EVALUATION OF EFFICACY OF SONOSALPHINGOGRAM FOR ASSESSING TUBAL PATENCY IN INFERTILE PATIENTS WITH HYSTEROSALPHINGOGRAM AS GOLD STANDARD

DISSERTATION SUBMITTED FOR
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THE TAMILNADU Dr. M.G.R. MEDICAL UNIERSITY
CHENNAI, TAMILNADU
INDIA

MARCH 2009

CERTIFICATE

This is to certify that **DR. K. P. Kasi Visalakshi** has been a post graduate student during the period May 2006 to March 2009 at Department of Radiodiagnosis, Madras Medical College and Research Institute, Government General Hospital, Chennai.

This Dissertation titled "Evaluation of efficacy of sonosalphingogram for assessing tubal patency in infertile patients with hysterosalphingogram as gold standard" is a bonafide work done by her during the study period and is being submitted to the Tamilnadu Dr. M.G. R. Medical University in Partial fulfillment of the M.D. Branch VIII RadioDiagnosis Examination.

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CONTENTS

INTRODUCTION

INTRODUCTION

Infertility has emerged as a significant psychosocial problem today with approximately 15% of married couples being infertile. [1]

DEFINITION OF INFERTILITY

It has been defined as one year of unprotected coitus without conception. It affects approximately 10 – 15% of couples in the reproductive age group.

ETIOLOGY

An assessment of causative factors have shown that

30% cases are due to male factors

30% due to female factors

30% due to combined male & female factors

10% due to unexplained causes.

Among the female infertility factors,

30 – 40% cases are due to ovulatory dysfunction

30 – 40% due to tubal pathology

10 – 15% due to unexplained causes

10 – 15% due to miscellaneous causes like endocrine factors.

Tubal pathology is responsible for 30 – 40% cases of infertility. [1]

Determining whether the fallopian tube is patent is part of initial evaluation

procedure in seeking the cause of infertility.

Currently available procedures each with its drawbacks include Rubin test, which is highly subjective; laparoscopy, which is invasive and hysterosalphingography, which expose the patient to ionizing radiation and contrast medium. Of the three techniques hysterosalphingography has been commonly used. [(2)]

In recent years major technologic advances in diagnostic ultrasound have led to improve image quality particularly with the use of vaginal probes. Negative contrast like saline can be used to visualize the endometrial cavity [(3)]. The presence of fluid in periovarian region and pouch of Douglas indicates the patency of the tube. Further the use of color Doppler to assess flow through the cornua can qualitate the direction of flow.

This study undertaken in the Barnard Institute of Radiology gives our experience in sonosalphinghography in 35 cases of infertility.

AIM OF THE STUDY

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1) To evaluate the specificity of employing sonosalphinghogram as a minimally invasive screening test in assessment of tubal patency.
2) To compare accuracy, positive predictive value and efficacy of sonosalphinghogram with that of hysterosalphingogram in assessment of tubal patency.

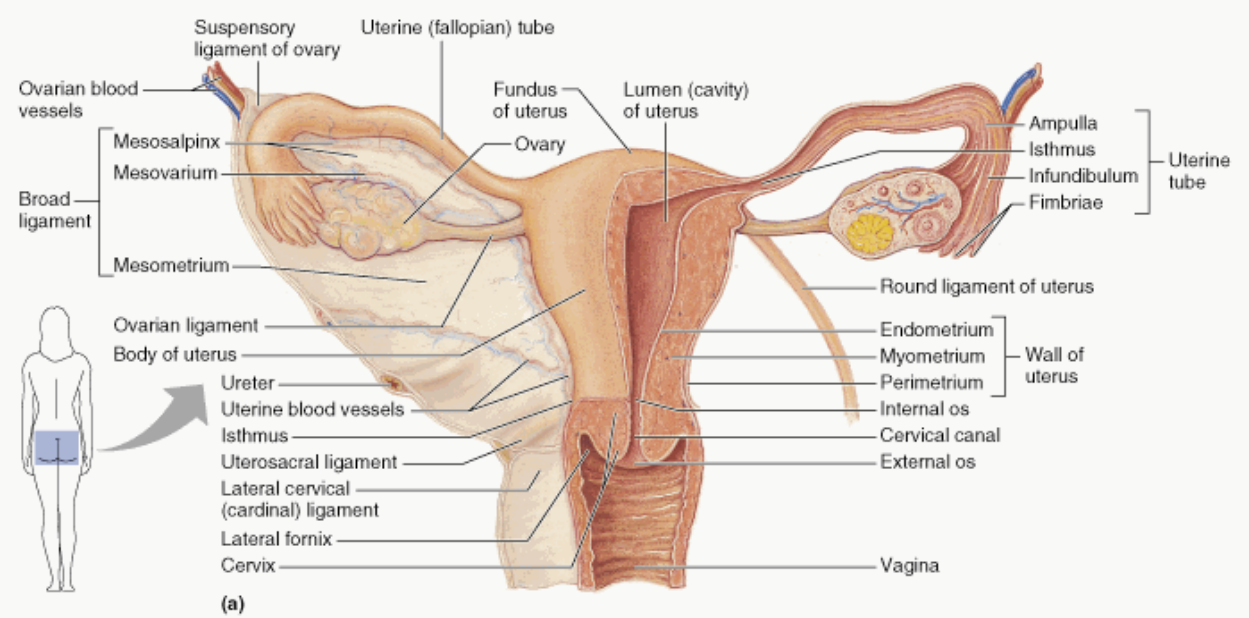
ANATOMY AND

PHYSIOLOGY OF TUBE

ANATOMY AND PHYSIOLOGY OF TUBE

GROSS ANATOMY

The fallopian tubes are paired tubular seromuscular organs which run from the cornua of the uterus medially towards the ovary laterally. The length of each tube varies from 7 – 14 cm.



The tube in its entire course is divided into 4 parts. From medial to lateral they are

1. **Cornual / interstitial portion**, which courses through the uterine wall to empty into the uterine cavity.
2. **Isthmus**, a round and cord like part constituting the medial 1/3 of the tube.
3. **Ampulla**, which is a thin – walled segment that forms more than half the length of the tube.
4. **Infundibulum**, lateral most portion of the tube where it becomes a funnel – shaped expansion terminating in the abdominal ostium, the circumference of which is enhanced by irregular processes called fimbriae.

HISTOLOGY

Tubal wall consists of 3 layers:

1. Internal mucosa i.e. endosalpinx consisting of columnar cells which are ciliated / secretary / peg cells.
2. Intermediate muscular layer i.e. myosalpinx.
3. Outer mucosa.

PHYSIOLOGY

The tubes act as ducts for sperm, oocyte and fertilized ovum transport in addition to being the normal site of fertilization. These functions depend mainly on 3 factors.

- Tubal motility
- Tubal cilia
- Tubal fluid

PATHOPHYSIOLOGY OF TUBAL OCCLUSION

PATHOPHYSIOLOGY OF TUBAL OCCLUSION

Fallopian tube gets occluded in various pathologic processes involving uterus and its adnexa.

PELVIC INFLAMMATORY DISEASE

It is the inflammation of upper genital tract characterized primarily by salpingitis. This may coexist with endometritis or oophoritis or may spread as peritonitis. Causative organism in most cases is Chlamydia trachomatis, Neisseria gonorrhea or Mycobacterium tuberculosis. Consequences of pelvic inflammatory disease include thickened tube, peritubal adhesion, decreased tubal motility and destroyed tubal cilia and epithelium causing poor tubal function and luminal obliteration. Tubal occlusion after infection usually is at the cornual region or at fimbriae. The risk of subsequent infertility is approximately 12% after 1 episode of PID, 35% after 2 episodes and 75% after 3 episodes.

ENDOMETRIOSIS

Some consider the presence of endometrial glands and stroma in the proximal

tube a normal finding. However, endometriosis has been found in the cornual and interstitial tube of 7 – 14% patients with proximal tubal blockage and infertility.

SALPINGITIS ISTHMICA NODOSA

It is a disease of unknown etiology, proposed to be sequelae of inflammation either of gonorrheal or TB type. Wang in 1989 in his series observed that SIN was the cause in 33% tubal obstruction characterized by nodular thickening in intramural and isthmic portion of fallopian tube.

CORNUAL POLYPS

Mucosal and endometrial polyps typically occur in the intramural or occasionally in the isthmic portion and more often cause incomplete occlusion of the tube.

AMORPHOUS DEBRIS, MUCOSAL AGGLUTINATION, VISCOUS SECRETION

They constitute a group of very frequently encountered cause of proximal tubal occlusion. The relative paucity of cilia and the narrow lumen at cornual and isthmic portion contribute in part to the stasis of debris and mucous plugs at uterine – tubal junction.

OBLITERATIVE FIBROSIS

Collagen fibres are deposited medial to the inner longitudinal layer of the myosalpinx, resulting in complete occlusion of the lumen. There is only minimal involvement of the tubal muscle, so there are no palpable or visible nodules.

DIAGNOSIS OF TUBAL OCCLUSION

DIAGNOSIS OF TUBAL OCCLUSION

Diagnosis of tubal occlusion can be done by the following tubal patency tests.

- Gas insufflation
- Hysterosalphingography
- Sonosalphingography
- HyCoS, (Hystero contrast sonosalphingography)
- Laparoscopic chromotubation
- Tuboscopy
- Falloscopy
- Scintigraphy
- CT virtual hysterosalphingography
- MR hysterosalphingogram.

Gas Insufflation (Rubin's Test)

Carbon dioxide gas is "blown" into the cavity of the uterus. There will be an increase in pressure of the gas within the uterus if the tubes are blocked. If the tubes are open, the initial rise in pressure is followed by a sudden reduction as the gas escapes along the tubes and into the abdominal cavity. However Rubin's Test is difficult to interpret, inaccurate and unreliable.

Hysterosalphingogram

In Hysterosalphingogram, radiographic contrast (dye) is injected into the uterine cavity through the vagina and cervix. The uterine cavity fills with dye and if the

fallopian tubes are open the dye will then fill the tubes and spill out into the abdominal cavity. It gives information regarding uterine abnormalities and the exact site of block.

A hysterosalpingogram is done to find a blocked fallopian tube. Occasionally the dye used during a hysterosalpingogram will push through and open a blocked tube. It also helps to find problems in the uterus like polyps, fibroids, adhesions and hydrosalphinx. It also helps to decide whether surgery to reverse a tubal ligation has been successful.

Sonosalphingography

In Sonosalphingography, saline is injected through the cervix. There is egress of saline from the fimbriated ends of the fallopian tubes (if they are patent) into the peritoneal cavity. Color Doppler can be used to lateralise the tubes. Sonosalphingography helps to find abnormalities regarding uterine cavity abnormalities like polyps, fibroids, adhesions, and the problems in the ovaries.

Laparoscopic Chromotubation

In laparoscopic chromotubation, Laparoscopy is done and the dye is injected intrauterine. Free spillage of dye looked for. Uterine and ovarian abnormalities, endometriosis, tubal and peritubal pathology can be seen in laparoscopic chromotubation.

Falloscopy

It is the inspection of the fallopian tubes through an endoscope that can be either inserted into the tube through its opening in the uterus, the tubal ostium. A camera

at the end of the falloscope transfers images of the inside of the tube to a monitor so the surgeon can thoroughly visualize and examine the inside of the tube. If problems are found, surgical repairs can be made at the same time.

Scintigraphy

This radioisotope method examines the patency of fallopian tubes using a solution of ^{133}Xe. T.Pertynski et al describes this dynamic study and used gamma camera for examining the patency of tubes. This method results in lower level of radiation to the patient than hysterosalphingography. [4]

CT virtual hysterosalphingography

This study illustrates various pathology in cervix, uterus and ovaries with 64 – slice multidetector CT. The patient radiation done was 2.58mSv. [5]

MR Hysterosalphingogram

This technique uses heavily T2 weighted sequences to visualize the tube. The fallopian tube is below the resolution of conventional 1.5T MR. Further the dynamics of the tube cannot be studied. It is expensive but provides for comprehensive study of the female pelvis. [6]

MANAGEMENT OF TUBAL OCCLUSION

MANAGEMENT OF TUBAL OCCLUSION TREATMENT OPTIONS

The treatment options available in the management of tubal occlusion are

1) Tubal surgery
2) Fallopian tube cannulation
3) Endotuboplasty techniques
4) Assisted reproduction technique

TUBAL SURGERY

Reconstructive surgery for tubal occlusion is more than hundred years old. TJ. Walkins reported the first successful case of utero-tubal implantation in 1986. It was observed that stenosis occurred at the implantation site in approximately 80% patients, mostly due to fibrosis and scarring from surgical trauma. In 1977, there was a transition from macrosurgical implantation to microsurgical anastamosis. The advantages of the latter include less disruption of cornual blood supply, no weakening of uterine musculature and lesser incidence of stenosis. Pregnancy rate following tubal surgery ranges from 15 – 30%. But this is an expensive and invasive procedure needing long convalescence period.

FALLOPIAN TUBE CANNULATION

This procedure can be done under radiological imaging guidance or under

hysteroscopic or laparoscopic guidance. The procedure essentially consists of securing a catheter at the uterine tubal ostia and overcoming the block by advancing a guide wire along the catheter into the tube. Tubal patency can be confirmed by HSG or sonosalphingography or laparoscopic chromotubation. This is a simple, safe and least invasive technique which can be done as an outpatient procedure. Pregnancy rate following the procedure ranges from 10 – 30%.

ENDOTUBOPLASTY TECHNIQUE

Falloscopy is the endoscopic visualization of proximal tubal lumen.

The co – axial technique described by Kerin required hysteroscopically directed tubal cannulation with a flexible guide wire followed by serial passage of Teflon canula over guide wire. The guide wire was then removed and the falloscope passed along Teflon canula. The balloon catheter of the falloscope is used for dilating tubal strictures.

The second, more recent type of falloscope is the linear eversion catheter (LEC) system which utilizes a pressurized tubular polyethylene balloon which can be unrolled from within a plastic polymer canula after having the falloscope preloaded into its lumen. The balloon carries the endoscope into and along the tube, protecting the tube and endoscope from damaging one another and negotiating the lumen and stricture.

The tubal endoscopic procedures provide a better assessment of the structure of the tubal mucosa. The equipment is very expensive. They are less invasive and have patency rates in the range of 80%, but appear to be limited to nonfibrotic tubal

obstruction. Complication of perforation is possible in cases of applied force to bypass complete pathological obstruction. [7]

ASSISTED REPRODUCTION TECHNIQUE

Advancement in infertility management has brought about an expanding array of assisted reproduction techniques. These are very expensive and have limited success rates. They offer single chance of conception per attempt. Pregnancy rate following ART is in the range of 15 – 25%. These techniques should be extended to approximately selected couples considering the expense and limited success rate.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

In 1984, Richman et al did a prospective study in 35 patients using transabdominal ultrasound for assessing tubal patency following fluid injection. The results were compared with conventional hysterosalphingogram. The presence of fluid in cul de sac was inferred as patency of atleast one tube. It demonstrated bilateral occlusion with a sensitivity of 100% and showed tubal patency with a specificity of 96%. The author designated the procedure as sonosalphingography. [(2)]

Hyskon (dextran in dextrose) can be used as ultrasound contrast material. It is highly viscous sterile fluid developed for the use during hysteroscopy. Saline may be used instead of Hyskon as it freely flows through the tube and comfortable for the patient.

Several contrast media have been used for HSG. The procedure was first performed in 1910 by Rindfleisch, who injected bismuth solution in uterine cavity. Lipiodol, oil soluble medium was first used in 1925 by Heuser for HSG. It became a standard media but side effects such as pulmonary oil embolism after intravasation and granuloma formation appeared. This led to the use of low viscosity oil soluble media. Apparently harmless water soluble media were developed and they were used for HSG. The cited advantages include good radiographic quality, absence of serious side effects and avoidance of the need to acquire a delayed radiograph. [(8)]

Lindequist et al and Rasmussen et al compared the pregnancy rates after HSG

when four different contrast media were used. They found that three times as many patients became pregnant after HSG with oil based contrast media than with water based contrast media. [9]

Contrast intravasation can occur via venous of lymphatic routes. Predisposing factors include increased intrauterine pressure on recent uterine surgery. It can also be seen in normal examination. [10] It is seen radiographically as thin lines forming a reticular pattern.

During routine supine hysterosalphingography, the normal asymmetry in pelvis allows contrast material to fill the more dependent fallopian tube, leaving the more elevated tube non visualized. Acute angulation of the more anterior tube may also be responsible. The simple addition of prone positioning during HSG has a valuable role and should be considered. [11, 12] There is also the potential for a systemic reaction to the contrast material if vascular intravasation occurs. In general, however, lymphatic or vascular intravasation is clinically insignificant and not dangerous. [13]

Absorbed ovarian radiation doses of 0.04 – 0.055 c Gy were estimated in various studies during HSG. An average skin dose of 1.33c Gy has also been reported with HSG. [14, 15, 16]

Magnetic resonance hysterography has been reported in the literature as a new technique for evaluating uterine abnormalities. Magnetic resonance imaging gives excellent soft tissue contrast in the uterus. Rouanet De Larit et al instilled saline into the endometrial canal as performed for Saline infusion sonography. T2 weighted sequences

would show injected saline in pelvic cavity if tubes are patent. The uterus was then imaged using a fluid attenuated inversion recovery sequence to null the signal from water to define any uterine pathology. [6]

In 1992, Tufekci EC et al did a comparative study of transvaginal sonosalphingography with chromolaparoscopy in subjects with unknown tubal function. They had a concordance rate for completely consistent of 76.3% and partial consistent for 8 cases. [17]

In 1992, allahbadia et al popularized sion test (saline infusion sonography) as a screening technique. A series of 50 infertile patients had a diagnostic laparoscopy and hysterosalpingography after sion test was done. They had compared the accuracy of the 3 methods of evaluating tubal patency and have found sion test an excellent screening technique for investigations in infertility. [18] When he pushed a mixture of water and saline through the Foleys catheter, there was gush of air and fluid past the ovary, which he termed as “waterfall sign”. [18]

In 1993, Fleischer et al successfully assessed tubal patency in 79% of women with saline solution and in 92% of those who received contrast agent. He correlated with endoscopy. This study demonstrated the efficacy of combined use of sonohysterography and sonosalphingography in infertility patients with uterine and tubal factor disorders. [19]

In 1998, Inki P et al compared the results of sonosalphingography using air and saline as contrast medium with that of laparoscopy and chromotubation. They had a

concordance of 88.7%, sensitivity of 90.2% and specificity of 83.3%. They used regular pediatric Foley urinary catheter instead of expensive HSG catheter. [20]

In 2006, Onah HE et al described findings in 100 infertile Nigerian women who underwent sonosalphingogram in a prospective study. In 18 women the findings were confirmed with laparoscopy or laparotomy. [21]

MATERIALS AND METHODS

MATERIALS AND METHODS

This study included 35 patients who presented with infertility in gynecology out-patient department. The study was conducted in Barnard institute of radiology.

INCLUSION CRITERIA

Age 18-40yrs

Normal semen analysis

Unprotected intercourse for more than one year

Normal menstrual cycles

EXCLUSION CRITERIA

Less than a year of unprotected intercourse

Medical or hormonal dysfunction

Azoospermia

Active PID

Detailed history is taken regarding type and duration of infertility, menstrual cycle, contraceptive use, tuberculosis, endometriosis, tubal surgery and uterine intervention. Following this, cases were assessed clinically.

After a brief clinical evaluation of patients every patient was subjected to a baseline transabdominal sonogram for evaluation of the pelvis following which a transvaginal and saline infusion sonography were performed. Transvaginal transducer of

7.5MHZ frequency Aloka make was used and Goldstein catheter was used for the infusion of saline. This catheter has a balloon tip which prevents backflow of fluid thus causing good uterine distension and better endometrial visualization. Apart from that the materials used were a speculum, a valsellum, a uterine sound, sterile sponge for cleansing purpose. In a few cases other catheters like infant feeding tubes or the intrauterine insemination tubes, 8 Fr Foleys catheter and Cooks balloon hysterosalphingography catheter were used.

TRANSVAGINAL SONOGRAPHY

Real time transvaginal sonography (TVS) is able to use higher frequencies and take advantage of their improved spatial resolution. Because of its orientation, it eliminates the need to image through the abdominal wall and places the transducer significantly closer to the structures of interest. Consequently, most transvaginal probes employ transducer frequencies in the 5 to 7.5 MHz range.

For gynecologic investigations, the TVS approach, with its superior resolution and close proximity to the structures of interest, provides a better look in a wide range of situations.

PATIENT PREPARATION

There is no specific preparation for TVS except an empty urinary bladder. An adequate explanation of the procedure is essential. The patient is placed in a supine position with knees bent and feet flat on the table, approximately shoulder width apart, if possible, a slightly reversed Trendelenburg position is desirable, as this should permit

intraperitoneal free fluid to gravitate to the posterior cul –de – sac.

PROBE PREPARATION

Prevention of cross contamination between patients must be tantamount when an intracavitary device is being used. To achieve this, the probe should be soaked in disinfectant between uses and a disposable cover, usually a latex condom, should be placed over the probe for the examination.

Once the probe has been disinfected and wiped clean, a small amount of transducer coupling gel should be placed inside the tip of the condom and the condom pulled over the shaft of the probe. The coupling gel should eliminate any air from the beam path. The final step in probe preparation consists of coating the covered tip of the probe with a sterile lubricant to facilitate probe insertion.

SCAN TECHNIQUE

Once the patient and the transducer have been prepared, the scanner's image should be unfrozen and an 8 to 10 cm depth of field selected to ensure that the transducer's position can be monitored during insertion. The probe may then be inserted and oriented. The control of the transducer's orientation is achieved by manipulating the transducer with a combination of three basic maneuvers: Rotation, angulation and insertion depth. The probe can be rotated from 0 degrees to 90 degrees about its long axis to obtain any plane of section from sagittal to coronal. The probe can be angled or pointed in any direction to direct the plane of section. The probe can be inserted or

withdrawn to position the structure of interest within the focal zone of the transducer.

During insertion the transducer's orientation is easily assessed by noting the position of the bladder, which usually contains a small residual volume of urine. The pelvic organs are visualized in the sagittal plane. Rotating the probe 90 degrees into the coronal plane permits visualization of both the uterus and the adnexa. This is followed by sweeping the beam from the cervix to the fundus of the uterus. Such a survey will ascertain quickly the relative positions of the uterus and ovaries as well as identify any obvious masses. After the pelvic survey the standard views taken are,

Sagittal plane:

Cervix, endocervical canal and posterior cul – de – sac

Uterus and endometrium

Right ovary and adnexa and

Left ovary and adnexa

Coronal plane:

Vagina

Cervix and posterior cul – de – sac

Uterine corpus and endometrium

Uterine fundus and endometrium

Right ovary and adnexa and

Left ovary and adnexa.

When the uterus is anteverted, a helpful technique for locating the ovary is to first

obtain a coronal image of the uterine fundus and then to angle the transducer laterally out to the cornua and broad ligament. Once this region is identified, the ovary usually can be found by slowly sweeping the beam anterior and posterior. If the ovary is positioned high in the pelvis, it is helpful to press down on the anterior abdominal wall, sweeping the free hand down toward the symphysis. If the probe needs to be angled extremely anteriorly to view an ovary or an anteverted uterus, it may help to raise the patient's hips. This allows the handle of the probe to be positioned more posteriorly, improving the anterior angulation of the probe hip. Using the probe tip to assess pelvic structures for tenderness is as added advantage of TVS.

LIMITATIONS

There are few limitations to the use of TVS. Care should be taken to remember that TVS provides a more limited field of view than TAS. For this reason, survey transabdominal scan is usually performed prior to the TVS to rule out the possibility of overlooking a mass such as an ovarian cyst or pedunculated fibroid lying outside the field of view of the TVS transducer.

UTERUS

The uterus is located in the true pelvis between the urinary bladder anteriorly and rectosigmoid posteriorly. The peritoneal space anterior to the uterus is the vesicouterine pouch. Posteriorly, the peritoneal reflection forms the posterior cul – de – sac. The uterus and ovaries are the primary structures to be examined with TVS. The normal uterus usually can be imaged in its entirety from cervix to fundus regardless of uterine

version or flexion. A distinct advantage of TVS over TAS is the ability to assess the retroverted or retroflexed uterus and to delineate the endometrium.

The closest part of the uterus to the vaginal probe is the cervix. Consequently, it is usually the first structure to be recognized and is a good starting point for the TVS examination. The cervix is readily identified as the probe is slowly inserted into the vagina.

The closed cervix appears as a relatively homogenous and moderately echoic, smooth – walled structure. The closed endocervical canal is seen as a central echo stripe that appears to originate from an interface consisting of cervical mucosa and mucus. This endocervical echo is usually more echogenic than the cervical wall. During the periovulatory period, the endocervical canal may appear to be less echogenic than the cervical wall, which is probably related to a greater fluid content in the cervical mucus. Air bubbles in the cervix may or may not have associated reverberation, ringdown, or shadowing behind them.

Immediately lateral to the junction of the cervix and the lower uterine segment are the uterine vessels. These vessels are readily visualized with TVS as a tortuous conglomerate of tubes. Flow echoes are often observed in these paracervical veins.

The size of the uterus is variable.

Age group	Length cm	Width cm	AP diameter cm
Nullipara	6 – 8.5	3 – 5	2 – 4
Multipara	8 – 10	4 – 6	3 – 5

Post menopause	3.5 – 7.5	2 – 4	1.7 – 3.3
Prepubertal	2 – 4.4		

ENDOMETRIUM

The endometrium is the inner lining of the uterus. It consists of a superficial functional layer (zona functionalis) and a deep basal layer (zona basalis). The functional layer is further divided into two zones, the zona compacta and the zona spongiosa. The functional zone is made up of glands and stroma. The basal layer of the endometrium is very thin and contains the blind ends of the endometrial glands from which new functional endometrium can regenerate after menstruation. The basal endometrium is located between the relatively hypoechoic zone of inner myometrium and the spongiosa layer of the endometrium but is not sonographically distinct. It does not change appreciably in thickness during the menstrual cycle.

Both endometrial thickness and echogenicity change during the menstrual cycle. During menstruation, the endometrium is thin, patchy, and difficult to appreciate. In the early proliferative phase (days 5 – 9), the endometrium remains relatively thin and displays an echogenicity similar to that of the myometrium. In the late proliferative phase (days 10 – 14), as the endometrium thickens, the superficial portion of the endometrium is sonographically hypoechoic, whereas the deeper portion of the endometrium appears as a uniformly echogenic band, giving the endometrium a stratified appearance. During the mid cycle of periovulatory period a characteristic trilaminar appearance occurs.

Finally, in the secretory phase (days 14 – 27), as the endometrium continues to thicken, the superficial endometrium begins to become more echogenic. Thus, by the end of the secretory phase, the entire endometrium is hyperechoic, often making it difficult to identify the central endometrial canal echo.

Endometrial thickness should be measured on a sagittal image of the uterus. A measurement of total endometrial thickness should include both anterior and posterior layers of the endometrium. Caliper placement should be perpendicular to the endometrial cavity echo. Endometrial thickness measurements should not include the hypoechoic halo surrounding the endometrium, as this represents the inner zone of myometrium.

Occasionally, an intracavitary mass or fluid collection (blood clot, pyometra, polyp, carcinoma, or leiomyoma) may be sonographically isoechoic to the endometrium. When this occurs, the endometrium may be indistinguishable from the central cavity mass, giving the false impression endometrial thickening. With true endometrial thickening, it should be possible to identify the central endometrial canal stripe. Thus, if this endometrial stripe cannot be found, an endometrial cavity mass should be suspected. Endometrial atrophy in the postmenopausal period results in a thin hypoechoic endometrium. Abnormal or suspicious endometrial patterns occur in a thick and hyperechoic pattern. Endometrial hyperplasia in post menopausal women appears as a thickened, hyperechoic endometrium with an intact subendometrial halo. Microinvasive endometrial carcinoma may have similar ultrasonic features. Once invasion is

established the subendometrial halo, consisting of compact myometrium is lost. This is the first ultrasonic feature of invasion. Sonohysterography helps in finding out the exact thickness of the endometrium in patients with post menopausal bleeding and distinguish endometrial atrophy, which appears as a thin endometrial line, from other conditions that result in a thickened endometrium.

The endometrial thickenss and appearances during the various phases of the menstrual cycle are as shown in the following table.

PHASE	THICKNESS mm	APPEARANCES mm
Menstrual phase	1 – 4	Thin, patchy
Proliferative phase	4 – 6	Iso or Hypoechoic
Periovulatory phase	6 – 10	Trilaminar
Secretory phase	8 – 16	Hyperechoic
Postmenopausal	< 5	

MYOMETRIUM

The corpus of the normal uterus has three layers of myometrium. These are referred to as outer or external, the middle or intermediate, and the inner or internal layers. The outer layer is very thin and consists mainly of longitudinal fibres that extend from the cervix and converge at the cornua. The outer layer is separated from the intermediate layer by the arcuate venous and arterial plexes. With TVS the arcuate veins are easily seen within the myometrium. The uterine arteries and veins run in the parametrium just lateral to the uterus. Their branches penetrate the outer myometrium to connect with the arterial and venous plexes.

The intermediate layer of the myometrium is the thickest layer. It consists of two spiral bands of muscle that arise from each uterine cornu and insert into the cervix. The two muscle groups interdigitate in the midsagittal plane of the uterus. Of the three myometrial layers, the intermediate layer is the most echogenic. It is considerably more echogenic than the inner layer and is usually slightly more echogenic than the outer layer.

The inner layer consists of longitudinal and circular fibres. The layer, between the relatively echogenic endometrium and intermediate myometrial layer, is sonographically poor reflective, appearing as a distinct hypoechoic band and has been referred to as the myometrial halo.

According to Mitchell et al, the increase in total uterine volume that occurs during the menstrual cycle is related mainly to an increase in endometrial volume and in the volume of the intermediate zone of the myometrium. There does not appear to be any significant change in the size of either the outer of inner myometrium.

In 1986, Fleischer et al reported the halo to be the inner myometrium and attributed its poor echogenicity to the relatively sparse vascular and compact nature of the inner myometrium.

MYOMETRIAL CONTRACTIONS

In 1990, de Vries et al reported endometrial motion occurring secondary to

rhythmic contraction waves of the inner layer of the myometrium. The contraction waves were most apparent on real – time images recorded on video tape and viewed at five times the regular speed.

Contraction waves that began at the cervix and extended to the fundus were called retrograde and those that moved from fundus toward the cervix were labeled antegrade. Contractions were present and were retrograde in all phases of the menstrual cycle, except during menstruation, when they were antegrade. The highest frequency of the contractions was noted in the preovulatory phase.

OVARIES

The ovary can be identified on TVS by virtue of its usual adnexal position anterior to the ureter and the anterior branch of the internal iliac artery, its elliptic shape and its multiple small cysts representing ovarian follicles at various stages development. Follicles as small as 1 to 2 mm may be discretely visualized with TVS. In the normally functioning ovary, a dominant follicle emerges to attain a diameter of 2 to 2.5 cm prior to ovulation. This discrete, thin – walled, anechoic dominant follicle disappears at ovulation, transformed into the corpus luteum. The corpus luteum typically appears as an irregular, crenated and ill – defined cystic structure often containing low level internal echoes. In the latter half of the secretory phase of the cycle, the corpus luteum gradually involutes and atrophies to become the corpus albicans, which is not perceptible with TVS.

There is considerable variability in the size of the normal ovary. Approximate

ovarian volume measurements can be obtained by making measurements in two planes and applying the formula for a prolate ellipse (length x width x thickness x 0.523). The mean normal ovarian volume in women of menstruating age is approximately 10 cm. locating the internal iliac vein and artery can be helpful in this regard, as the ovary often can be found lying anterior to the bifurcation of the internal iliac artery into its anterior and posterior branches.

FALLOPIAN TUBES

The normal fallopian tube is not often clearly identified with TVS. In the absence of intraluminal or surrounding fluid, the small diameter of the normal tube and its lack of strong interfaces make it difficult to identify. Nonetheless, the uterine fundus and cornua can be easily found, and thus the region of the proximal tube and surrounding ligaments usually can be identified.

POSTERIOR CUL – DE – SAC

The posterior cul – de – sac is the most dependent region of the peritoneal cavity, and throughout the cycle it often contains a visible amount of anechoic free fluid. This is a normal finding. The volume of the free fluid in the posterior cul – de – sac may increase somewhat after the rupture of the dominant follicle at ovulation. However, the volume of fluid in the posterior cul – de – sac is not a reliable indicator of ovulation. Large volumes of free fluid in the posterior cul – de – sac, especially if echogenic,

indicate a pathologic condition.

SONOHYSTEROSALPHINGOGRAPHY

PROCEDURE

The procedure is usually performed during the mid follicular phase on the 8th day, it was done. In women with irregular bleeding the procedure is done soon after the cessation of the bleeding. The patient is atropinised. A preliminary transvaginal sonogram is done to determine the type and amount of uterine version. With the patient in lithotomy position, a speculum was introduced into the vagina and the cervix cleansed with an antiseptic solution. Sterile saline is infused through the catheter to get rid it of small amounts of air which can cause a very echogenic artifactual appearance. Analgesia or anesthesia is not required.

The anterior lip of cervix is held with a valsellum and after passing a uterine

sound through the cervix, the catheter is inserted into the uterine cavity. Once the catheter is in place, the balloon is inflated; the speculum is carefully removed so as not to dislodge the catheter. The vaginal probe is then re – inserted. The position of the catheter is then reassessed. The catheter is then pulled back gently to the level of the internal os under real time ultrasound monitoring. Sterile saline (about 5 to 20 ml) is infused through the catheter under real time ultrasound observation. Even a small amount of fluid allows adequate evaluation of the anterior and posterior walls of the uterus in long axis. Saline is injected at a slow rate to prevent patient discomfort (5 – 10 ml / min as a function of uterine size and amount of backflow). Gaucherand et al (1995) described a total volume of 5 – 30 ml of normal saline to provide high quality imaging without provoking pain. [22] When the uterus has been completely surveyed from cornua to cornua in long axis projection, the transducer is rotated to 90° into coronal plane and additional fluid is instilled while fanning down towards the endocervical canal and up towards the uterine fundus. In this way we recreate three dimensional images of anatomy. Great care is taken not to overlook any portion of the uterine cavity. [23] Excellent discrimination between intracavitary, intraluminal and diffuse process can be obtained. [24] Photographs of images are taken, appropriate measurements performed. Antispasmodic Inj. Buscopan 1 ml is given intramuscularly. After studying the endometrium and myometrium, the probe is angulated in such a way that uterine cornua and that side ovary is noted in a single plane 10 ml of fluid pushed rapidly .Color flow is noted from uterine cornua to that side ovary. However patient movement or transducer

movement can result in artefactual color flow. The presence of periovarian fluid is noted which infers tubal patency. The same procedure is repeated for the opposite side. If no periovarian fluid is noted, the procedure is repeated with another 10 ml of fluid. In case of bilateral tubal block, instillation of saline results in distension of uterine cavity and pain. Fluid will also be noted in pouch of Douglas. If there is an already small amount of fluid before saline instillation, there will be increase in fluid afterwards if the tubes are patent. In case of prolapsed ovaries into pouch of Douglas, it would not be possible to identify whether one of tube is patent or occluded as fluid from one side ovary would easily surround the other.

NORMAL FINDINGS

The cavity should distend symmetrically.

Homogenous single layer thickness of endometrial lining.

Periovarian fluid.

Fluid in cul – de – sac.

ABNORMAL FINDINGS

No periovarian fluid

Thickened endometrium (focally or diffuse)

Atrophic endometrium

Polyps

Myomas

Uterine synechia

The transducer and the catheter are removed. The patient is put under observation for one hour. Mild spotting and pain are common. These patients are put on antispasmodic and 5 days of antibiotics - doxycycline and metronidazole.

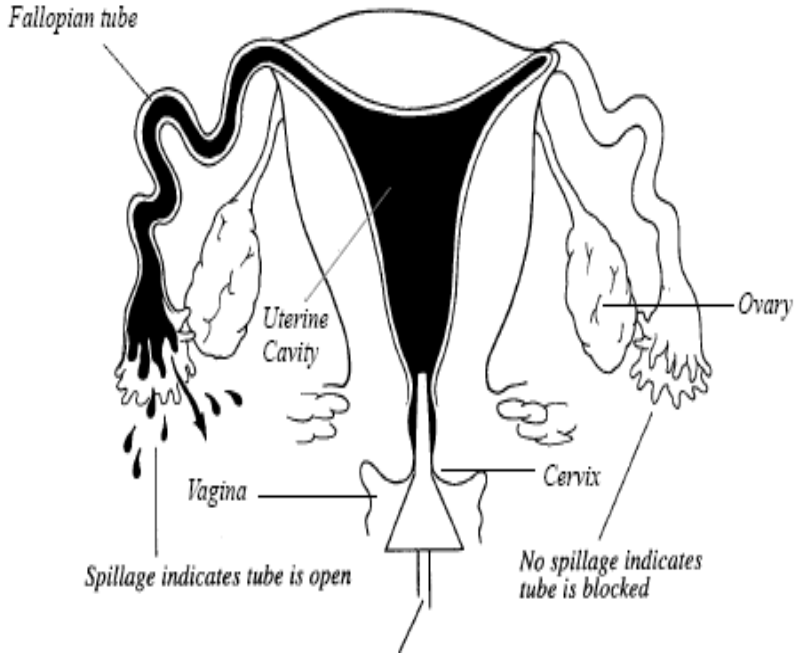
HYSTEROSALPHINGOGRAM

This is done on tenth day post- menstrually.

Informed consent is obtained from the patient. After the patient had emptied her bladder, pelvic examination is done. Injection Atropine and injection Avil is given parenterally. The patient is brought to edge of the table. The local area is cleansed with povidone. Then speculum is inserted. Cervix is visualized. Valsellum is applied at 12'o clock position. Cervix is cleansed with povidone. LEECH-WILKINSON canula is inserted after pushing air out with contrast. With fluoroscopic control, 10 ml of contrast is pushed. Contour of uterine cavity and spill from either end of tubes are noted. Spot films are taken: one film to visualize the spill and another taken 5 minutes later to visualize the free dispersion of contrast in the pelvic peritoneal cavity. The site of block is ascertained

TECHNIQUES
SONOSALPHINGOGRAM

HYSTEROSALPHINGOGRAM



RESULTS AND OBSERVATIONS

RESULTS AND OBSERVATIONS

Analysis based on type of infertility

Type of infertility	No. of cases	%
Primary	30	86
Secondary	5	14

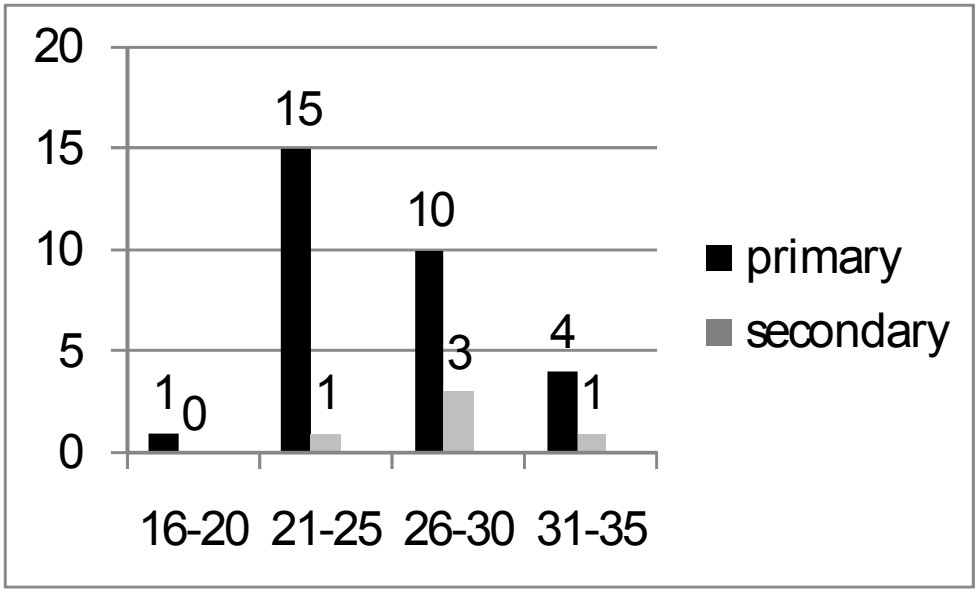
Analysis based on age group

Primary infertility

e	No. of cases	%
16 – 20	1	3.3
21 – 25	15	50
26 – 30	10	33.3
31 – 35	4	13.3

Secondary infertility

Age	No. of cases	%
16 – 20	Nil	Nil
21 – 25	1	20
26 – 30	3	60
31 – 35	1	20



Mean age

Type of infertility	Mean age years
Primary	25.5
Secondary	28

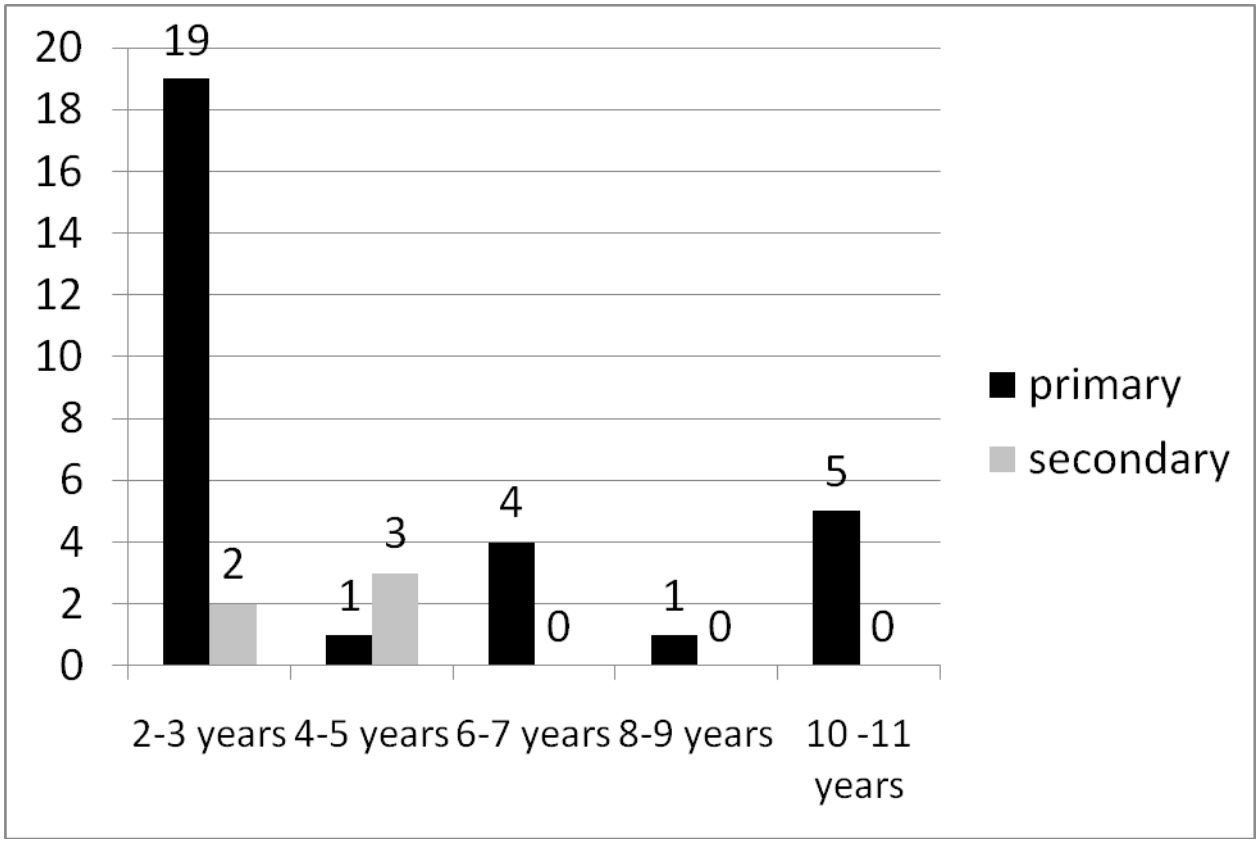
Duration of infertility

Primary infertility

Duration in years	Primary infertility
2 – 3	19
4 – 5	1
6 – 7	4
8 – 9	1
10 – 11	5

Secondary infertility

Duration in years	secondary infertility
2 – 3	2
4 – 5	3
6 – 7	Nil
8 – 9	Nil
10 – 11	Nil



Mean duration of infertility

Type of infertility	Duration in years
Primary	4.4
Secondary	3.6

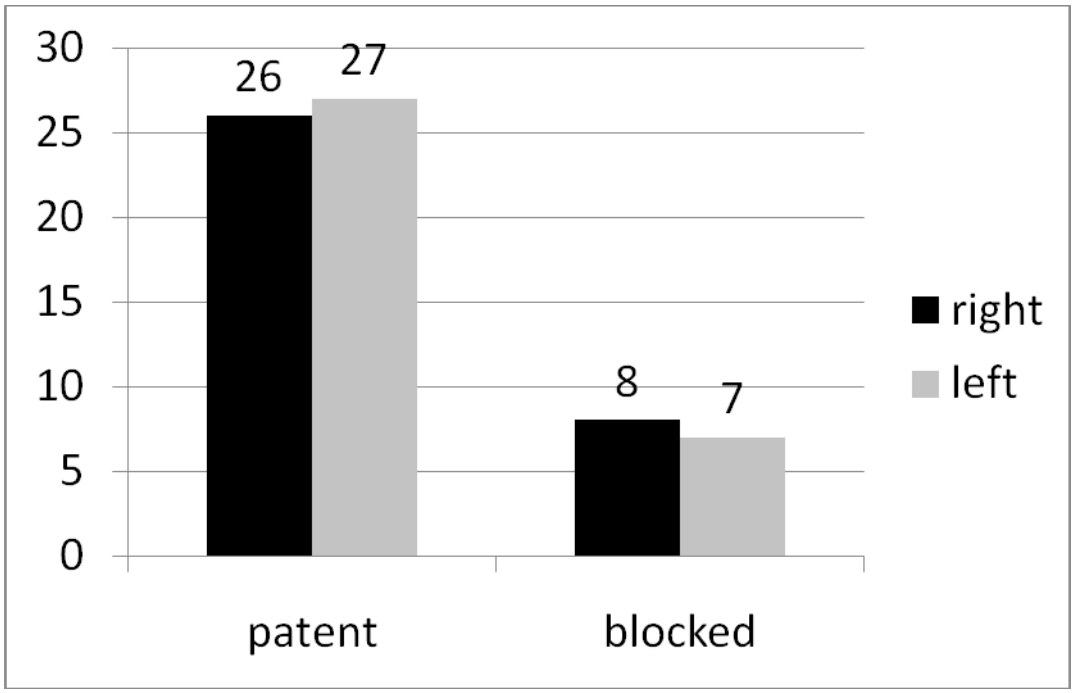
Previous uterine / tubal intervention

Primary	1
Secondary	2

One case of primary infertility had undergone myomectomy for cervical fibroid. In secondary infertility, one patient had previously underwent puerperal sterilization and another patient had underwent right partial salphingectomy and left salphingostomy for tubal pregnancy.

Tubal patency – diagnosis by sonosalphingography

Results	**No. of tubes**	
	Right	**Left**
Periovarian fluid	26	27
No periovarian fluid	8	7



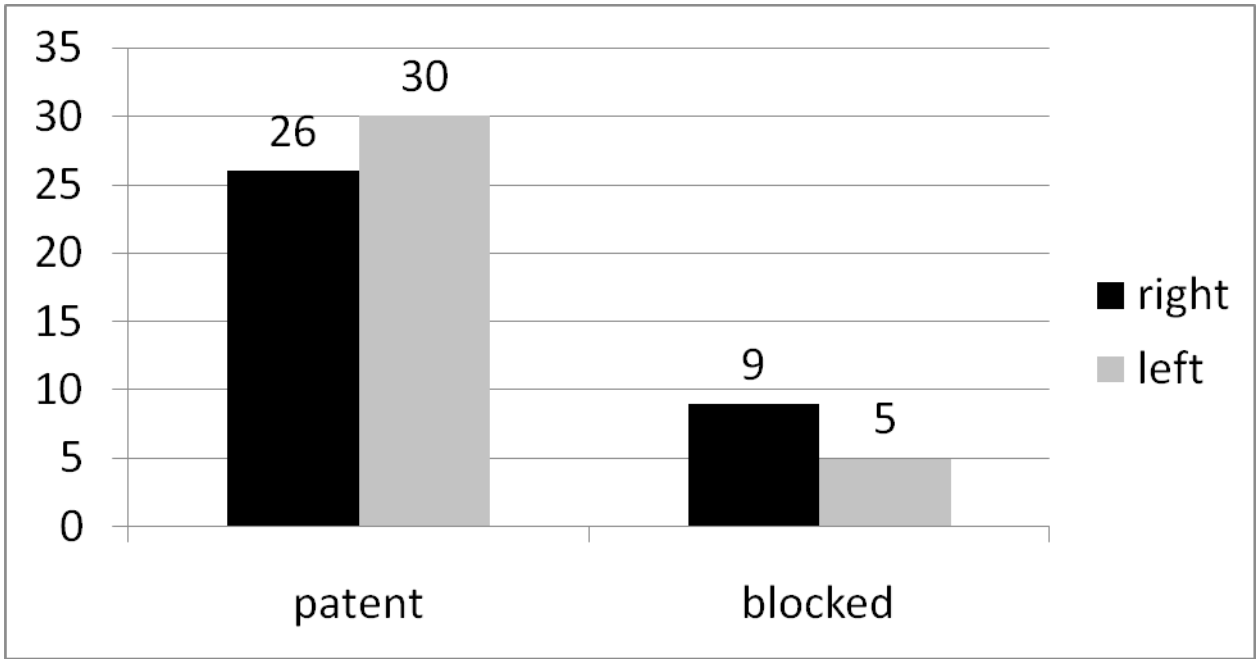
In one case, both the ovaries were prolapsed into the pouch of Douglas and it was difficult to identify the sides which were patent. Subsequently both the tubes were

shown to be patent in hysterosalphingogram. Hence this case was not taken into consideration for the above mentioned table.

Tubal patency – diagnosis by hysterosalphingography

Results	**No. of tubes**	
	Right	**Left**
Peritoneal spill	26	30
No peritoneal spill	9	5

In 56 tubes, peritoneal spill was seen which is suggestive of tubal patency. In 14 tubes, no spill was seen which is suggestive of blocked tubes. 5 patients had unilateral block and 6 patients had bilateral block. Of those patients with unilaterally blocked tubes, 3 were found to be in the right side and 2 were found to be in the left side. The advantage of hysterosalphingogram is identifying the site and side of block.



Comparison of HSG & SSG

Procedure	Patent	Blocked
SSG	52	16
HSG	54	14

Statistical table

HSG SSG	Patent tubes	Blocked tubes	Total
Patent tubes	49 TP	3 FP	52

Blocked tubes	1 FN	15 TN	16
Total	50	18	68

TP – true positive TN – true negative

FP – false positive FN – false negative

Sensitivity of patent tubes by sonosalphingogram is found to be 98.1% while specificity is 83.3%.

Accuracy is 94.1% while positive predictive value is 94.2% and negative predictive value is 93.7%

Associated pathology

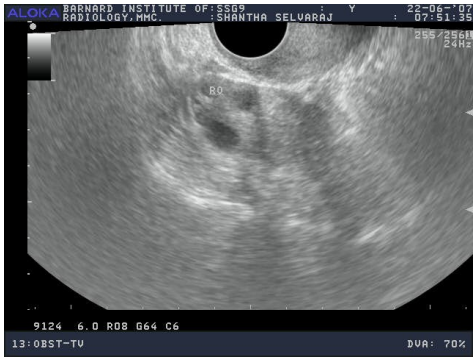
Pathology	SSG	HSG
Hydrosalphinx	Nil	3
Ovarian cyst	3	Nil
Uterine fibroid	2	Nil
Sub mucosal polyp	2	Nil

The associated pathology was more easily demonstrable with SSG according to my study.

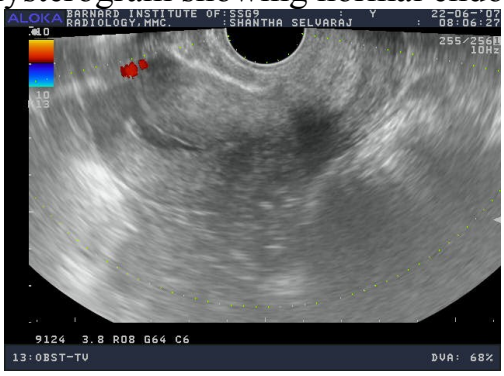
IMAGES

Patent tubes

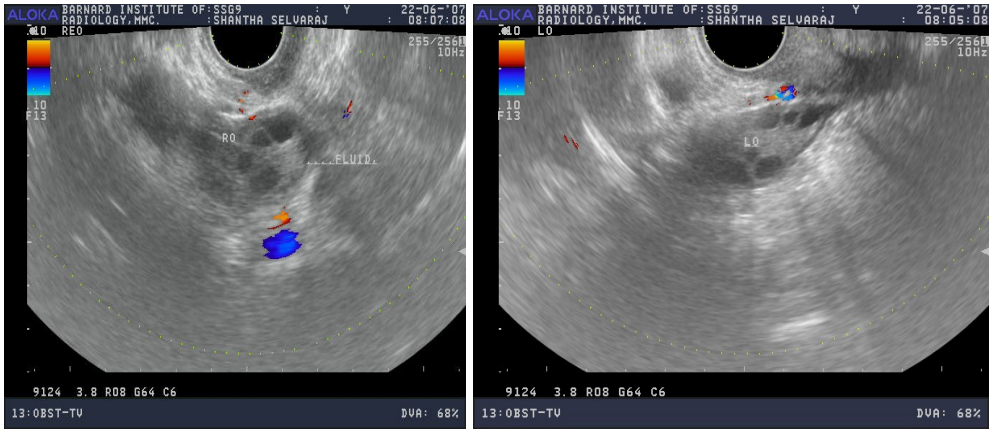
TVS showing rt ovary



Sonohysterogram showing normal endometrial lining



SSG showing periovarian fluid suggesting tubal patency



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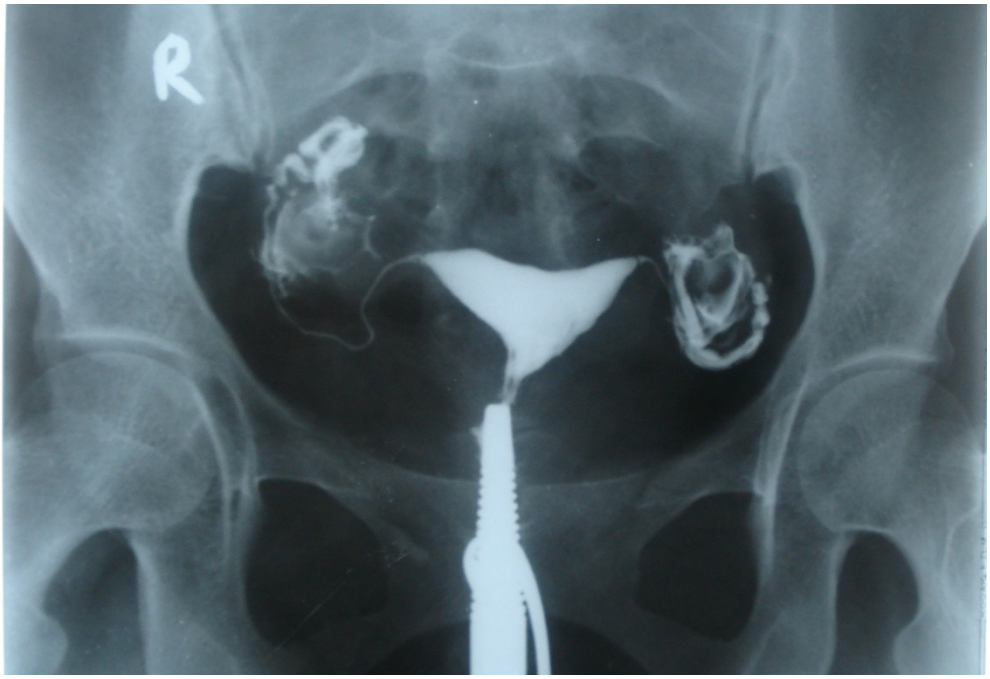
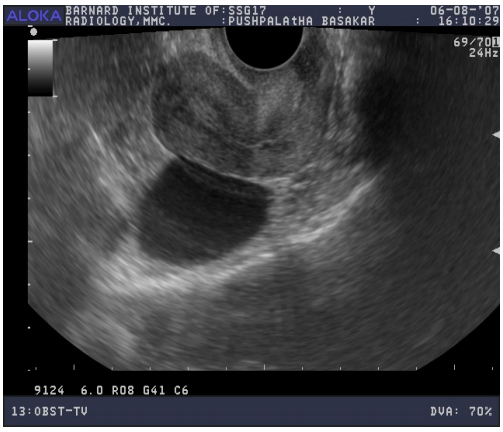
HSG showing spill of contrast into peritoneal cavity



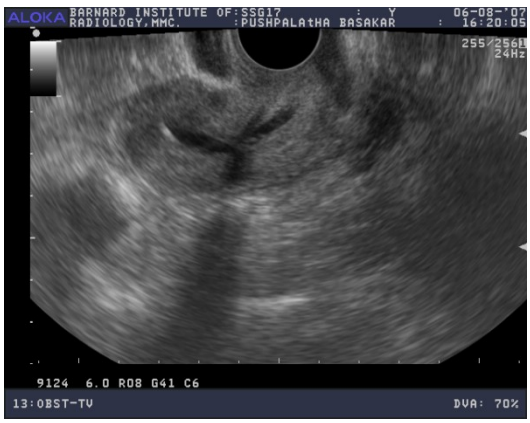
Bilateral block

TVS: RT. OVARIAN CYST



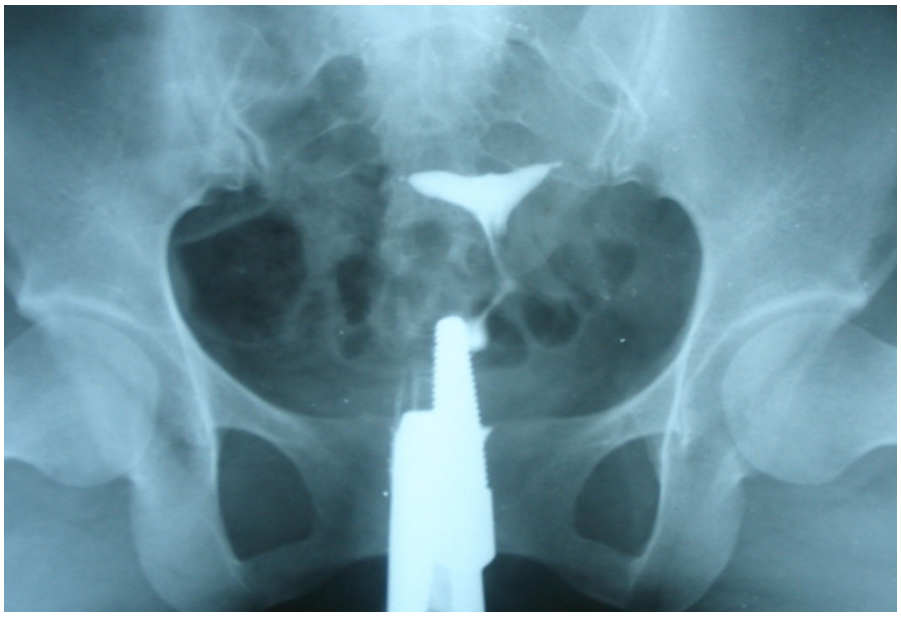
sonohysterogram: distended uterine cavity

[redacted]



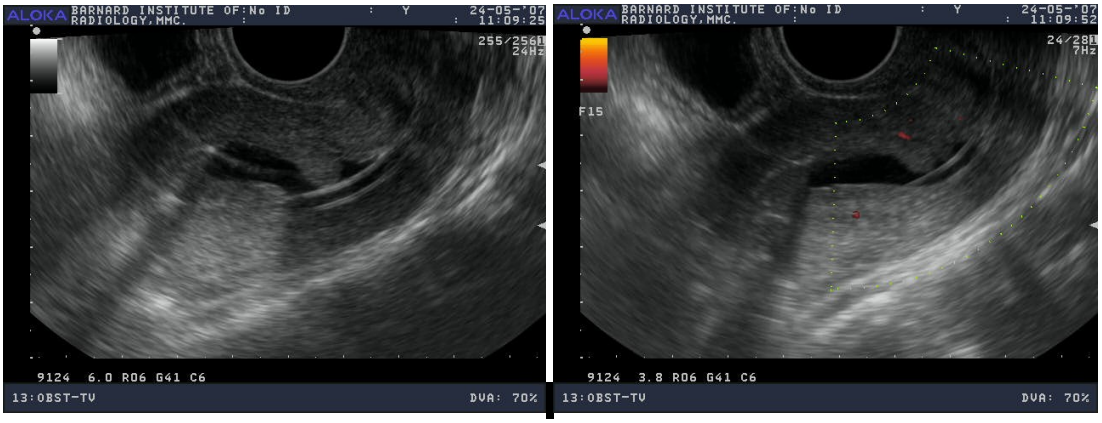
SSG: No periovarian fluid bilaterally suggestive of blocked tubes

HSG: Bilateral cornual block

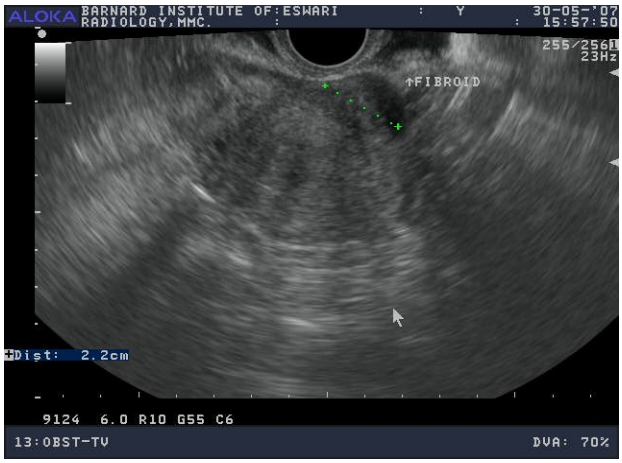


Associated pathology

SSG: submucosal fibroid with a feeding vessel



SSG: mural fibroid



DISCUSSION

DISCUSSION

This study undertaken in Barnard institute of Radiology included 50 cases of infertility.

On analysis, 30/35 cases were found to be primary infertility and 5/35 cases were of secondary infertility. Mean age of primary and secondary infertility was 25.5 and 28 years respectively. The mean duration of infertility was 4.4 and 3.6 years in primary and secondary infertility respectively.

By hysterosalphingography, peritoneal spill was seen in 56 tubes which are suggestive of patency. In 14 tubes, no peritoneal spill was seen which is suggestive of tubal block. Of these, 5 patients had unilateral block, and 6 had bilateral block. Of the patients with unilateral block, 3 showed block in right tube, 2 in left tube.

5 tubes showed proximal tubal block, 2 tubes showed mid tubal block and 7 showed distal tubal block. The advantage of hysterosalphingogram is its ability to identify the side and site of block. No congenital contour abnormality of the uterus was noted. One case of Asherman syndrome showed adhesions and the tubes were patent. No other ovarian, endometrial or myometrial pathology was made out.

By sonosalphingogram, 52 tubes were patent and 16 tubes were blocked. Of the 52 tubes, 49 were truly blocked and three were false positive. Of the 16 blocked tubes, 15 were truly blocked and one was false negative. The findings in 64 tubes correlated well with hysterosalphingogram. The findings in 4 tubes did not correlate. These four

cases were analysed. The 3 tubes which showed false positivity had distal tubal block and showed distension of the fallopian tube on instillation of contrast. This distension could have been misinterpreted as peri ovarian fluid. No reason could be attributed for the false negative case.

Three cases had ovarian cysts which were made out only with ultrasound. Two cases of intramural fibroid was noted which could not be made out with hysterosalphingogram. Two cases had pedunculated sub mucosal polyp which was made out in sonohysterogram only whereas it could not be made out with hysterosalphingogram or the transvaginal ultrasound. Three tubes had hydrosalphinx with distal tubal block which was made out by hysterosalphingogram.

Identification of free fluid in cul de sac indicates alteast one tube is patent. This is sufficient because the patients are either placed on fertility drugs or other causes of fertility can be evaluated.

Sonosalphingogram can also be used to assess tubal state after recanalisation or with a history of untoward reactions on exposure to iodinated contrast media.

Much ancillary information such as

(1) Regarding fibroid, endometrioma can be obtained.

(2) A correctly timed study will show follicle on ovary

(3) A distended uterine cavity following saline injection suggests bilateral tubal occlusion or spasm. Inj. Buscopan relieves spasm and free spill will be noted.

This technique offers several advantages over conventional Hysterosalphingogram

1) Visualization of uterine and extra uterine pathology
2) Avoidance of exposure to ionizing radiation
3) Therapeutic effect – saline washes out obstructing mucous plugs

Sonosalphingogram cannot be used to define tubal pathology. Hysterosalphingogram should be used for this purpose.

Comparison was made with previous studies conducted in evaluation of sonosalphingography and hysterosalphingography in the management of infertility.

Author	Year	sensitivity	specificity	Positive predictive value	Negative predictive value
SHAILESH Kore et al, journal of Obst. & Gyn, India [25]	2000	100	83	97	100
Oguntoyinbo et al, African Journal of Rep. health.[26]	2001	85.5	96.8	98.3	75
RADIC V et al, Eur. J .Radiol.[27]	2005	100	88	100	97
My study	2007-2008	98.1	83.3	94.2	93.7

My study correlated with the other studies.

SUMMARY/CONCLUSION

SUMMARY/CONCLUSION

Transvaginal sonography is a vital tool in assessing the reproductive organs of an infertile female patient.

Better resolution of pelvic structures

- The dimensions and the contour of uterus
- The endometrial lining and thickness
- The myometrium
- Adnexae- follicular development and ovulation
- Cul-de-sac fluid
- It gives physiologic information with Doppler.

Sonosalphingography is a simple office procedure,

- cost effective
- Less invasive
- No iodinated contrast
- No radiation
- No risk of perforation or hemorrhage
- Excellent visualization of endometrial cavity
- Can differentiate polyp & fibroid
- Simultaneous study of intramural and adnexal pathology

Disadvantages and pitfalls

- Site of block not well made out
- Anatomy of tubes not delineated
- False positive results with hydrosalphinx ,tubal flow may give false impression of tubal patency
- Intratubal pathology cannot be detected.
- Peritubal adhesions and motility of the tubes cannot be assessed properly.

Hysterosalphingogram remains the best method to evaluate fallopian tube patency. It provides the fine anatomic detail required for recanalization procedures.

Disadvantages

- Exposure to radiation
- Exposure to iodinated contrast with possible allergic reactions
- Cannot diagnose myometrial and adnexal disorders
- Cannot distinguish polyp and fibroid
- Complications - pain, intravasation of dye, granuloma formation.

To conclude, sonosalphingogram is an easy, Outpatient procedure, less time, cost effective and a Noninvasive procedure without anesthesia. It is free from radiation hazard and allergic reactions. The diagnostic accuracy is almost equal to that of hysteroscopy and laparoscopy. It is a better screening procedure in the infertility work-

up. Sonosalphingography can be done as a patency test in initial work-up of infertile women. In patients with negative or suspicious findings Radiographic salphingography can be done. A simplified approach will lead to a significant reduction in both the time and cost of investigating an infertile couple. Care must be taken to avoid exploitation of the infertile couple with expensive unnecessary tests.

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PROFORMA

PROFORMA
EFFICACY OF SONOSALPHINGOGRAPHY IN EVALUATION OF TUBAL STATUS IN INFERTILITY PATIENTS WITH HSG AS GOLD STANDARD

Name: Age:
Address:
Occupation:
Husband's occupation:
Menstrual H / O:
- Menarche: LMP:
- Cycles: Regular / Irregular
- Once in ……. days
- Lasts for …… days
- Flow: normal / scanty / increased / clots
- Dysmenorrhea: Yes / No if yes - congestive / spasmodic

Marietal H / O:
- Age at marriage:
- Married since

Contraception H / O:
- Yes / No
- If yes - Natural / barrier / OCP / IUCD
- Duration:

Infertility:
- Type: primary / secondary
- Duration:
- If secondary
    1. No. of previous pregnancies
    2. Parity
    3. No. of live children
    4. Abortions – spontaneous / induced / septic
    5. Interventions (D & C)
    6. Caesarean section
    7. H / O ectopic pregnancy

H / O previous / present salpingitis:
- Leukorrhoea
- Purulent discharge
- Pruritus
- Lower abdominal pain

Fever with chills
Dyspaereunia
Dysmenorrhoea: congestive / spasmodic
Polymenorrhoea
Menorrhagia
Metorrhagia

Intervention:
D + C
Laparoscopy / Laparotomy

H / O endometriosis
Pain lower abdomen
Dysmenorrhoea: spasmodic / congestive
Dyspaereunia
Dysuria
H / O medication
H / O laparoscopy / Laparotomy
H / O previous tubal surgery: Yes / No
H / O tuberculosis
Fever
Anorexia
Weight loss
Cough
Treatment taken
Regular / Irregular
Complete / Incomplete
Evidence of ovulation
Metteleschmierch
Cervical mucus changes
Basal body temperature changes
Dysmenorrhoes
USG evidence
Endometrial study
Male factor – semen analysis
Volume
Count
Total
Normal / Abnormal
Motility
Uterine and tubal evaluation

Per abdomen
Tenderness
Rigidity
PV uterus size: AV / RV / MP
Mobility: Present / restricted / Fixed
USG findings:
TVS: Uterus :myometrium
endometrium
Ovaries
SSG : Uterus-myometrium
Endometrium
Ovaries
Tubes –periovarian fluid
Fluid in pouch of doughlas
HSG
Uterine contour
Block: Yes / No
Site:
Cornual
Proximal tubal
Distal tubal
Peritoneal spill of contrast
Hysteroscopic findings:
Laparoscopic finding