REVIEW OF LITERATURE
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Infertility has become most sought after medical problems, now a days. The availability and awareness of the newer techniques and areas of investigation have been a major foothold in this area.

There are six major factors of importance in fertilisation and implantation of an ovum (according to Novak's Textbook of Gynaecology)

1. **Ovulatory factors**: Involving the physical act of ovulation and release of mature oocytes.

2. **Male factor**: Involving adequate production of normal sperms.

3. **Mucus or cervical factor**: Involving the presence of adequate cervical mucus which can act as a transport medium and repository for sperms.

4. **Endometrial or uterine factor**: Involving the preparation of the endometrial implantation site that is dependent on ovarian endocrine function, and uterine and ovarian normality and response.

5. **Tubal factor**: Involving patency of tubes allowing transport of sperm and ovum.
6. **Peritoneal factor**: Involving the absence of any physical or mechanical barrier to fertility within the peritoneal cavity.

For a successful pregnancy all these factors must function properly. Defect in any single factor leads to infertility. For evaluating infertility, both partners have to be considered simultaneously. Once the male factor is found to be normal. The female factors have to be evaluated.

The tests of tubal function are diagnostic as well therapeutic, in that they tend to overcome minor obstructions and fimbrial agglutination. The historical evaluation of these tests have depended upon the indication based improvement of the techniques and media used and also the promotion of safety and patient acceptability of the test.

The first method was of tubal insufflation using carbon dioxide described by Rubin (1920). Though convenient to perform and uncomplicated, it is technically unsatisfactory and gives misleading information.

In 1895, Roentgen discovered a new kind of ray (X-ray) which when used at different wavelengths could be used to project the image of the body tissues on radiographic plate.
Namehow (1909) for the first time obtained Roentgenogram of uterine cavity by injecting Lugol's iodine solution.

This was the evaluation of the technique of 'HYSTEROSALPINGOGRAPHY'. It is a technique of the radiographic demonstration of uterine cavity, fallopian tubes and the peritoneal spillage after the transcervical injection of a contrast media.

Rindfleisch in 1910 used Bismuth emulsion to delineate uterine cavity radiographically and is thus credited with first observation of the uterine cavity in humans. Since then several attempts have been made to use various contrast media. Bartigue and Diner (1913), William and Cary (1914) and Rubin (1914) used 10% collargol solution. But it was reported to be non-absorbable and also caused peritoneal irritation so was discarded.

Polak (1921) used Thorium for hysterosalpingography. Sodium bromide was used by Kennedy in 1923, emulsions of Barium sulfate and Bismuth were tried by Williams and Reimolds in 1925. As all of these were found unsatisfactory, they were discarded.

Sisard and Ferrateur (1922) used Lipidal (40% iodine in poppy seed oil) as an oil soluble contrast media for exploration of uterine cavity and fallopian tubes.
Forsdike in 1925 also used Lipoidal for this purpose. The results were better with fewer complications such as peritoneal irritation. These complications were reported by Rubin and Bendick in 1926 and 1928 respectively.

Morbid reactions following the injection of Iodopin or Lipoidal were reported by Odenthal (1927), Dovary (1927), Hoffman (1928) and Brun and Cortesi (1929). Reis and Lash (1929) emphasized that foreign body effect and encysted masses were produced by Lipoidal.

Heussner (1913) was the first to advocate the use of water soluble contrast media. Diadram (1929) was the first such medium used which had inadequate viscosity. Gradually, several such media came into use.

Pyelosil (1946), Hydrobrine '60', Hodoaque 'M' (1933), Viscorayopaque (1945), Skiodan Endografin, Urograftin 60%, Biligrafan 50%, Diagonal 50% and Sinografin were used. Inadequate supply of Diagonal, which had showed good results, lead to the discovery of Maglumine Iothalamate 60% (CONRAY 280).

Gajzio (1931) reported uterovaginal and utero-lymphatic extravasation after hysterosalpingography.

Green Amytage (1943) is credited with the description of the technique for hysterosalpingography.
Murles et al (1946) found hypoplastic uterus as the only positive finding in many infertile women on hysterosalpingography.

Ko-chisum (1948) observed 6 cases out of 138 hysterosalpingograms on infertile women, who showed radio-opaque shadows in the pelvic scout film of 4 cases and other two had fibrosalpinx adhesions present at laparotomy. No peritoneal spillage was seen.

Sun (1949) studied 138 cases of infertility having either unilateral or bilateral tubal blocks and found 6 cases had tubercular salpingitis.

Rutherford et al (1949) studied 43 sterile women by hysterosalpingography and found 27 patients (62.8%) of primary sterility and 16 cases (37.2%) of secondary sterility.

Brown Jennings and Bradbury (1949) observed that oily substances produced a transient peritoneal irritation. Persistent oil in the pelvis frequently produced oil retention cyst and granulomas. Patients who have apparently partially occluded tubes may suffer complete closure as a result of this chronic inflammatory change in the tube induced by persistence of injected oil.

Drasman and Poina (1951) studied the phenomenon of intravasation in 62 cases out of 2000 hysterosalpingograms.
Roland (1953) used Medopaque - H for hysterosalpingography in 50 cases of infertility. 25 cases showed obstruction or occlusion of tubes, they also reported pregnancies following hysterosalpingography.

Subzero, A.J. et al (1961) reviewed 500 infertile women and subjected them to tubal insufflation and hysterosalpingography. They found 73% patients had primary infertility and 27% had secondary infertility. Their results of tubal insufflation were:

- Unilateral patency: 96 cases (19.2%)
- Both tubes blocked: 76 cases (15.2%)
- Bilateral patency: 328 cases (65.6%)

According to the results of HSG performed in 74 cases out of 500 cases. There were pathological findings on X-rays such as hydroalpinx in 33 cases, Submucous fibroid in 8 cases, bicorneate uterus in 4 cases, arcuate uterus in 2 cases, bicornuate uterus in 2 cases, Didalphiic uterus in 1 case and cervical polyp in 1 case.

Due to risk of pulmonary embolism after hysterosalpingography, Levinson (1963) advised to use water soluble contrast media.

Copenhagen and Wise (1963) used high speed hysterosalpingography utilizing the pelacoid rapid radiographic process. By this method an X-ray picture could be
obtained 15 seconds after the injection of the dye. The exposure of the medical personnel and patient to radiation is reduced as much as to one thirteenth that resulting from normal HSG.

Finda (1964) observed that in a few cases of hydrosalpinx, repeated hysterosalpingography opens up tubes and conception occurs.

Gillespie (1965) stated that primary therapeutic function of hysterosalpingography is to clear the ovarian passage and if necessary, restore the patency of the tube at a period most favourable for conception. The contrast media has been suggested to have bacteriostatic action and stimulatory action on cilia of tubal epithelium. But the most accepted view is that the contrast medium causes mechanical clearing of the tubes by dislodging mucus plugs or breaking down the fine adhesions.

Catalano, D. (1966) tried Conray - 200 for the first time in hysterosalpingography procedure (60% aqueous solution of meglumine salt of iotmalmic acid with 2.8% iodine). He studied 100 cases and none of his patients complained of local pain. The only complaints were of heaviness and discomfort in lower abdomen which disappeared spontaneously within 10-15 minutes after the procedure.

Sned et al (1967) performed HSG with fluoroscopy and emphasized that this gave better results.
According to Norman, L. Avnet and Milton Elkin (1967) -

(a) Approximately 2% of patients have some infection after hysterosalpingography which is well controlled by antibiotics. The cause is faulty cleaning of instruments, retrograde infection from the cervix and exacerbation of latent tubal infection.

(b) Uterine rupture is most often associated with preliminary sounding.

(c) Intramural infection by contrast media.

(d) Intravasation of contrast.

(e) Pain.

They reviewed that sterility may be related to tubal lesions as well as congenital anomalies of uterus. Tubal obstruction is most commonly due to salpingitis or pelvic inflammatory disease.

Ozaras (1968) analysed hysterosalpingography of 300 women having infertility surgery in hospital and found that the chances of post operative pregnancy was much better, in cases where tubal rugs were well visualised on the pre-operative roentgenogram.
Page (1968) presented 2 cases of infertility who revealed bilateral cornual block on HSG. Suspecting cornual spasm, he repeated the procedure one and half hour after giving vasodilan (vasodilator) and found the tubes patent bilaterally with peritoneal spill. He emphasized that if tubes be blocked at first investigation, the procedure should be repeated after giving a vasodilator.

Philip et al (1970) had studied the rugal pattern in 114 patients suffering from infertility and performed a number of surgical operations on fallopian tubes depending on the case and compared the result with those of Osarac (1968). To their surprise, the result was very satisfactory and 70.3% of women becoming pregnant who had excellent rugal pattern whereas only 42.1% of the patients having poor rugal pattern and only 7.3% of those having no rugal markings become pregnant.

Gregary et al (1972) studied 2437 cases of infertility and found that 72.2% had primary infertility and 27.8% had secondary infertility. Observation of tubal blocks were more common in patients with secondary infertility (21.8%) and unilateral block 17.7%. He also observed that 36% cases had bilateral normal block.

Tiwari and Tiwari (1977) studied 77 cases of infertility by positive contrast hysterosalpingography using
Diagonal viscus and Conray 280. The authors observed tubal abnormalities in 50% cases, uterine and tubal abnormalities in 15.5% cases and uterine fibroid in 3.1%.

Nickerson, C.W. (1977) in his series of 190 primary infertility patients with patent fallopian tubes and no obvious causes for infertility, revealed 74.21% incidence of uterine anomalies.

Ansari, A.H. (1978) used Glucagon in an attempt to eliminate tubal spasm during hysterosalpingography because Glucagon has relaxing effect on the fallopian tubes.

Nukherjee et al (1978) subjected 45 patients of sterility and habitual abortion to hysterosalpingography using Conray 280. Except mild pain in 5 cases and headache in 2 cases no serious side effects were seen.

Jhaveri (1978) studied 100 cases of sterility by hysterosalpingography using CONRAY 280, out of which 89 were of primary sterility and 11 of secondary sterility. Seventeen of these 100 cases were reported to be having tubal abnormality, 70 were normal, 11 had uterine abnormality and 2 were of uterine fibroid. Peritoneal spillage was seen and 6 patients complained of mild to moderate pain.

According to Ansari, A.H. (1978) tubal factors are the most common cause of infertility contributing to 45% cases of infertility, being caused by -
1. Pelvic inflammatory disease
2. Pelvic endometriosis
3. Peritubal adhesions, previous pelvic surgery, previous appendectomy.
4. Tubercular salpingitis
5. Extrauterine pregnancy
6. Intrauterine contraceptive devices.
7. Neoplasm.

Cervical factors contribute to 20% cases, ovarian factors 10%, uterine factors 10% and rest are contributed by vaginal factors.

Hornutz, R.G. et al (1979) contended that hysterosalpingography should be a preliminary procedure in every case and in many might be the only investigation of tubal patency required prior to surgery or conservative management. Of the 196 fallopian tubes studied by them only 6 showed cornual spasm and 8 had cornual occlusion.

Sharma et al (1979) in their study of 125 cases of HSG used Conray 200 in 113 cases and Diaginal viscous in 10 cases. 70 were of primary sterility and 40 of secondary infertility and 7 of repeated abortions. Bilateral peritoneal spill was seen in 27, 78.74% cases showed uni-lateral peritoneal spill and normal and patent fallopian
tubes. 20 patients had unilateral block, 21 had bilateral block, 6 had hydrosalpinx and beaded appearance was seen in 4 cases.

Cameron, D.D. et al (1979) described a simple method of hysterosalpingography using a Foley's catheter to inject contrast media. The technique allowed the patient to assume a more comfortable position during the study. The radiologist could perform the examination without the need of second physician to assist during spot filming and with no chance of metal artifacts during anatomy.

Jankharia, G.R. et al (1981) in their study of 105 patients - 55 of primary, 35 of secondary sterility and 15 others - reported that 13 patients had abnormal uterus and 92 had normal. The abnormal were further divided as bicornuate uterus 4, adenomyomatosis 1, fibroid uterus 2, hypoplastic regular 3 and hypoplastic irregular 3. Peritoneal spill was seen in 60 cases. Both the tubes were patent in 47 cases. One tube patent in 13 cases and both blocked in 42 cases. Abnormal appearances of the tubes unilaterally in 16 cases, bilateral hydrosalpinx in 13 and others like beading in 4 cases. 79 patients complained of mild pain, 19 had no pain, 7 patients suffered from moderate pain and vomiting, and 2 patient had pain in the right shoulder.
DeCherney and Michael R. Soules et al (1982) in their study established that oil based media were not as dangerous as sometimes indicated by proponents of water based media. Both types of contrast medium have evolved to the point of reliably providing information about uterine tubal anatomy, with minimal side effects. Therefore, useful diagnostic information could be consistently obtained with the use of both oil and water based media. Oil soluble contrast media might be superior to water soluble contrast media in regards to a therapeutic effect in relation to establishment of pregnancy.

Mark G. Schwaib et al (1983) emphasized to utilize HSG with oil contrast medium as a treatment modality for patients with the diagnosis of infertility of unknown cause. In his study, the cases with infertility of unknown cause had a significantly higher pregnancy rate after HSG with oil than after HSG with aqueous contrast medium.

Winfield, A.C. (1984) used Hemabrix (monosodium) dimeric iodinated compound as a contrast material, on 52 patients. They found tubal disease in 14 patients, an incidence of 26%.

Pandav, Pushpa et al (1986) performed hysterosalpingography in 378 patients of infertility. They observed that cervical length was normal in 76% cases and
elongated in 24% of cases. 5 patients showed filling
defect in cervix due to polyp. The cervix dilated in 4% of cases. 80% had normal sized, 4% had large sized
uterus. All of these were because of myoma. The congeni-
tal hypoplasia was responsible for small size uterus in
12%, the remaining were due to tuberculosis. Tubal occlu-
sion was seen in 60% and hydrosalpinx in 31% cases. Out
of these, 44% had bilateral blockage. Tubal occlusion was
located at cornual end (30%), fimbrial end was the next
common site (20%) of block and isthmic block (6.7%). Free
bilateral peritoneal spillage was seen in 43% cases while
13% showed unilateral spillage only. Complications were
few and minor. HSG, thus can pinpoint the site and the
type of pathology. Moreover, it has low incidence of false
positive and false negative results.

Agarwal, C.N. et al (1988) tried hysterosalpin-
ography in 2000 cases of both primary and secondary steri-
lity. Abnormal findings were noted in 910 (45.5%) of these
cases. Uterine anomalies were present in 48.5% and tubal
pathology in 51.5%. Uterine malposition was commonest an-
omaly present in 13.4% cases followed by infection of female
genital tract in 10.1%. 41.9% of 1160 cases of primary in-
fertility showed anomaly. 46.4% of these had uterine patho-
logy, while 53.6% had tubal pathology. Uterine malformation
was the commonest finding accounting for 17.5% cases. 52.7% of 910 cases of secondary sterility showed abnormality. 50.7% of these showed uterine pathology and 49.3% showed tubal pathology. Uterine malposition was the commonest finding with an incidence of 26%. Overall uterine malformation was seen in 4.35% of cases, the three most common malformations were arcuate uterus, uterus subseptus and unicornuate uterus.

Hysterosalpingography and tubal insufflation were the invasive type of procedures which were time consuming and cost wise were not economical and also the patient found them agonising. Though HSG was superior but it could give help in knowing the intramural condition of uterus and tubes only. The ovaries and other pelvic structures were totally excluded.

There was a constant search for a newer approach to the study of condition of the pelvic organs. This led to the evolution of 'Sonosalpingography' i.e. a technique using ultrasonography to detect fallopian tube patency by detecting presence of free fluid in pouch of Douglas following transcervical injection of a sterile fluid.

For the first time, according to the available literature, Richman, T.S. et al (1984) evolved this technique. They studied 25 infertile women and compared the
results with conventional hysterosalpingograms, which had been obtained simultaneously. Ultrasound demonstrated bilateral tubal occlusion with a sensitivity of 100% and showed tubal patency with a specificity of 96%. This technique eliminated unnecessary exposure of the female pelvis to ionizing radiation and avoided use of iodinated contrast material.

A pre-gynaecological scan of the pelvic organs was made to rule out presence of free fluid in cul-de-sac. Thus the condition of ovaries and adnexa could be assessed for any abnormality or presence of any lump in the pelvis. This rules out the detection of small hydrosalpinx and pelvic infections.

According to the study of Rasmussen, P. et al (1986) in which 24 infertile patients were assessed for fallopian tube patency by HSG and ultrasonography following transcervical injection of a sterile isotonic solution of sodium chloride. The presence of fluid in the posterior pouch, after the injection, was taken to indicate tubal patency. 87.5% (21 patients) patients showed tubal patency. Pitfalls consisted of fluid accumulation in periadnexal adhesions, adnexa in the bowel wall and spill of the injected saline into a large hydrosalpinx.
According to another study made by Randolph, J.F. Jr. et al (1986) comparison made between ultrasonography, hysterosalpingography and laparoscopy/hysteroscopy in the evaluation of uterine abnormalities together with tubal patency. They studied 61 women of the reproductive age group diagnosed as cases of infertility. They took surgical findings as the standard and recorded that the accuracy in demonstrating uterine abnormalities was:

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<td>USG</td>
<td>98%</td>
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<tr>
<td>HSG</td>
<td>98%</td>
<td>92%</td>
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and in demonstrating the presence of tubal patency:

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<td>USG</td>
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<td>91%</td>
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<tr>
<td>HSG</td>
<td>96%</td>
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but USG is not accurate for establishing which of the tube(s) is patent.

In 1989 Sharma, R.P. studied 30 cases of primary and secondary infertility. These cases had been diagnosed as having bilateral tubal block on HSG examination. Trans-cervically 50 ml of normal saline was injected through a Foley's Catheter. A routine pelvic gynaecological scan had been done before fluid injection to rule out presence of free fluid in pouch of Douglas. After fluid injection,
collection of fluid was seen, the presence of which indicated unilateral or bilateral tubal patency and absence of fluid indicated bilateral tubal block. He found that 86% of these patients showed tubal patency of USG examination, thus proving that USG technique is superior to HSG.

Besides using normal saline as the fluid medium for assessing tubal patency by sonosalpingography, Luo, L.L. (1990) used 1.5% hydrogen peroxide for transcervical injection. The study was made in 147 sterile women. These patients had already undergone HSG. 28.7% (42 cases) cases underwent laparoscopic examination of the tubes to assess the accuracy of the two diagnostic procedures. The correspondence rate between laparoscopic findings and ultrasonography was 88.0% and 60.0% with HSG. Animal experiments did not reveal any untoward effect of 1.5% hydrogen peroxide on the local tissues exposed to the solution except a transient increase of lymphocyte infiltration and exudate.

In 1991, Tsarri, M.C. et al published a paper on the comparative results of HSG, laparoscopic chrooniophotography and USG for fallopian tube patency of 90 patients. According to their study 34% patients showed bilateral block on HSG while only 23% on laparoscopy and the number increased to 36% on USG. 48% showed bilateral patency on HSG and 64% on laparoscopy and also USG. Unilateral tubal
patency could not be assessed by ultrasound technique but HSG showed 18% block and laparoscopy 8%. According to this study USG is economical and technically simple with less false negative results besides being non-invasive and so it is superior.

Advancing to the newer approach to assess the tubal patency by ultrasonography U. Daichert et al (1992) made additional use of pulsed wave Doppler. Their objective was to determine whether the additional use of pulsed wave Doppler can improve the tubal diagnosis reached with gray scale imaging in doubtful cases. 17 patients between ages 23 - 27 years, diagnosed as cases of sterility were studied. The contrast agent SH U 454 was administered transcervically during transvaginal gray scale and pulsed wave Doppler sonography. Hysterosalpingo-contrast-sonography by gray scale and by pulsed wave Doppler were performed. Follow up study was done by chromolaparoscopy or hysterosalpingography. The diagnostic efficacy of gray scale and pulsed wave Doppler were compared with each other and against a conventional control procedure. According to the study, the additional use of pulsed wave Doppler was recommendable as a supplement in suspected cases of tubal occlusion and in event of intratubal flow.
According to another study of Bonilla-Musoles, F. et al (1992) the value of hysterosalpingosonography (HSSG) as a diagnostic tool was evaluated in 76 patients and compared to hysteroscopic, laparoscopic and/or hysterosalpingographic (HSG) findings. Saline solution and Dextran 60 were used as distension media. The results indicated that HSSG had more sensitivity but less specificity than hysteroscopy or HSG in the diagnosis of uterine cavity pathology. Hysteroscopy seemed to be the best technique for the diagnosis of endometrial pathology and HSSG seemed to be the most effective in the study of the myometrium. According to the authors HSSG cannot be considered a reliable and accurate method for the diagnosis of tubal patency.