdominal scan. Note thin myometrium between the pregnancy sac and bladder.

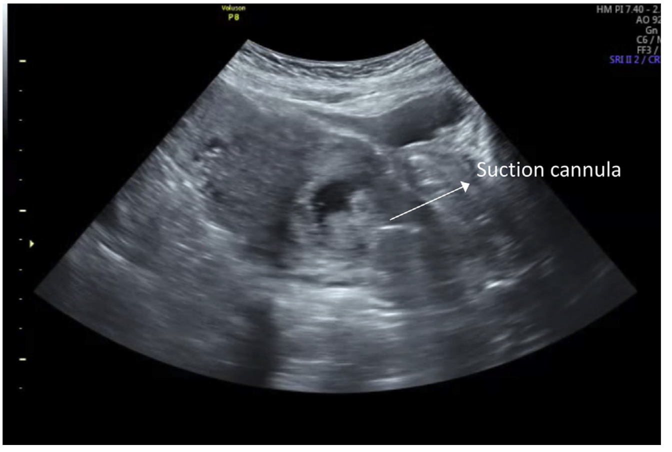

Fig. 6. Evacuation of caesarean scar pregnancy under ultrasound guidance.

later in the outpatient setting. Follow up is recommended a week after the procedure to ensure complete resolution of the ectopic pregnancy with either serum hCG estimation or urine pregnancy test±US. Long-term follow up beyond 1–2 weeks is rarely needed.

Medical management of CSP includes local or systemic injection of methotrexate, although long-term follow-up is required. Gestational sac aspiration with the administration of methotrexate into the sac is the preferred approach for exogenic type of CSP, with thin myometrial tissue between the gestational sac and bladder. This approach alone, or combined with systemic administration of methotrexate, appears to have a better success rate and requires fewer additional interventions. In this effective technique, the gestational sac is aspirated and methotrexate injected into it under US guidance. Although transabdominal and transvaginal injection approaches are both feasible, the transvaginal approach is recommended as it has the advantage of being anatomically closer to the target lesion and thus helps to avoid visceral injury. This procedure is like "transvaginal egg collection" done as part of in-vitro fertilisation (IVF) with a biopsy guide attached to the vaginal US probe, then the 16 to 18 Fr needle is inserted through the vagina and into the gestational sac (Fig. 7). The time required for complete resolution of the ectopic mass correlates with the initial sac size and hCG levels. The dose of the methotrexate, pre-procedure evaluation, counselling and follow up are similar to that for systemic methotrexate injection for ectopic pregnancy management.

Oocyte retrieval

Controlled ovarian stimulation and subsequent oocyte retrieval are critical steps during IVF. Oocyte retrieval was done laparoscopically during the first decade after development of IVF. Introduction of US-guided oocyte retrieval has made the procedure simpler, easier and more acceptable with lower complication rate.

Appropriate patient preparation, adequate analgesia and selection of suitable equipment are essential for the procedure to be conducted safely and to obtain optimal results. The transvaginal probe should be covered in a sterile latex-free probe cover with US gel to assure optimal pelvic organ visualisation. A sterile well-fitting needle guide is attached to the transvaginal probe (Fig. 8). Following introduction of the transducer into the vagina, a scan should be conducted to evaluate the pelvis, assess the ovaries and the uterus and evaluate for presence of any free fluid in the pouch of Douglas or in the adnexae. At the same time, assessment of the possible entry points is carried out by evaluating accessibility to follicles, and if needed, ruling out any vessels in the vaginal wall or in the pelvis (along the needle path) between the ovary and vaginal entry point by power Doppler. The relationship of the

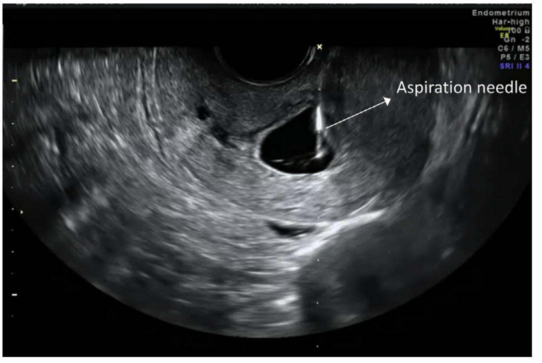

Fig. 7. Caesarean scar ectopic – aspiration of gestational sac and injection of methotrexate directly into the sac under TV ultrasound guidance.

ovary with the neighbouring vessels is also assessed at the same time for the operator to be aware to carry out the procedure safely. It is important to distinguish a spherical or elliptical follicle from a vessel by probe rotation as appropriate, that in one plane a vessel may be circular but becomes a tubular structure in another plane. Doppler imaging may also help to differentiate these structures. When choosing a point of entry of the oocyte collection needle, ensure there are no intervening structures such as bladder, bowel, cervix or other pelvic structures between the vaginal wall and the follicle areas to avoid inadvertent injury. Gentle abdominal pressure may be employed to bring down the ovary, if ovaries are placed high in the pelvis to help with easy accessibility. When access to the ovary is possible only through the uterus, transuterine puncture is a safe alternative. In this instance, the needle is passed through the myometrium avoiding the endometrium and uterine vessels [21].

Biopsy needle guide line on the machine/screen is activated. The ovary should be positioned in the centre of the field of view with the depth and angle of vision set to allow visualisation of the entire ovary and parts of the underlying structures in the screen. Firm, constant pressure on to the vagina with the probe should be applied throughout the procedure. The needle is then advanced through the vaginal wall at around 10'o clock and 2'o clock positions (for right and left ovary, respectively) into the follicle, with the needle tip being kept under constant vision in the centre of the follicle (Fig. 9). Rotating the needle reflects the bevel allowing for better visualisation. The aspiration pump should be activated while entering the follicle with deactivation only when all the possible follicles along the needle line (biopsy guide line) were aspirated, as withdrawing the needle without negative pressure may cause loss of follicular fluid and oocytes. Additionally, ensure the needle is in the centre of the follicle and not abutting the follicular wall, as this may impede complete aspiration of the follicular fluid. Rotating the needle also assures complete aspiration of the fluid and maximises the chances of obtaining an oocyte. Before moving the probe to focus the next follicle/s, the needle is withdrawn to the outer edge of the ovary to reduce the risk of ovarian shearing and damage. Needle is advanced to the next follicle to aspirate, and procedure is completed systematically. It is important to limit the number of vaginal punctures to one on one side as multiple vaginal entries are associated with a higher risk of infection, bleeding and injury of pelvic

Fig. 8. TV probe with needle guide attached and oocyte aspiration needle introduced through the needle guide.

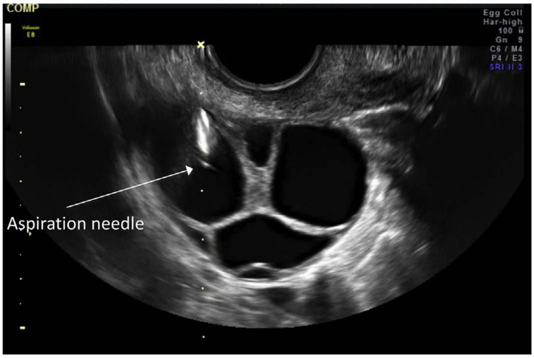

Fig. 9. Egg collection needle in the follicle.

structures [22]. However, more than one puncture on either side may be needed at times especially if the ovary is large. Once one side is completed, the needle is withdrawn out of the vaginal wall, keeping the needle tip inside the biopsy guide. Rotating the probe, the other ovary is entered to systematically aspirate all the follicles. When all follicles have been aspirated, the needle is withdrawn and flushed with the culture medium, followed by a quick scan to assess presence of free fluid in the pouch of Douglas, which might indicate haemorrhage and helps to monitor its progress.

If there is a distorted anatomy with highly placed ovaries as seen in some cases of Rokitansky syndrome, enlarged uterus displacing the ovaries high up and prophylactic ovarian transposition prior to radiotherapy, transvaginal access may not be possible even with abdominal pressure. Trans-abdominal US-guided oocyte retrieval is preferred for laparoscopic procedures, with a combination of transvaginal and trans abdominal procedures as an option. Similar safe US principles are followed.

Ovarian cyst and hydrosalpinx aspiration

Ovarian cyst aspiration

Ovarian cysts, especially functional, if present before starting ovarian stimulation during IVF are not desired as they may interfere with stimulation response and IVF outcome [14]. Ovarian cysts can be aspirated transvaginally under US guidance (Fig. 10). The procedure is similar to "transvaginal oocyte

Fig. 10. Ovarian cyst aspiration under TV ultrasound guidance.

collection” and is relatively an easy procedure in experienced hands. The transvaginal probe is used with the biopsy guide attached. A routine egg collection needle, 16–18 gauge long needle with Teflon tubing, is used. The tubing is attached to the aspiration (suction) pump. When all the fluid is aspirated and the cyst is empty, the needle is removed. Scan is done to rule out any bleed or fluid collection in pelvis. Usually, postoperative pain is very mild, but if required, analgesics may be given. Aspirated fluid, especially if uncertainty as to the nature of the cyst exists, is sent to pathology for cytological evaluation. As the refilling and recurrence risk is high after aspiration, it is best to start the ovarian stimulation soon after ovarian cyst aspiration.

Hydrosalpinx aspiration

Available evidence suggests that hydrosalpinx has a negative impact on IVF outcome [15]. This may be due to the toxic effect of tubal fluid on the implanting embryo or from a direct mechanical flushing effect. Salpingectomy or tubal ligation/clipping has been recommended to improve IVF outcome in those affected with hydrosalpinx. In patients, who have had complex abdominal surgery, where laparoscopy poses significantly increased surgical risks or if hydrosalpinx is seen during the ovarian stimulation stage of IVF treatment, US-guided transvaginal aspiration of hydrosalpinx has been suggested as a treatment option to improve embryo implantation and IVF outcome [16] (Fig. 11). As potential for re-accumulation of the tubal fluid exists, aspiration of the hydrosalpinx could be considered as an interim measure, until definitive treatment in the form of clipping or surgical resection can be safely conducted. The procedure is again similar to that of “transvaginal oocyte collection.” Perioperative antibiotics are generally given because of the risk of infection.

Transvaginal hydrolaparoscopy

Transvaginal hydrolaparoscopy (THL) has been used in some centres as a first-line procedure in the investigation of the pelvis in infertile women, with its potential advantage being outpatient procedure without the need for general anaesthesia. The procedure involves insertion of Veress needle/trocar through pouch of Douglas. US guidance can facilitate intuitive access and reduce complication rates [24]. Ma et al. (2012) described the procedure of US-guided THL, which is performed within 3–7 days after cessation of menstruation. Prior to the procedure, the patient is asked to fill her bladder as for transabdominal US. Patient is put in dorso-lithotomy position and transabdominal ultrasonography is then performed. A diagnostic hysteroscopy is then performed. Normal saline solution is used to distend the uterine cavity at a filling pressure of 100 mmHg, and this helps to evaluate uterine cavity as well as to facilitate passage of some fluid through the fallopian tubes to peritoneal cavity. After completion of the hysteroscopy, a size 8 or 10 Foley catheter is introduced into the uterine cavity and the balloon inflated with 3 ml normal saline solution, to permit the instillation of methylene blue dye later on. The

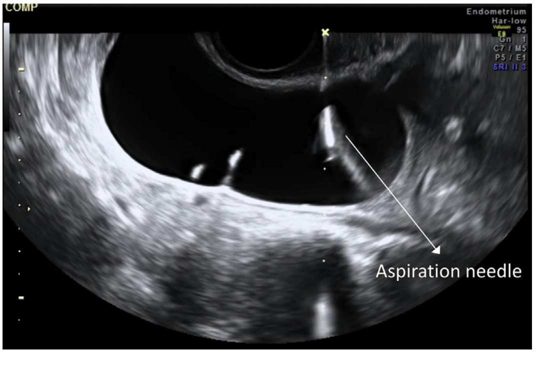

Fig. 11. Hydrosalpinx aspiration under TV ultrasound guidance.

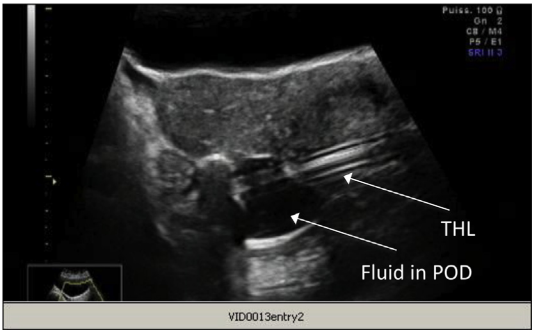

Fig. 12. Transvaginal hydrolaparoscope (THL) in the pouch of Douglas (POD) examining the posterior surface of uterus.

pouch of Douglas is then inspected by transabdominal US for the presence of any fluid (Fig. 11). If there is no evidence of fluid collection, THL is abandoned. If, however, there is evidence of fluid collection in the pouch of Douglas, the trocar needle was introduced via the posterior vaginal fornix under US guidance. A tenaculum is placed over the posterior lip of the cervix to lift it upwards to expose the pouch of Douglas. Under US guidance, the specialised designed trocar needle for TLH is introduced into the pool of fluid in the pouch of Douglas, thereby avoiding any pelvic organs during the process. Both the direction and depth of the advancement of the needle are guided by US. Once the tip of the trocar needle is successfully introduced into the pouch of Douglas, the outer sheath is pushed in for 2–3 cm and the needle is withdrawn. Once the correct position is confirmed, endoscope is introduced (Fig. 12) and the pelvic organs are inspected.

Conclusion

Due to the ability of US to provide direct visualisation of pelvic structures, contents, tissue plane and operating instruments, US guidance improves the safety and efficacy of various gynaecological procedures discussed in this chapter. US should be used in our operating theatres more often to guide various intrauterine procedures to reduce the intra-operative risks and complications including uterine perforations and visceral injury. The use of US necessitates an additional assistant experienced in US in the theatre, but regular use of US improves the training opportunities of the trainees and clinicians.

Practice points

- Although abdominal US is commonly used, transrectal or transvaginal US also could be used to guide operative procedure.
- A full bladder during abdominal US-guided procedure helps to provide a better view of the uterus and cervix.
- Uterus and cervix are displayed in sagittal plane during the procedure.
- US guidance allows the accurate localisation of the instruments within the cervical canal and uterine cavity and visualisation of myometrial depth
- Always keep the distal end of the instrument used in view with US (e.g.: dilator, hysteroscope, scissors, resectoscope or aspiration needle). The probe is dynamically moved either by rotation or by angling to keep the distal tip of the instrument under vision. The operator may have to wait till scanner has localised the distal tip of the instrument, and this should be kept in view during any operative steps.

Research agenda

- US-guided hysteroscopy procedures such as adhesiolysis and resection of fibroid should be evaluated in randomised controlled trials
- Evaluation of intraoperative US monitoring for operative laparoscopy and hysteroscopy using miniature US probe in gynaecologic surgery
- Role of 2D and 4D intraoperative US may be an important area to be looked at to establish its role.

Conflict of interest

None.

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