Urol Radiol 13:67–73 (1991)

Urologic Radiology

Hysterosalpingography

Stephen Karasick
Department of Radiology, Thomas Jefferson University Hospital, Philadelphia, Pennsylvania, USA

Abstract. During the past decade, there has been a dramatic increase in the number of women seeking infertility evaluation. Hysterosalpingography (HSG) is an invaluable procedure for evaluating internal architecture of the female reproductive tract. Utilizing HSG, it may be possible to minimize the use of invasive procedures, such as hysteroscopy and laparoscopy, in defining such problems as peritubal adhesions, leiomyomas, and congenital anomalies. This review re-emphasizes the wide range of available information and advantages of HSG which can be extremely useful in the diagnosis and management of infertile patients.

Key words: Hysterosalpingography — Uterus — Fallopian tube — Synechia — Leiomyoma — Tubes — Inflammation — Tubal ligation.

Historically, hysterosalpingography (HSG) has been, and still remains, the initial procedure in the assessment of tubal and peritoneal factors leading to infertility. HSG can also aid in planning proper treatment for various gynecological problems, such as abnormal uterine bleeding, pelvic masses, menstrual disorders, repeated pregnancy loss, and fistulae. Leiomyomata, malignancy, endometrial polyps, and cervical stenosis are other important conditions evaluated with HSG.

HSG is generally quite safe and easy to perform. It involves the injection of either water- or oil-soluble radiopaque contrast material through the cervix into the uterine cavity with subsequent filling of the fallopian tubes, providing information regarding the shape and patency of uterine and tubal lumens. Significant improvement in the technique and equipment used in HSG has occurred during the last 70 years thus providing increased safety, diagnostic reliability, and dependability [1]. Contraindications to this procedure include active or recent pelvic inflammatory disease, intrauterine pregnancy, and a history of severe allergic reaction to contrast media.

HSG should be performed in the follicular phase of the menstrual cycle before ovulation has occurred. The patient is placed in the modified lithotomy position on the radiographic table with a sterile speculum inserted into the vagina after cleansing the cervix and vaginal wall with antiseptic solution. An introducing cannula or Foley catheter can be used and placed in the external os. Injection of 4–10 ml of contrast media into the uterine cavity is monitored under fluoroscopy. A scout radiograph of the pelvis is usually obtained only if oily contrast material from a previous study is visible on the image-intensification screen. Considerable controversy exists over the proper choice of contrast material for HSG. The improved contrast and sharpness of the image provided by oil-soluble contrast media (OSCM) permits easy detection of many intrauterine and tubal abnormalities (Fig. 1). OSCM causes less pain, discomfort, and peritoneal irritation than water-soluble agents. The slow absorption and clearance of the OSCM and the ability to form droplets allows delayed films to be obtained, yielding information regarding free spillage or presence of peritubal adhesions (Fig. 2). In this author's opinion, the superior mucosal coating of the ampullary region of the tube with the water-soluble agent is of

Address offprint requests to: Stephen Karasick, M.D., Department of Radiology, Thomas Jefferson University Hospital, 111 South 11th Street, Philadelphia, PA 19107, USA

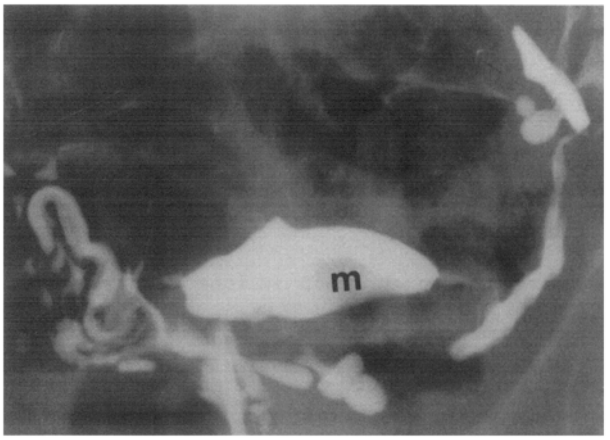

Fig. 1. Small fundal submucous myoma (*m*) with bilateral tubal patency and right peritubal adhesions.

Fig. 2. Ten-minute delayed radiograph showing bilateral loculated spillage of contrast from convoluted distal tubes (*arrows*) due to adhesions.

limited diagnostic value [2]. Some authors have even suggested that the use of OSCM increases the pregnancy rate in infertile patients after HSG [3, 4]. Fluoroscopic guidance has reduced the incidence of venous and/or lymphatic intravasation with potential oil emboli. Knowledge of any condition that predisposes to intravasation, such as distal tubal occlusion or recent uterine curettage, would allow the radiologist to opt for water-soluble contrast media.

The radiographic study consists of an early radiograph outlining the uterine cavity and proximal fallopian tubes (Fig. 3) and subsequent radiographs delineating early peritoneal spill from the fimbriated ends of the tubes. Oblique radiographs aid in the evaluation of uterine configuration and further tubal anatomy and spillage pattern. In addition to supine views, prone positioning of the patient is helpful in differentiating free from loculated spillage related to peritubal adhesions. Although complications of the

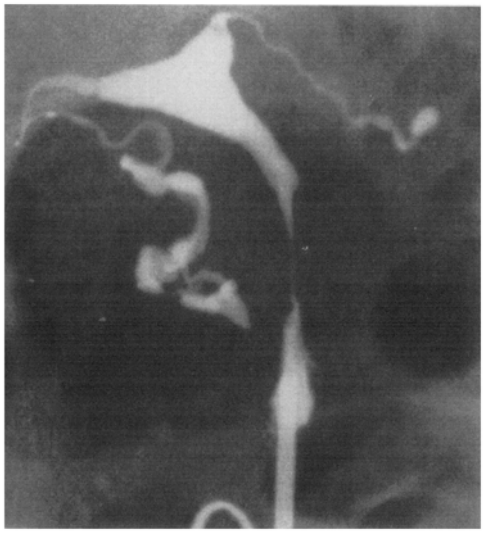

Fig. 3. Early radiograph showing convoluted fallopian tubes, which can be due to peritubal adhesions.

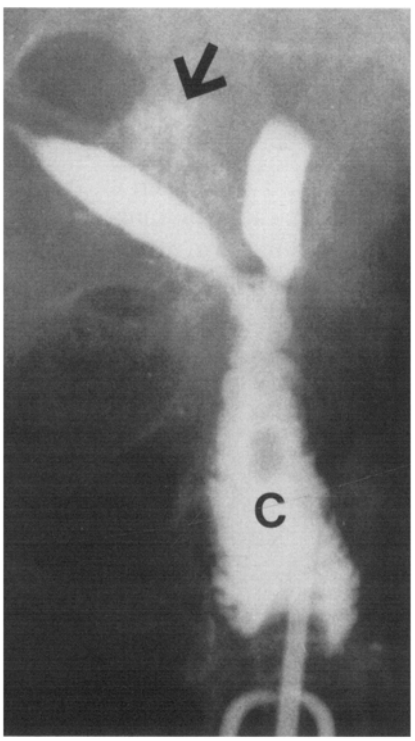

Fig. 4. Septate uterus with area of myometrial intravasation (*arrow*). Note endocervical canal with visible ridges representing plicae palmatae (*C*). Differentiation from bicornuate uterus can be obtained with laparoscopy and examination of the serosal surface.

procedure are few, hemorrhage and infection remain major concerns. Antibiotic prophylaxis is suggested if there is any evidence of tubal disease or history of pelvic inflammatory disease.

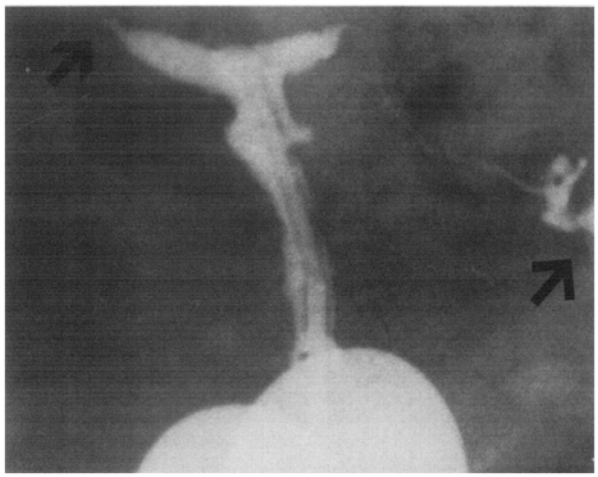

Fig. 5. T-shaped uterus with right intramural tubal occlusion and convoluted left distal tube due to adhesions (*arrows*).

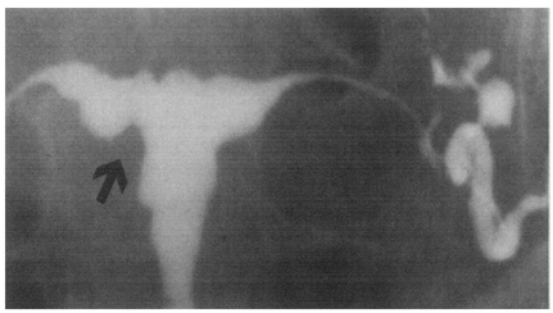

Fig. 6. Characteristic appearance of DES exposure in utero with T-shaped uterine configuration and constriction deformity (*arrow*).

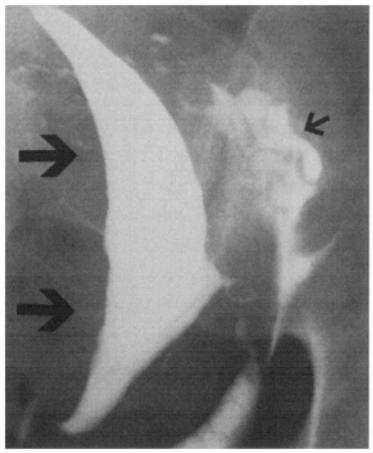

Fig. 7. Markedly distorted crescent-shaped uterine cavity secondary to large leiomyoma (*large arrows*). Note convoluted distal left tube in the upper pelvis secondary to adhesions (*arrow*).

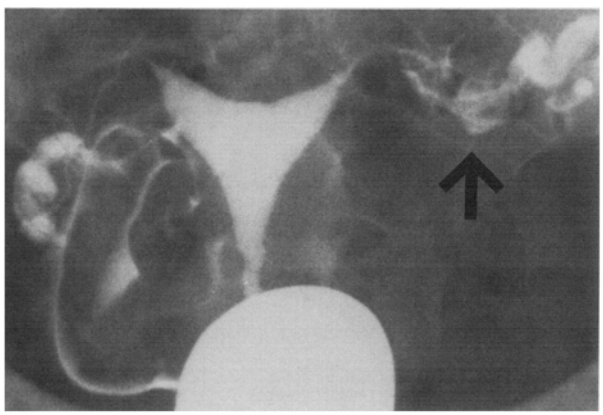

Fig. 8. Elevation of the entire left tube (*arrow*) with normal uterus due to subserosal leiomyoma.

The normal uterine cavity has a triangular appearance with either straight or concave lateral walls. The endocervical canal, comprising one third of the entire uterine length, is variable in appearance and sometimes possesses a serrated appearance related to longitudinal ridges or plicae palmatae. The isthmic canal defines the region of the internal os and may vary in width according to physiologic factors. A width greater than 8–10 mm is strongly suggestive of incompetent cervical os when there is a positive obstetrical history of late second or third trimester pregnancy loss. The fallopian tubes are paired musculomembranous structures ranging from 10–14 cm in length. Lying completely within the myometrium, the intramural or interstitial segment varies from 1–2 cm in length. The isthmic and ampullary segments comprise the extrauterine portions of the tube. The isthmic portion of the tube is wider than the intramural segment; the ampullary portion is the widest and longest segment ending in the infundibulum, which encompasses the fimbriated end and the tubal ostium. Spasm of the intramural tube can simulate organic obstruction for which treatment with an antispasmodic agent may be helpful.

HSG is a useful diagnostic procedure in the evaluation of uterine anomalies. Symmetric defects of the uterus represented by didelphys, bicornuate, and septate uteri, result from abnormal midline fusion of the Mullerian ducts or lack of degeneration of the fused septum. Such anomalies may cause complications during pregnancy with increased risk of premature labor, vaginal and postpartum bleeding, and spontaneous abortion [5, 6]. HSG, in addition to laparoscopy, has contributed to the more recently developed surgical techniques designed to overcome these reproductive problems associated with these anomalies [6].

A true unicornuate uterus is usually displaced laterally in the pelvis and is often associated with renal agenesis. The arcuate uterus is a minor malformation in which the fundus is mildly concave as

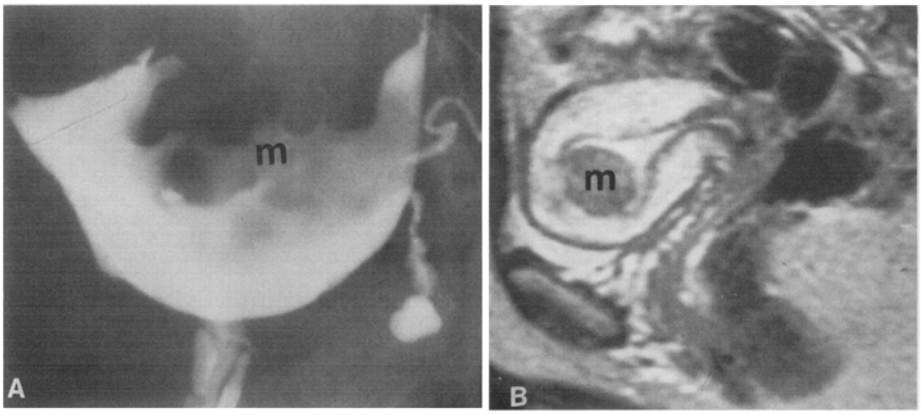

Fig. 9. **A** Large submucous mass (*m*) distorting and enlarging the uterine cavity. **B** Sagittal magnetic resonance image of pelvis (TR 2000 ms, TE 80 ms). Hypointense submucous leiomyoma (*m*) projecting into endometrial cavity.

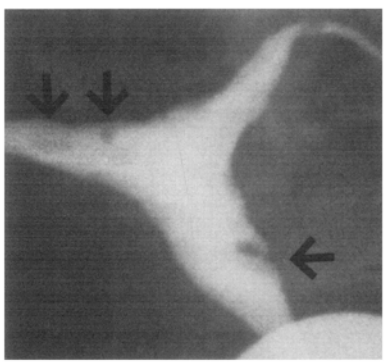

Fig. 10. Several small endometrial polyps (*arrows*) varying in size, shape, and location. Larger polyps may be difficult to differentiate from submucous myomas.

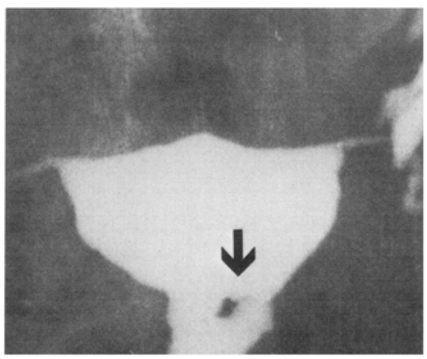

Fig. 11. Sharply marginated filling defect in the lower uterine segment due to synechiae (*arrow*).

opposed to a deeper depression seen with bicornuate or septate uterus (Fig. 4). Differentiation of the latter two lies in the configuration of the external surface of the uterus; both conditions must be distinguished from a submucous fundal leiomyoma. The didelphic uterus shows two entirely separate uterine cavities with a vertical septum in the proximal vagina. Rarely is a uterine anomaly the cause of primary infertility. The majority of uterine anomalies are not suspected or discovered until the patient presents with a recurring history of pregnancy loss. Uterine unification surgery has improved postoperative obstetric outcome, with up to 83% of women delivering a viable fetus [7].

HSG has recently aided in the evaluation of DES-exposed patients, especially when gross cervicovaginal structural abnormalities are present [8]. Maternal DES ingestion during the period of embryogenesis can be associated with Mullerian system abnormalities; the extent of the effect in female offspring appears related to the dose given prior to the 19th week of pregnancy [9]. On HSG, the uterus is usually T-shaped and hypoplastic and may have constriction bands, polypoid defects, and synechiae, as well as a narrowed endocervical canal (Figs. 5 and 6). The DES-exposed daughter may have a poorer prognosis for pregnancy outcome, especially if there are congenital anomalies present in the cervix and the uterus [9].

Important information about the number, size, and location of leiomyomata can be obtained with HSG. Submucous leiomyomas can present as single or multiple round filling defects, with or without distortion or enlargement of the cavity (Fig. 7).The endometrium overlying some submucosal tumors is very thin and may predispose to vascular intravasation of contrast media. Interstitial or intramural leiomyomas often enlarge the uterine cavity in a globular fashion without distortion. Subserous leiomyomas usually give no definite radiographic findings, but may cause deformity of the uterine cavity with compression, deviation, or even occlusion of the tubal ostia (Fig. 8). Reproductive consequences of leiomyomas include infertility, premature labor, and first or second trimester pregnancy losses [10]. Demonstration of bilateral tubal patency on HSG and precise anatomic detail with magnetic resonance scanning allows the physician

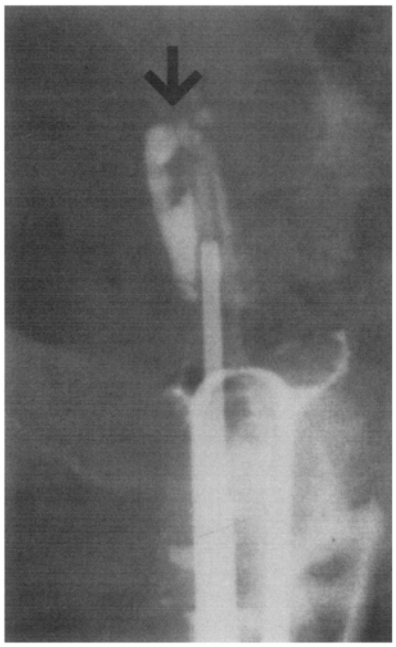

Fig. 12. Cervicoisthmic synechiae. Only the endocervical canal is seen due to completely obstructing synechiae (*arrow*).

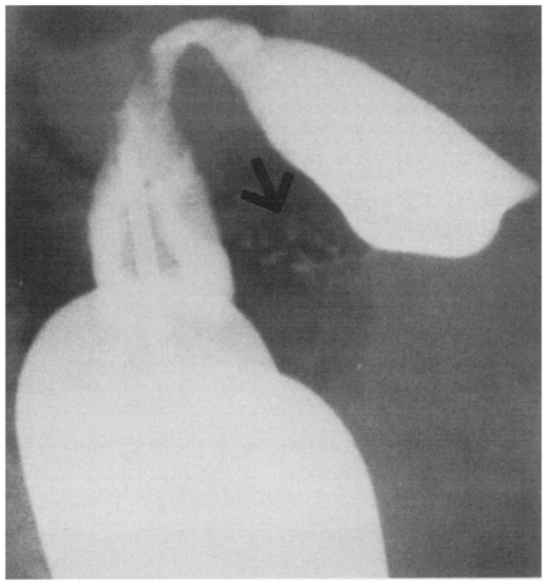

Fig. 13. Salpingitis isthmica nodosa of the right tube with typical periluminal globular collections of contrast in the isthmic region (*arrow*).

to offer an optimistic preoperative evaluation of myomectomy surgery (Fig. 9) [11].

In addition to submucous leiomyomas, other filling defects within the uterine cavity include endometrial polyps and synechiae. The former are localized outgrowths of normal endometrial glands and stroma, originating in any part of the uterine cavity. They are usually solitary and sessile with varying size, ranging from 1 mm to complete occupation of the uterine lumen (Fig. 10). Sessile polyps may be difficult to distinguish from small submucous leiomyomas. Synechiae or intrauterine adhesions are characteristically irregular, angulated, and stellate with well-demarcated borders (Fig. 11). They present as filling defects due to adhesion or apposition of the walls of the uterus with failure to distend the lumen. Adhesions vary markedly in their density and size, ranging from minimal filmy adhesions to complete obliteration of the cavity. The most significant causative and predisposing factors include intrauterine trauma, infection, and retention of products of conception [12]. Infertility and menstrual functional impairment can be associated with synechiae. Adhesions in the cornual region may result in tubal occlusion, while those in the cervicoisthmic region may completely obstruct with secondary amenorrhea (Fig. 12). Other uterine deformities occasionally encountered with HSG include an outpouching deformity of the lower uterine segment due to scarring from previous cesarean surgery. Retained products of conception are a rare cause of irregular shaggy filling defects in an enlarged uterine cavity [13].

One primary indication for HSG in the diagnostic work-up of the infertile woman is to evaluate fallopian tube patency. Tubal abnormalities account for one third to one half of all cases of infertility [14]. The most common causes of tubal obstruction are salpingitis isthmica nodosa and luminal fibrosis usually at the uterotubal junction. They are the cause of infertility in approximately 20% of women with tubal disease [15]. The uterotubal junction or transition area between the intramural and isthmic portions of the tube is considered a vital physiologic unit primarily involved with ovum and sperm transport [16]. Salpingitis isthmica nodosa is a descriptive term for nodular swelling of the isthmic portion of one or both fallopian tubes, presumably as a result of some inflammatory process within the tube. Periluminal small globular collections of contrast media, confined to the isthmic portion of the fallopian tubes, are usually seen with or without interruption of the clear linear continuity of the lumen (Fig. 13). The ipsilateral tube can reveal additional abnormalities, such as hydrosalpinx and peritubal adhesions.

Distal tubal disease usually appears secondary to peritubal adhesions formed as a result of inflammation from pelvic inflammatory disease, endometriosis, or surgery. These adhesions disturb the delicate anatomic relationship between the tube and ovary, interfering with normal ovulation or pre-

Fig. 14. Vertical left tube (*arrow*) with loculated spillage of contrast due to peritubal adhesions.

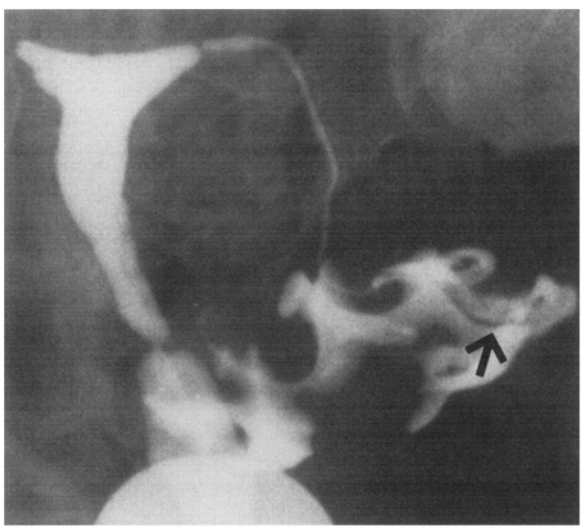

Fig. 15. Convoluted left tube with peritubal halo effect (*arrow*) and loculated spillage of contrast due to peritubal adhesions.

venting normal capture and transport of the ovum. Although peritubal adhesions cannot be reliably distinguished from tubal occlusion on HSG, the former can be detected in up to 75% of cases when certain objective radiographic criteria are used [17]; the presence of a convoluted or corkscrew fallopian tube, and loculated spillage of contrast material are especially important (Figs. 14–16).

In assessing tubal status, HSG should be performed before laparoscopy. Occasionally, there are false-positive proximal tubal occlusions on HSG. A contrast study showing unilateral uterotubal junction or proximal isthmic occlusion in a patient without a history of infection, tubal sterilization procedure, or uterine surgery should be viewed with suspicion; these apparent occlusions may be related to either spasm or preferential flow through the patent tube. Bilateral occlusion may also be related to spasm or even faulty technique, such as inadequate cervical seal [16]. If repeat HSG or follow-up laparoscopy fails to demonstrate bilateral patency, then selective fallopian tube catheterization can be utilized to visualize the tubes. Recently, fluoroscopic transcervical fallopian tube catheterization has been performed as a means of opening the proximal fallopian tubes without surgery. Casts of amorphous debris or organizing exudate account for the majority of causes of proximal tubal occlusion [15]. If selective ostial injection of contrast media in the fallopian tube fails to unplug or open the tube, then recanalization can be obtained with the use of a tapered guidewire and catheter. Women with proximal tubal obstruction can be offered this nonsurgical catheter technique prior to *in vitro* fertilization or tubal microsurgery [18, 19].

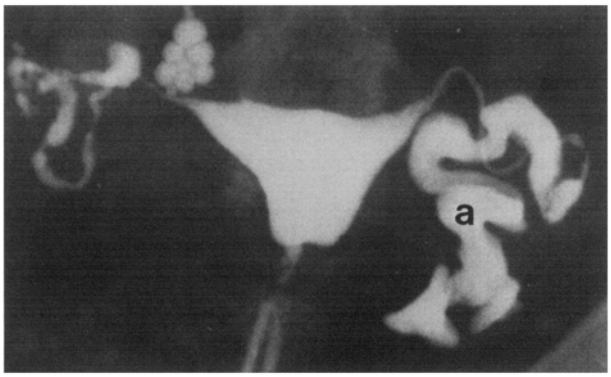

Fig. 16. Loculated spillage from both tubes with left ampullary dilatation (*a*) due to bilateral peritubal adhesions.

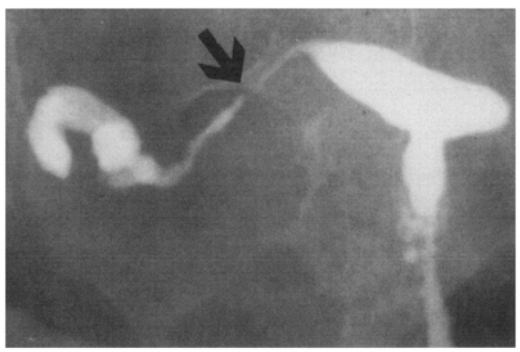

Fig. 17. Tubal reanastomosis in patient with previous tubal ligation. Note abbreviated tubal length and sudden change in caliber at the anastomotic site (*arrow*).

HSG is a useful technique for determining the postligation status of the uterine end of the fallopian tube when reversal is planned. The length of the remaining tube after tubal ligation, usually bipolar electrocautery or postpartum ligation is significant

in the prognosis for future pregnancy when reversal of the procedure is attempted [20]. The chances of pregnancy are good if the total tubal length after ligation is 3–4 cm or more with an intact 1 cm of ampulla and fimbriae [21]. This information concerning tubal length and status is invaluable, especially when the operative and pathological reports of the sterilization procedure are incomplete or unavailable. Restoration of tubal patency after sterilization procedures primarily involves anastomosis of the patent adjacent segments, usually isthmic–isthmic. The reversal of tubal ligation by reanastomosis shows a prominent contour defect with change in caliber of the shortened tube at the anastomotic site (Fig. 17). Intramural or cornual anastomoses are other options when there is thermal injury to the cornu. Such microanastomosis involves careful shaving of the cornu, identification of the intramural tube, and subsequent anastomosis directly to the intact intramural segment. Uterotubal implantation plays a much smaller role in tubal surgery because of certain disadvantages; these include undue tubal shortening, tubal vascular damage, and potential uterine scarring and rupture with any subsequent pregnancy [22].

HSG plays a large and extremely important role in the evaluation of female infertility. Careful monitoring of this procedure by the radiologist with appropriate spot radiographs enables the reproductive endocrinologist or gynecologist to promptly and safely obtain information regarding the female reproductive tract. Peritubal adhesions, leiomyomas, and synechiae are among the many conditions reliably diagnosed with HSG. Selective transcervical catheterization of fallopian tubes with use of a modified angiographic technique now complements conventional HSG in evaluation of the tubal factor in infertility; this new technique has a promising potential for nonsurgical treatment of infertility due to proximal tubal occlusion.

References

1. Siegler AM: *Hysterosalpingography,* 2nd ed. New York: Medcom, 1974, pp 1–3
2. Karasick S: Point-counterpoint contrast media for hysterosalpingography. *Radiol Rep 2:*204–207, 1990
3. Alper MM, Garner PR, Spence JEH, Quarrington AM: Pregnancy rates after hysterosalpingography with oil-and-water soluble contrast media. *Obstet Gynecol 68:*6–9, 1986
4. Soules MR, Spandoni LR: Oil versus aqueous media for hysterosalpingography: A continuing debate based on many opinions and few facts. *Fertil Steril 38:*1–10, 1982
5. Golan A, Langer R, Bukovsky I, Caspi E: Congenital anomalies of the Mullerian system. *Fertil Steril 51:*747–755, 1989
6. Rock JA, Murphy AA: Anatomic abnormalities. *Clin Obstet Gynecol 29:*886–911, 1986
7. Freedman MF: Uterine anomalies. *Sem Reprod Endocrinol 4:*39–54, 1986
8. Nunley WC, Pope TL, Bateman BG: Upper reproductive tract radiographic findings in DES-exposed female offspring. *AJR 142:*337–339, 1984
9. Barber HRK: An update on DES in the field of reproduction. *Int J Fertil 31:*130–134, 1986
10. Garcia GR, Tureck RW: Submucosal leiomyomas and infertility. *Fertil Steril 42:*16–19, 1984
11. Dudiak CM, Turner DA, Patel SK, Archie JT, Silver B, Norusis M: Uterine leiomyomas in the infertile patient: Preoperative localization with MR imaging versus US and hysterosalpingography. *Radiology 167:*627–630, 1988
12. Shaffer W: Role of uterine adhesions in the cause of multiple pregnancy losses. *Clin Obstet Gynecol 29:*912–923, 1986
13. Schenker J, Margalioth EJ: Intrauterine adhesions: An updated appraisal. *Fertil Steril 37:*593–610, 1982
14. Winfield AC, Wentz AC: *Diagnostic Imaging of Infertility.* Baltimore: Williams and Wilkins, 1987, pp 127–157
15. Sulak PJ, Letterie GS, Coddington CC, Hayslip CC, Woodward JE, Klein TA: Histology of proximal tubal occlusion. *Fertil Steril 48:*437–440, 1987
16. Musich JR, Behrman SJ: Surgical management of tubal obstruction at the uterotubal junction. *Fertil Steril 40:*423–440, 1983
17. Karasick S, Goldfarb A: Peritubal adhesions in infertile women: Diagnosis with hysterosalpingography. *AJR 152:*777–779, 1989
18. Lang EK, Dunaway HE, Roniger WE: Selective osteal salpingography and transvaginal catheter dilatation in the diagnosis and treatment of fallopian tube obstruction. *AJR 154:*735–740, 1990
19. Thurmond AS, Rosch J: Nonsurgical fallopian tube recanalization for treatment of infertility. *Radiology 174:*371–374, 1990
20. Karasick S, Ehrlich S: The value of hysterosalpingography before reversal of sterilization procedure involving the fallopian tube. *AJR 153:*1247–1250, 1989
21. Gomel V: Microsurgical reversal of female sterilization: Reappraisal. *Fertil Steril 33:*587–597, 1980
22. Silber SJ, Cohen R: Microsurgical reversal of female sterilization: The role of tubal length. *Fertil Steril 33:*598–601, 1980
23. Karasick S, Karasick D: *Atlas of hysterosalpingography.* Springfield, IL: Thomas, 1987, pp 163–169