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PICTORIAL ESSAY

Hysterosalpingographic Findings from Uterus to Peritoneal Cavity: A Pictorial Essay

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BACKGROUND

With social trends of late marriage and increasing maternal age, there is ongoing demand for assisted reproduction and subfertility investigations. Since tubal occlusion is an important cause of female subfertility,[1] assessment of tubal patency is a crucial part of investigations to identify the cause of subfertility.

Hysterosalpingography (HSG) is a fluoroscopic examination of the uterus and fallopian tubes with contrast instillation through the cervical canal. It has remained a popular investigation of tubal patency in modern reproductive medicine despite being invented more than 100 years ago.[2] It is considered a standard first-line test for assessment of tubal patency[3,4] in view of its reliability, less invasiveness than laparoscopy, and more efficient use of medical resources.[4]

With age-related fertility decline,[4] expeditious management is essential. Severity of tubal disease identified on HSG guides the management decision for intervention.[5] A finding of bilateral tubal occlusion prompts early referral for consideration of in vitro fertilisation. Detection of uterine cavity or contour abnormalities on HSG can guide further imaging, endoscopic investigations, and intervention. A radiologist's familiarity with HSG interpretation and awareness of the spectrum of pathology is advantageous to overall patient care and outcome.

This article presents a pictorial review of HSG cases with emphasis on a spectrum of pathologies including tubal occlusion, tuboperitoneal pathologies, uterine contour anomalies, and intracavity filling defects.

PERFORMING HYSTEROSALPINGOGRAPHY

Prior to instrumentation of the uterine cavity, exclusion of pregnancy and active pelvic infection are of utmost importance.

The optimal time to perform HSG is between day 7 and 12 of the menstrual cycle.[6] This helps avoid pregnancy and improve image interpretation with the thinner endometrium of the early proliferative phase. Conducting the examination during active menstruation may impair assessment of the endometrial cavity configuration. Contrast injection into an already distended uterine cavity during active heavy menstruation may also cause unnecessary patient discomfort.

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The patient should be positioned in a lithotomy position for pelvic examination. Aseptic technique with cleansing and draping of the perineum, speculum examination to expose the cervical os, followed by cleansing of the ectocervix and vagina are mandatory before catheter insertion to minimise the risk of ascending infection.

Different catheters can be used for an HSG, including infant Foley catheter (8 Fr) or commercially available HSG 5F catheters (CooperSurgical, Trumbull [CT], United States). In our institution, an 8-Fr infant Foley catheter and water-soluble contrast (such as iohexol or iodixanol) are used.

Flushing of the Foley catheter and all extension tubes to eliminate dead space before catheterisation will help reduce introduction of air bubbles into the uterus. Catheter insertion followed by slow gentle inflation of the balloon (around 1-3 mL of water) to secure the catheter is required. Nulliparous patients generally tolerate a lower volume of balloon distension than patients with prior pregnancy.

With successful catheterisation, the patient is repositioned supine for fluoroscopic examination. The standard views in HSG are based on the recommendations of the American College of Radiology's Practice Parameter for the Performance of Hysterosalpingography.[6,7] Chapman & Nakielny's Guide to Radiological Procedures[8] is also in consensus with the above references.

Based on the above recommendations, the standard set in each HSG study should contain four images: (1) early uterine filling (to assess small uterine filling defects); (2) late uterine filling and tubal filling (to assess uterine contour and tubal abnormalities); (3) peritoneal spillage (to document tubal patency), and (4) an image taken after Foley balloon deflation and catheter removal (to assess the lower uterine segment and endocervical canal).

If tubal occlusion is suspected, manoeuvres such as delayed screening, decubitus position, and use of spasmolytic agents (glucagon or hyoscine butylbromide) should be performed in an attempt to determine if it is genuine.

HYSTEROSALPINGOGRAPHIC FINDINGS

Normal Anatomy

The uterine cavity has a well-defined smooth border with inverted triangular shape and no persistent filling defect

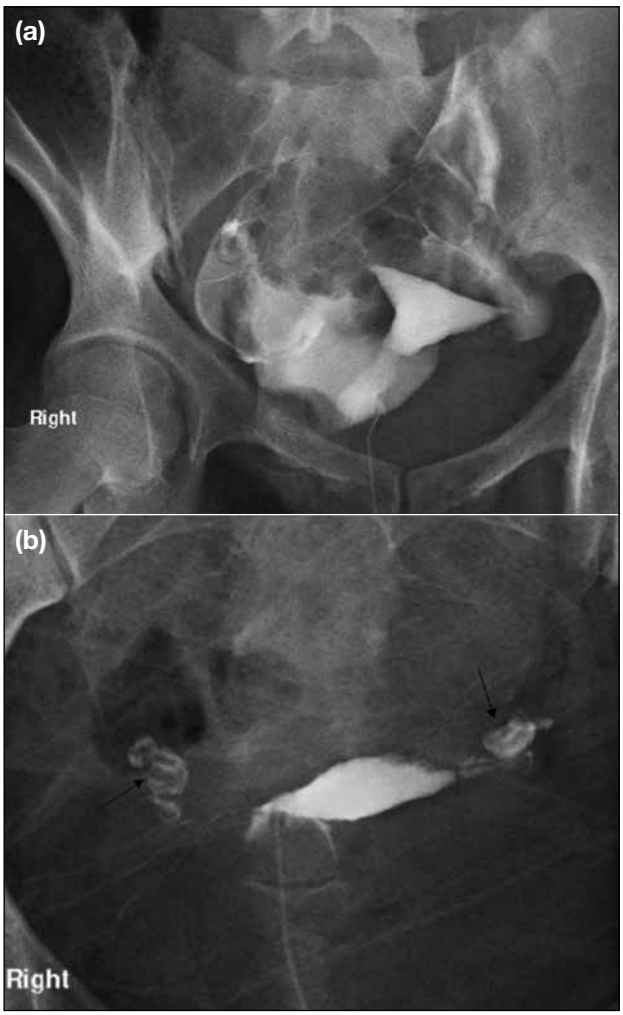

Figure 1. (a) A 27-year-old woman with normal triangular uterine cavity without filling defect on hysterosalpingography. (b) A 30-year-old woman with normal fallopian tube appearance. Note the mucosal folds (arrows) in the ampullary portions of both tubes.

(Figure 1a). The fallopian tubes are evident as thin, elongated smooth lines with a widening at the ampullary portion and variable pelvic location.[6] Opacification of the ampullary portion of the fallopian tube can be confirmed by visualisation of mucosal folding (Figure 1b).[6] Free peritoneal contrast spillage from the fimbrial end indicates tubal patency.

Tubal Pathology

Non-opacification of the fallopian tube or absence of peritoneal contrast spillage can be due to cornual smooth muscle spasm or genuine tubal pathology. The sensitivity and specificity of assessing bilateral tubal patency or occlusion on HSG has been reported to be 92.1% and 85.7%, respectively.[9] There is no published consensus on the most effective manoeuvre to relieve cornual spasm.

Laparoscopy is considered as the traditional clinical reference standard for diagnosis of tubal disease.[5,9] Chromotubation of the fallopian tubes with contrast dye injection and visualisation of peritoneal dye spillage provides assessment of tubal patency.

Tubal Occlusion

Tubal occlusion manifests as abrupt transition from the contrast-filled proximal fallopian tube to a non-opacified distal portion and absent peritoneal contrast spillage (Figure 2). Tubal occlusion can be due to pelvic adhesions from prior pelvic inflammatory disease, endometriosis, or less commonly to congenital Müllerian duct malformation.[6,10]

Tuboperitoneal Pathologies

Hydrosalpinx

Hydrosalpinx represents a distended fallopian tube with serous fluid accumulation secondary to tubal blockage (Figure 3).[11] It is associated with pelvic inflammatory disease, endometriosis, or prior tubal surgery (e.g., ligation), tubal pregnancy or rarely tubal malignancy. On HSG, hydrosalpinx manifests as contrast-filled dilated fallopian tubes without distal contrast spillage into the peritoneal cavity.[6]

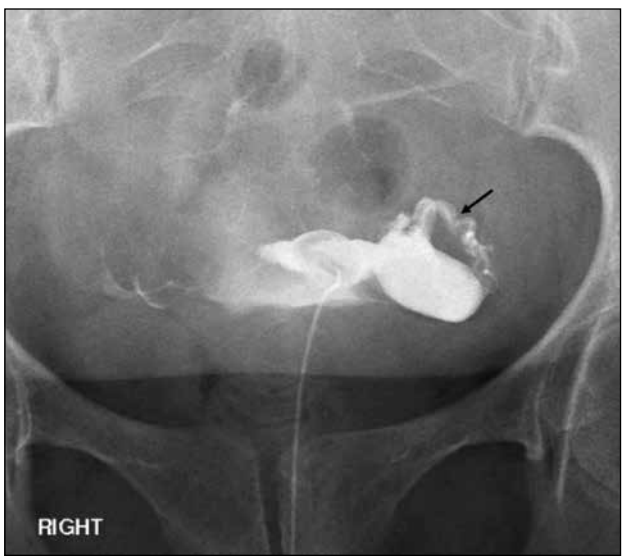

Figure 2. A 32-year-old woman with distal left fallopian tube blockage without hydrosalpinx. Delayed hysterosalpingography images show persistent round contrast collection closely related to the distal left fallopian tube. Normal mucosal fold pattern at the non-distended ampullary portion is still visible (arrow) and would not be present in hydrosalpinx. Peritoneal contrast spillage originated from the patent right tube. Subsequent laparoscopic chromotubation confirmed distal left fimbrial end blockage without hydrosalpinx formation. Right tube was patent.

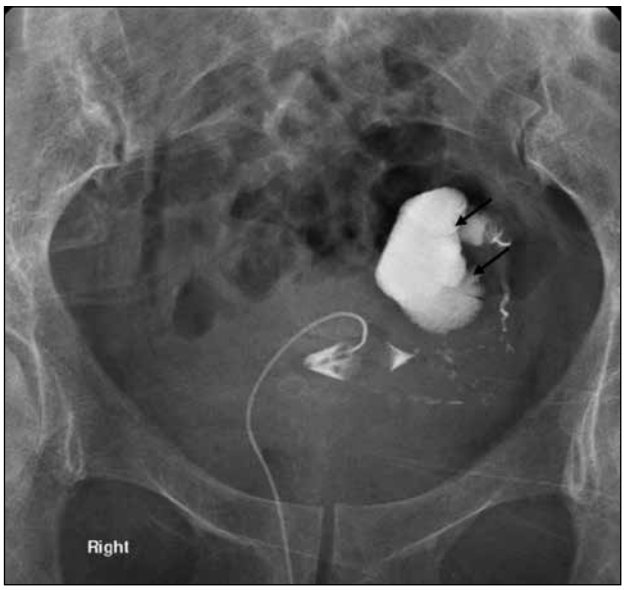

Figure 3. A 33-year-old woman with left hydrosalpinx. Delayed hysterosalpingography film demonstrated persistent absence of peritoneal contrast spillage compatible with bilateral tubal blockage. Distended contrast fills the left fallopian tube with horizontal folds (arrows) resembling a cogwheel pattern, suggestive of hydrosalpinx formation. Subsequent laparoscopic surgery confirmed left 5 × 3 cm hydrosalpinx.

Peritubal adhesion and pelvic peritoneal loculated collections

Pelvic inflammatory disease can result in pelvic and peritoneal scarring and consequent adhesion bands around the pelvic organs.[11] Adhesions around the fallopian tubes can result in tubal blockage with loculated contrast collections.[6] A loculated pelvic collection can manifest as a persistent localised contrast-filled region in delayed screening on HSG (Figure 4).

Salpingitis isthmica nodosa

Salpingitis isthmica nodosa (SIN) is a fallopian tube disease of unknown aetiology that is characterised by proximal tubal (isthmic portion) nodular thickening, associated diverticulosis of isthmic tubal epithelium invading into the muscular layer with secondary smooth muscle hypertrophy, and preserved smooth serosal surface (Figure 5).[12] Features are more often bilateral than unilateral. The reported incidence of SIN is 0.6% to 11% in healthy fertile females with a strong association with infertility and ectopic pregnancy.[13] Although SIN can be diagnosed on HSG from its distinctive appearance, histological proof is the gold standard.[12] The presence of nodular outpouchings along the cornual isthmic portions of fallopian tubes on HSG represents contrast-filled tubal diverticula.[6,10] The tubal outpouchings may measure up to 2 cm.[12]

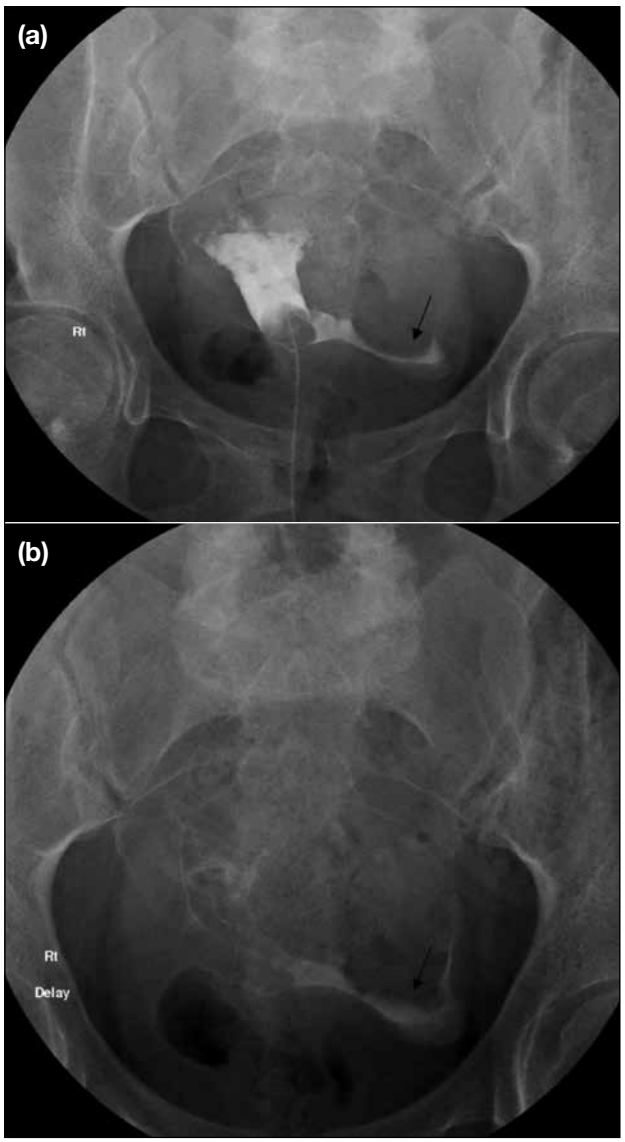

Figure 4. A 28-year-old woman with a history of pelvic inflammatory disease. (a) Hysterosalpingography showing loculated fluid collection (arrow). (b) Delayed film after ambulation showing persistent localised contrast pooling at the left pelvic region (arrow) suggests the presence of a loculated fluid collection.

Uterine Cavity Contour Abnormalities

Uterine cavity contour abnormalities can be categorised as uterine cavity outpouching or extrinsic indentation or irregular outline (that can be associated with prior surgery, infection or inflammation).

Contour outpouching

Adenomyosis is the extension of endometrial glandular tissue into the myometrium and can be diffuse or focal in extent (Figure 6). When regions of endometrial glands are connected to the uterine cavity, they can become opacified on HSG study and show as diverticula or outpouchings in the uterine cavity.[6] Further imaging with ultrasound or magnetic resonance imaging (MRI) allows confirmation of the diagnosis and visualisation of the extent of adenomyotic changes. Differentiation with irregular cavity outline may be encountered if HSG is performed during menstruation (Figure 7).

Uterine contour indentation

Leiomyoma is a benign tumour composed of uterine smooth muscle (Figure 8). Sizable leiomyoma, especially at a submucosal location, may be evidenced by smooth indentation of the uterine cavity with cavity distortion on HSG.[6,10] Distorted endometrial cavity contour may contribute to subfertility owing to changes in endometrial receptivity, development, and hormone environment.[10]

Intracavity Filling Defects

Sensitivity of HSG in detecting intrauterine abnormalities has been reported to be about 58.2%, compared with 82% for ultrasonography.[10] Intracavity filling defects can be artefactual and due to air bubbles or intracavity pathology such as endometrial polyps, intracavity leiomyoma, or synechiae. Persistent and stationery filling defects are more suspicious of intracavity pathology. Preprocedural flushing of the catheter helps minimise the chance of air bubble contamination.

Endometrial polyps

Endometrial polyps are benign focal proliferations of endometrial tissue, usually seen as smooth oval to roundish filling defects on HSG (Figure 9). Saline infusion sonohysterography with ultrasound assessment after saline instillation into the uterine cavity can help distinguish the causes of an intracavity filling defect with superior accuracy for endometrial polyps than transvaginal ultrasound or HSG.[14] Hysteroscopy is the gold standard for diagnosis[14] and can be applied to provide therapeutic treatment with polypectomy or adhesiolysis.

Synechiae

Intrauterine adhesions or synechiae result from insult to the basal endometrial lining, such as prior surgery (especially dilatation and curettage) or endometritis (Figure 10). Asherman's syndrome is the presence of intrauterine adhesions with clinical manifestations of abnormal menstruation (e.g., amenorrhoea/hypomenorrhoea) and subfertility.[6] On HSG, adhesions are more often linear, irregular or angulated.

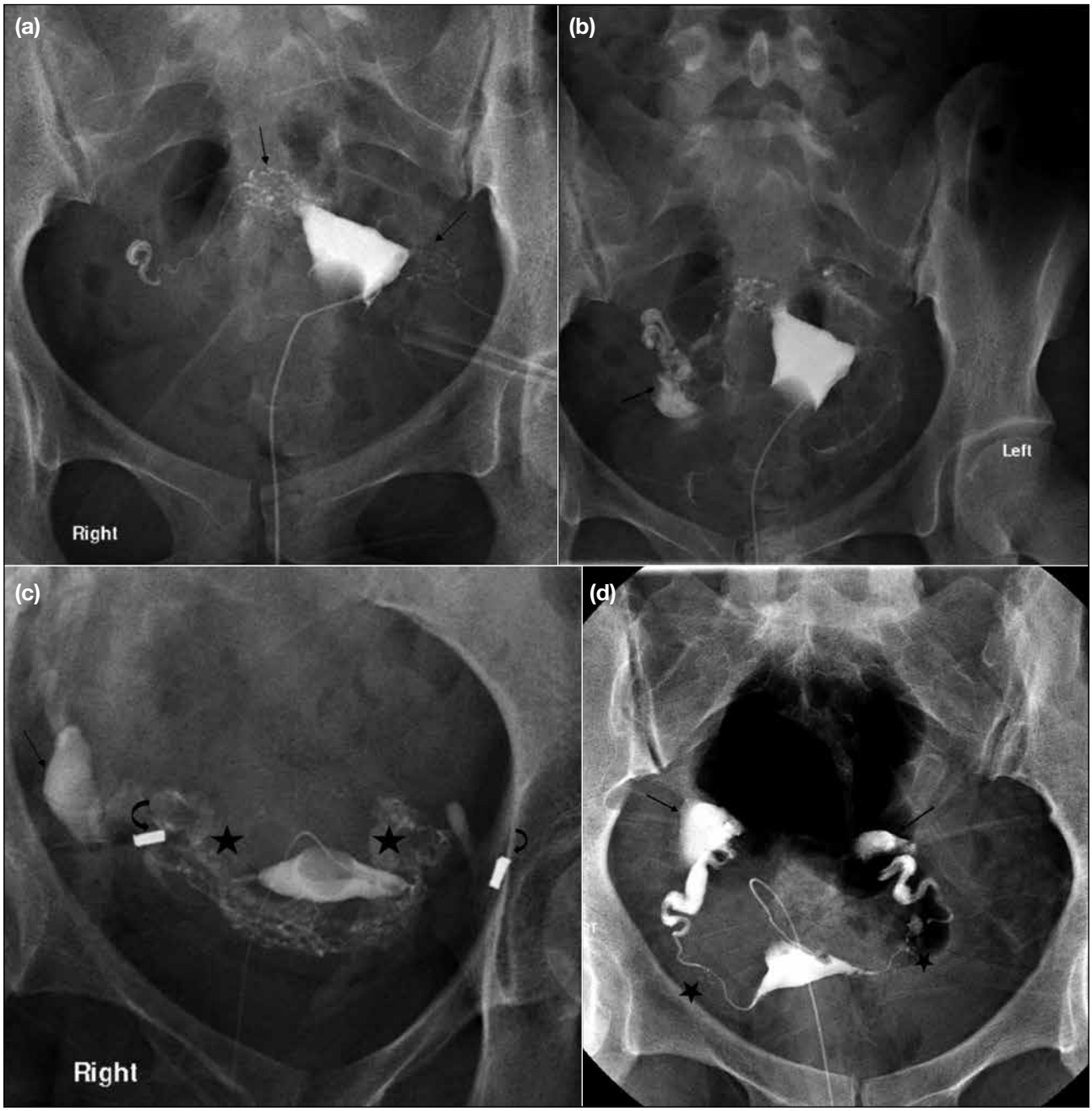

Figure 5. Three cases of salpingitis isthmica nodosa (SIN). (a and b) A 29-year-old woman with SIN, patent right tube and blocked left tube. (a) Tiny nodular contrast-filled outpouching at bilateral isthmic fallopian tubes (arrows). (b) Further imaging showing peritoneal contrast spillage (arrow), from patent right tube. (c) A 42-year-old woman with SIN with prior bilateral tubal ligation and right hydrosalpinx (ordinary arrow). The patient requested reversal of tubal ligation. Hysterosalpingography shows bilateral tubal ligation clips (curved arrows). Nodular outpouchings from bilateral proximal tubes (stars) were compatible with SIN. Bullous dilatation of right distal fallopian tube suggests hydrosalpinx. (d) A 38-year-old woman with bilateral SIN and blocked distal tubes. Typical SIN features in bilateral isthmic portions (stars) were more conspicuous on the left. Nondilated bilateral ampullary portions with normal mucosal fold pattern. Roundish contrast collections adjacent to distal fallopian tube (arrows) with lack of peritoneal spillage suggest bilateral distal blocked tubes.

Variant Anatomy or Congenital Malformation

Arcuate uterus

Arcuate uterus is classified as class VI Müllerian duct abnormality according to the American Fertility Society scheme.[15] Arcuate uterus arises from incomplete septal resorption at the level of the uterine fundus resulting in mild focal bulging. On HSG it manifests as broad mild concavity of the fundal cavity contour (Figure 11). Further imaging with three-dimensional ultrasound

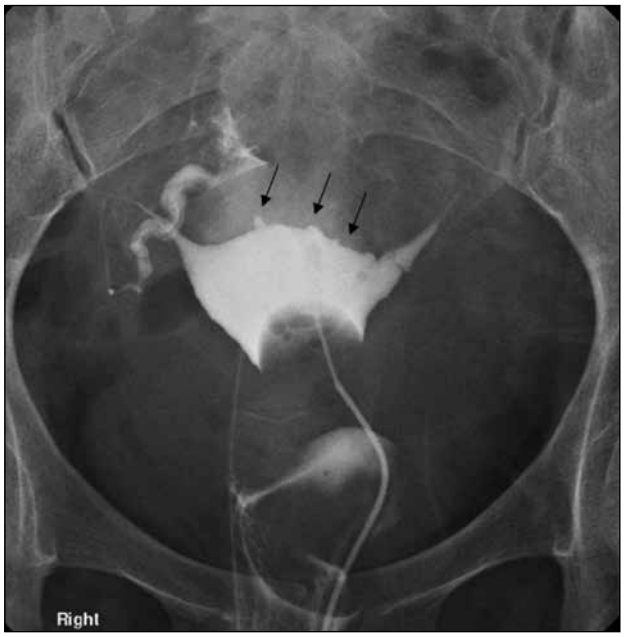

Figure 6. A 32-year-old woman with adenomyoma. Known fundal adenomyoma was found on prior transvaginal ultrasound. Hysterosalpingography demonstrates irregular uterine cavity contour with small outpouchings at fundal aspects (arrows), in keeping with deep extension of endometrial glandular tissues within the myometrium.

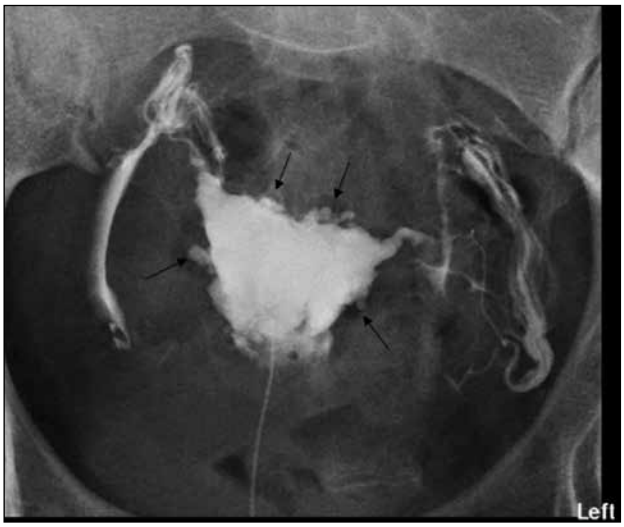

Figure 7. A 32-year-old woman with menstruation-related cavity changes mimicking diffuse adenomyosis. Hysterosalpingography (HSG) was performed at day 6 of menstruation. Irregular uterine cavity with multiple small contrast-filled outpouchings (arrows) are evident. Subsequent pelvic ultrasound showed unremarkable uterus without features of adenomyosis. No history of dysmenorrhoea was reported. Performing HSG during menstruation may result in diagnostic errors as cavity changes during menstruation may mimic diffuse adenomyosis.

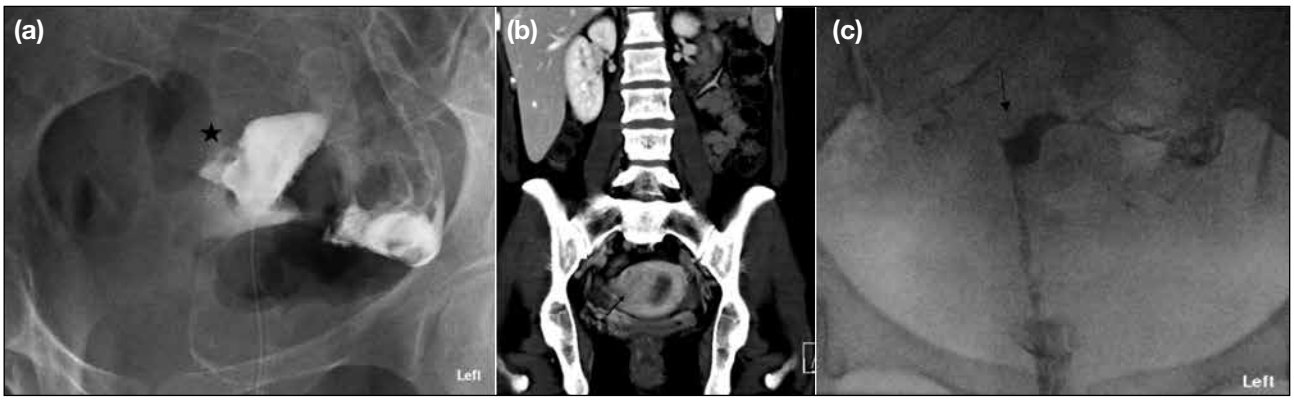

Figure 8. (a and b) A 29-year-old woman with leiomyoma indenting the uterine cavity. (a) Hysterosalpingography showed indentation (star) of the right uterine cavity. (b) Follow-up computed tomography scan of the abdomen and pelvis showed a hypoenhancing uterine mass (arrow) suggestive of leiomyoma with displacement and indentation of the right fundal uterine cavity. (c) A 36-year-old woman with submucosal leiomyoma. Hysterosalpingography showed a filling defect at right cornual region (arrow) with smooth border. Hysteroscopy showed a fundal polypoid lesion and polypectomy was performed. Pathology revealed submucosal leiomyoma.

or MRI to visualise the normal outer uterine contour is helpful. It has been regarded as a normal uterine variant without significant adverse impact on fertility.[15,16]

Congenital uterine anomalies

The wide spectrum and complex pathogenesis of congenital uterine anomalies are beyond the scope of this pictorial review. The developmental stages of the uterus include organogenesis of paired Müllerian ducts, fusion, and septal resorption. Disorders in these developmental stages result in congenital uterine anomalies with varying severity and implications for fertility.[10] HSG offers valuable information regarding uterine cavity morphology and can suggest the presence of a congenital uterine anomaly. Further evaluation with three-dimensional pelvic ultrasound or MRI is warranted

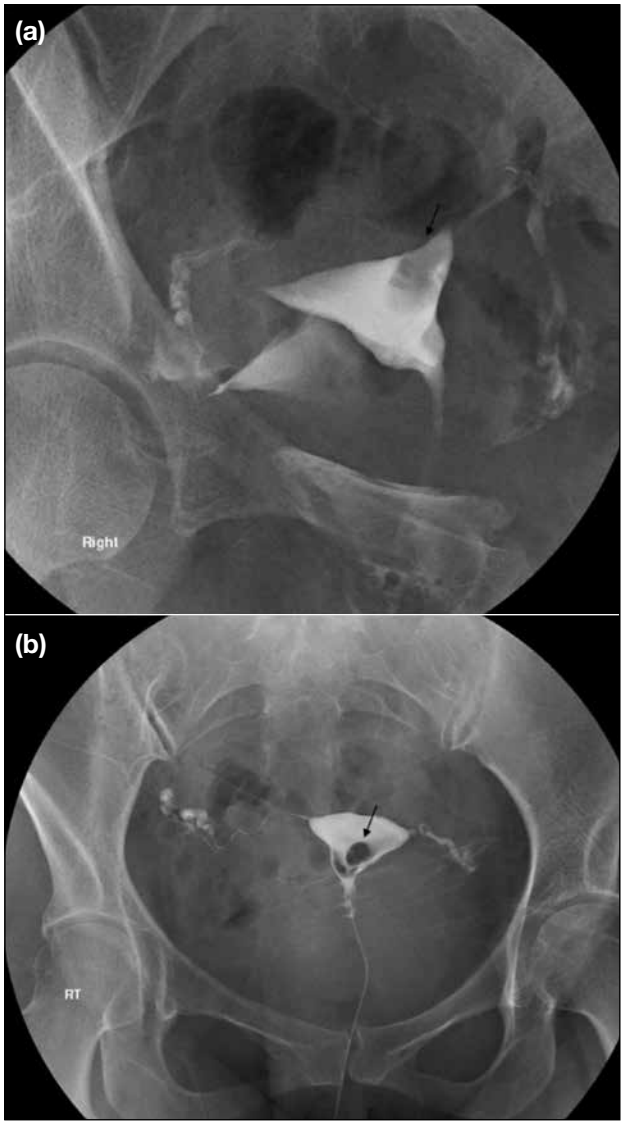

Figure 9. Two cases of benign endometrial polyps. (a). A 33-year-old woman with left cornual endometrial polyp. Hysterosalpingography revealed a filling defect with smooth border at the left cornua (arrow), suspicious of endometrial polyp. Follow-up hysteroscopy with polypectomy confirmed presence of a 1-cm endometrial polyp with benign histology. (b) A 33-year-old woman with intracavity endometrial polyp. Hysterosalpingography shows a roundish intracavity filling defect with smooth border (arrow). Hysteroscopy revealed endometrial polyp with polypectomy performed and subsequent benign histology.

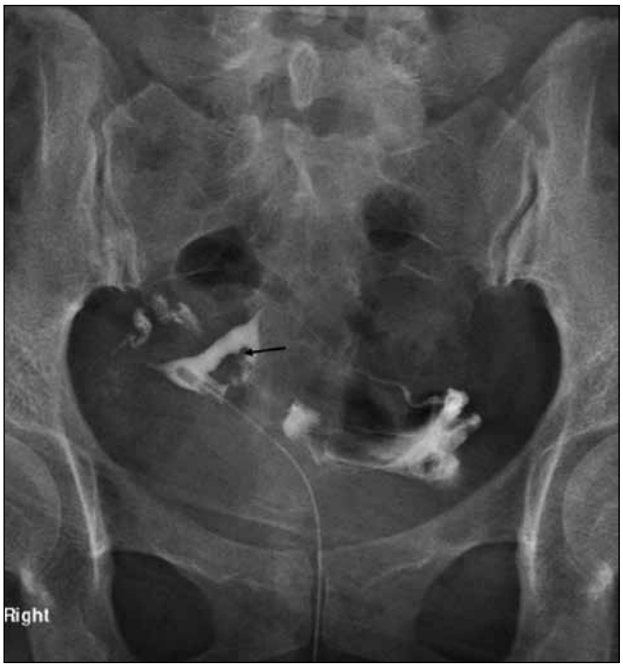

Figure 10. A 38-year-old woman with uterine synechiae with Asherman's syndrome. Intracavity irregular angulated filling defect was observed on hysterosalpingography (arrow), confirmed by subsequent hysteroscopy with adhesiolysis performed.

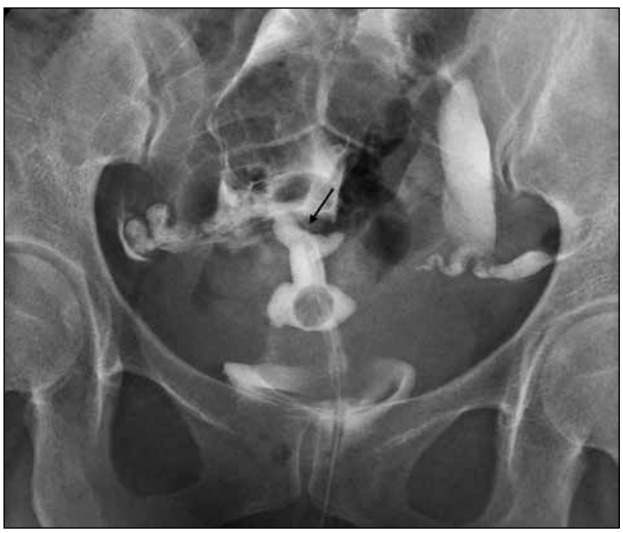

Figure 11. A 37-year-old woman with arcuate uterus. Hysterosalpingography shows broad concavity at fundal cavity contour (arrow). Prior computed tomography of pelvis and follow-up transvaginal ultrasound showed smooth convex outer fundal contour. Overall features were consistent with arcuate uterus.

for assessment of outer or fundal uterine contour for accurate diagnosis.

CONCLUSION

HSG is vital in reproductive medicine given its reliability in diagnosing tubal occlusion with relatively low invasiveness. Systematic interpretation of HSG findings and understanding of the spectrum of pathologies, including uterine contour changes, intracavity filling defects, tubal patency, and tuboperitoneal pathology will facilitate identification of the cause of female subfertility and expedite management to improve reproductive outcome.

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