Management of Tubal Obstructions

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ABSTRACT

Management of the tubal factor could have the most difficult and debatable role in infertility management. The methods used ranged from gaseous insufflation, hydrotubation, laparotomy, and traditional microsurgery to the more recent tactile or hysteroscopic catheterization, and laparoscopic surgery. Results of the in-vitro-fertilization-embryo transfer (IVF-ET) or intracytoplasmic sperm injection (ICSI) were compared to the surgical procedures' results and the debate continues: shall we proceed directly to assisted reproductive techniques or should surgery be tried first in tubal obstructions?

INTRODUCTION

Fallopian tube disease is responsible for more than 20% to 30% of female infertility worldwide (1). The lesions range from intrinsic intraluminal malformation of cilia, mucosa, or muscularis, to gross occlusion of the lumen. Tubal obstruction has preoccupied many gynaecologists for centuries. Its importance as a major cause of infertility was recognised by Burns in 1809 (2).

Whereas tubal surgery has been criticised for lack of convincing evidence of ability to improve reproductive outcomes, untreated complete bilateral tubal obstruction offers no hope of pregnancy (3). Earlier attempts regarding surgical repair of the fallopian tube were met with poor pregnancy outcome. A success rate of 1 in 20 was reported in 1957 and 1 in 6.5, 28 years later (1). Until recently, many surgeons believed that low pregnancy rates (PRs) were due to the major invasive surgery that was the main treatment (4,5).

Despite development of endoscopy during the 1960-1970s, the idea that large problems require large incisions so deeply dominated surgical thinking that there was little room to appreciate the advances of "Key Hole" surgery. Effective surgical correction of diseased fallopian tube is a relatively new aspect of gynaecological surgery that began with the "laparoscopic evolution" in the 1980s. Its reported success raised the question of when to use traditional open surgery, and encouraged surgeons to consider new perspectives (6).

Currently, a 50% overall success rate in surgery on the fallopian tube has been reported (1). This improvement may be due to the recent development of tubal endoscopic and carbon dioxide laser, techniques that have led to better assessment of tubal disease, and less-invasive tuboplasty or tubal recanalization procedures. However, despite these innovations, absence of a universally accepted classification of the location, type, and severity of tubal disease combined

with conflicting views of management distorts the appreciation of the true pregnancy outcome rates.

PATHOGENESIS

Diagnosis

Clinical Presentation. The fallopian tube has been described to be the most sensitive pelvic organ to pain (7). Patients with acute or chronic salpingitis may have either a current or previous history of pelvic pain or dysmenorrhoea. Some who had undergone treatment may be asymptomatic, but subsequently have either primary or secondary infertility. Others may have had an abortion, a puerperal infection, or had either undergone a voluntary surgical sterilisation or pelvic surgery for a gynaecological problem such as ectopic pregnancy.

Investigations

Bacteriological. It has been suggested that before any assessment of tubal patency and structure, the first line of investigation should be bacteriological investigation followed by treatment with appropriate antibiotics.

Assessment of Extent of Tubal Patency

Hysterosalpingography (HSG). Hysterosalpingography is commonly accepted as the initial test of tubal function in the investigation of infertility (2). However, it may give rise to a false diagnosis of proximal obstruction because of tubal spasm. Additionally, tubal diverticulum may be wrongly diagnosed as distal obstruction (8). The combined use of hysterosalpingogram

(HSG) with laparoscopy increases the diagnostic possibilities to include endometriosis (9).

In 1995, Swarth et al. did a metaanalysis of 20 studies that compared HSG and laparoscopy for tubal patency and peritubal adhesions (10). They observed that HSG was of limited use in tubal diagnosis because of its low sensitivity. However, its high specificity makes it a useful test for ruling in tubal obstruction. For evaluation of peritubal adhesions, HSG is not reliable.

To circumvent the problem of tubal spasms and distinguish organic tubal obstruction from functional obstructions, some authors have recommended the use of muscle relaxants such as terbutaline (11).

Contrast Sonography. Contrast sonography has the advantage over HSG of not using radiation (2,12), and the site of obstruction can be ascertained more accurately with colour Doppler depending on the contrast medium used. The proponents of this technique claim that its high concordance of approximately 86% in diagnosing blocked tubes gives it an edge over laparoscopic chromopertubation (13).

Laparoscopic Chromopertubation. With the use of intrauterine dye injection, tubal patency can be checked during laparoscopy. Under local anaesthesia, laparoscopic chromopertubation can be an office procedure (14). Laparoscopy has the added advantage of diagnosing fibroids, ovarian abnormalities, endometriosis, and/or other congenital abnormalities (15).

Patency of the fallopian tube does not necessarily equate with normality of the mucosa, and intraluminal pathological lesions may be missed if more accurate methods of tubal assessment are not used (2).

Fallopian Tube Endoscopy. Fallopian tube endoscopy either by the transvaginal (Falloscopy) or transabdominal approach (Salpingoscopy) permits direct visualisation of the tubal epithelium. *Falloscopy* is used in investigation of the status of the proximal tube. Two types exist: The coaxial guidewire falloscope, described by Kerin et al. in 1990, requires hysteroscopy for its introduction (16). The second type, the linear everting catheter (LEC) falloscope, has a terminal everting balloon sheath that facilitates its introduction without hysteroscopy. Falloscopy may be used with or without general anaesthesia. They are suitable for office use, for both diagnostic and therapeutic purposes.

In instances of proximal tubal obstruction, the only alternative for assessing the state of the tubal mucosa is by performing transabdominal *salpingoscopy* during laparoscopy. It is most convenient in evaluation of the distal segment of the tube (2,15-17).

TREATMENT OF TUBAL OBSTRUCTIONS

In the literature, many techniques and technique combinations have been reported when used in treatment of tubal disease. These range from the laparotomy, gaseous insufflation, hydrotubation, and traditional microsurgery to the more recent laparoscopic surgery. Irrespective of the type of surgical procedure laparotomy or laparoscopic surgery, the general principles of infertility surgery include gentle manipulation, meticulous hemostasis, and prevention of postoperative infection and adhesion development (2). These goals can be optimized, to the extent possible, by use of good microsurgical instruments, continuous irrigation, and pinpoint hemostasis.

The once commonly used gaseous insufflation became obsolete with the advent of radiologic imaging studies. Postoperative hydrotubation also is currently used infrequently to

maintain tubal patency, and some believe it may predispose to infection. In contrast, Grant (1971) (18) used hydrotubation and had a PR of 37% as compared to 16% pregnancies in treated controls, whereas recent reports especially from China suggest a value of hydrotubation in treatment of tubal disease (19). Those who use hydrotubation as an adjuvant to the post-surgical management of tubal obstruction do it on days 3, 6, and 14 (1).

TREATMENT OF PROXIMAL TUBAL OBSTRUCTION

Endotuboplasty Techniques

The first known attempt to pass instruments through the vagina and enter the tubal lumen by the uterotubal ostium (UTO) was attributed to Tyler Smith in 1849. In 1856, Gardner described a method for transvaginal passage of graduated probes. In 1970, a fibroscope 1 mm in diameter was used to examine the tubal lumen, but poor illumination and technical problems made it difficult to explore this adequately (17). Intra-luminal tubal endoscopy may be performed by the transvaginal (falloscopy) or transabdominal (salpingoscopy) approach (2).

FALLOSCOPY

The coaxial technique of falloscope described by Kerin in 1990 (17) requires hysteroscopically directed tubal cannulation with a flexible guidewire having an outer diameter (OD) of 0.3-0.8 mm followed by serial passage of a Teflon cannula (OD up to 1.3) over the guidewire. The guidewire is then removed and the falloscope passed down the lumen of the Teflon cannula (2). The falloscope has balloon catheters with a shaft of 1 mm and inflated balloon diameters ranging from 2 to 5 mm over lengths of 2 cm used for dilating tubal strictures, breaking down intraluminal adhesions, and mobilising intraluminal debris. This coaxial balloon

catheter has its balloon mounted outside the catheter shaft (17).

The second (more recent) type of falloscope is the LEC system (Imagyn Medical Inc., San Clemente, CA, USA). It uses a pressurised tubular polyethylene balloon, which can be unrolled from within a plastic polymer cannula 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 curves and strictures without exerting sharing forces on the tubal wall (2). The LEC system may be used without hysteroscopic control (2,17).

Falloscopic descriptions of endotubal lesions, secondary to endotubal infection, tubal surgery, ectopic pregnancy, salpingitis isthmica nodosa (SIN), endotubal polyps and non-specific areas of devascularization, epithelial flattening, atrophy, and fibrosis have been published (20).

In 1992, Kerin et al. developed a scoring system for objective and reproducible recording of the type, size, and severity of the intramural, isthmic, ampullary, and fimbrial tubal segments (as seen in Table I), based on the above observations of their study (20).

A cumulative score for each tube of: 20 = Normal tubal lumen; >20 but <30 = Moderate endotubal disease; >30 = Severe endotubal disease.

Mucus plugs or tubal debris, endotubal polyps, salpingitis isthmica nodosa, inflammatory, infective, neoplastic conditions, and absent tubal segments are each assigned a score of 2-3 depending on the significance of the lesion (Table II).

Falloscopy may be combined with other procedures such as:

(1) Laparoscopy.

(2) Ultrasound.

(3) Fluoroscopy.

(4) Hysteroscopy and laparoscopy.

(5) Lavage under pressure.

The coaxial technique may be used to canalise the tubal lumen, and/or the balloon catheter may be used to dilate the lumen (Balloon tuboplasty) (11). Tables III to X summarise the various techniques and technique combinations that have been used by various authors. Where possible, the respective PRs are included.

With the varied techniques and combinations, it is not possible to compare the various methods used. Generally accepted is that tubal endoscopic procedures provide a better assessment of the structure of the tubal mucosa, thus facilitating patient selection. Falloscopic techniques are less invasive, have high patency rates (>80% in most studies), but appear to be limited to non-fibrotic tubal obstructions. Complications of perforation are possible in cases of undue force to bypass complete pathologic obstructions such as SIN (21). Their use without general anaesthesia gives it a further advantage in daily office use.

HYSTEROSCOPIC TUBAL CATHETERIZATION AND HYDROTUBATION

This technique has been reported in the Chinese literature with success rates between 36% and 60% (19,22). In the 1994 Li et al. series, 54 infertile women with previously diagnosed tubal disease underwent hysteroscopic catheterization (19). Catheterization was performed by the introduction at the UTO of a plastic tube of 1.4 OD, up to 1-5 mm into the tubal lumen under hysteroscopic guidance. The procedure was followed by successive monthly selective hydrotubation over a period of three months. Patency was achieved in 62.5% of cases of intramural block and 38.8% of isthmic stenosis. Globally, complete patency was achieved in

54.1%, 13 women became pregnant; 12 were intrauterine pregnancies and one was an ectopic pregnancy. They, however, pointed out the possible complication of hydrosalpinx with this technique.

INTRAUTERINE INJECTION OF "ANGELICAE" COMPLEX

"Angelicae" complex is a Chinese medication of the Kampo medicines that has an effect on the clearance of circulating immune complex (23). In 1991, Lian et al., after preliminary experimentation in rabbits, followed up 48 infertile women (24). Fallopian tubal obstruction had been proved previously by hysterosalpingography in all the women. These women were divided into two groups for clinical study. Thirty patients were treated with intrauterine injection of "Angelicae" complex. The control group of 18 women was treated with transcervical intrauterine injection of gentamycin and 0.9% saline in three to six months. The effective rates were 94.6% and 56.6% ($p < 0.01$), and the subsequent pregnancy rates were 46.7% and 27.8% in the different groups, respectively. So far, to our knowledge, no other studies have appeared in the literature regarding the use of "Angelicae" complex in treating tubal obstructions.

MICROSURGICAL ANASTOMOSIS FACILITATED BY CO_2 LASER MICRODISSECTION OF INTRAMURAL SEGMENT AND RESECTION OF SCARRED TISSUE

In 1991, Vilos reported use of the CO_2 laser technique in microdissection of intramural segment and resection of scarred tissue before microsurgical anastomosis (5). Within a period of 5 years, 21 fallopian tubes in 14 patients had been anastomosed using this technique. After reanastomosis, tubal length was 4 to 8 cm in all tubes. All patients were followed for at least one

year post-surgery. In this study, 7 of the 14 women had proximal tubal occlusion after electrocautery for sterilisation. In this group, the tubal patency rate was 100%, whereas the intrauterine pregnancy rate was 71% (5 of 7 patients). One other patient had two successive ectopic pregnancies. The seventh patient was 40 years old and did not ovulate on 150 mg of clomiphene citrate. In the other group of seven women, proximal tubal obstruction was associated with other tubal diseases. In this group, one patient with salpingitis isthmica nodosa conceived twice after bilateral intramural reanastomosis.

TREATMENT OF MID-SEGMENT OBSTRUCTION

The most common indication for reanastomosis of the mid-segment is reversal of sterilization (1). Other causes may be localised constriction from previous tubal repair following ectopic pregnancy, endometriosis, infection, and congenital constrictions (1,3).

In the selection of patients, preoperative HSG and laparoscopy to determine the length of the proximal tube and that of remaining tube, respectively, are important (1). The PR after surgery in most studies has been associated with the length of tube (25-27). The longer the tube above the critical length of 3 cm, the better the PR outcome (1). In a large study by Kim et al. in 1997, no statistically significant difference was reported in the lengths of tubes (27). However, they observed that the younger patients had longer tubes and became pregnant earlier than the older patients with shorter tubes.

The success rate also depends on the type of sterilisation carried out (1). It is higher with the Pomeroy and Uchida techniques as well as with the fallopian ring and the Hulka clip methods of ligation (1,28).

Reanastomosis of the “chronically ill” tube is not helpful. In 1999, Wang, in a series of 60 cases of female infertility in which several operative procedures were used, reanastomosis of the “chronically ill” tubes was of no benefit (29). Moreover, neither unilateral nor bilateral reanastomosis seemed to affect the PR outcome.

The different varieties of possible anastomosis are isthmic-isthmic, isthmic-ampullary, and ampullary-ampullary (1). Reanastomosis of tubal segments requires adequate proximal and distal lengths of normal tube. After excision of the occluded segment, the mesosalpinx is approximated, and an end-to-end, layer-to-layer anastomosis is achieved. Disparity between the caliber of the residential normal tube segments is compensated by angulation incision of the smaller diameter segment, or by a small incision made in the potentially larger segment. The anastomosis may be performed over a nylon splint (1).

Theoretically, the procedure of reanastomosis is better achieved by way of microsurgery under magnification (1). However, in 1978, Jones and Rock reported no difference between macro and microsurgery (30). In 1990, Gupta et al. reported a high PR of 88% with macroscopic tuboplasty in 57 cases of reversal sterilization (31). Despite these controversies, many large studies have reported high success rates following microsurgery. In 1997, Liu et al. reported that of 1029 cases, 960 had intrauterine pregnancies (IUP) and only 12 ectopic pregnancies (EP) (32). Kim et al. reported that of 922 cases had a global PR of 53% (27). In 1997, Kim et al. reported that of 387 cases, 91% got pregnant. (25). In a relatively smaller study of 23 patients in 1996, Fischer obtained an overall PR of 78.3% and a IUP of 68.6% (33).

Laparoscopic microsurgery, although relatively new, is gradually being considered an alternative to open microsurgery. The first laparoscopic microsurgical anastomosis was carried out in February 1992 and since then most cases of laparoscopic microsurgery have had

encouraging results. Yoon et al. reported a PR of 77.7% (38/49) in 1997 (34). In 1995, Lee et al. reported a successful case in a woman 33 years of age who previously had a failed tubal anastomosis (35). In 1995, Silva and Perlins used a combination of laparoscopic and minilaparotomy techniques in treating 11 patients of whom five (45%) had an IUP and one had two successive ectopic pregnancies (36). In 1994, Karz and Donesky reported that of ten patients underwent laparoscopic mid-segment reanastomosis, five got pregnant with a PR of 50% (37). Various stitch techniques to ease laparoscopic microsurgery have been developed. Dubuisson and Swolin, in 1995, used a new one-stitch technique to treat four patients (38). The stitch was placed at the "12 o'clock" site of the antimesenteric border. Barjot et al. in 1999, used a three-stitch technique in 16 patients and had a PR of 31.2% (5/16) (39). However, in 1993, Reich et al., in a retrospective review of 22 laparoscopic tubal anastomosis cases in which the Swolin's two-stitch technique was used, reported a low overall fertility rate (40).

TREATMENT OF DISTAL TUBAL OBSTRUCTION

The frustrating PR results (0%-5%) of tubal surgical repair in the pre-antibiotic era of the 1930s led almost 60% of the participants of the Chicago Gynaecologist Society to be definitely opposed to salpingostomies and tubal implantation (41). From that period until 1977, the combination of a thick-walled ampulla and an intramural occlusion was considered irreparable, and the tube was left *in-situ* (42). However, in the case of thick-walled tubal end, a so-called cuff neostomy was performed. In 1960, Palmer described a less radical technique (43), which consisted of stripping the fibrotic muscular layer under the microscope so eversion of the mucosa was easier.

In addition to conventional and traditional microsurgery, other operative techniques on the distal tube include the use of laparoscopy and CO_2 laser. All of these can be used in performing salpingostomies, fimbrioplasties, and salpingectomies. To date, there remains no consensus regarding which of the methods yields the best results in terms of intrauterine pregnancy outcome.

CONVENTIONAL SURGERY AND TRADITIONAL MICROSURGERY

Earlier PR results of conventional surgery ranged from 5.6% to 41%, whereas those of traditional microsurgery range from 21% to 37% (42). Term pregnancy rates in conventional surgery are variable and generally less than 20%, whereas those of microsurgery are less variable and most are in 20% to 30% range (41). Success depends on the type of technique used. Verhoven et al., in 1983, in a review of 167 cases, reported a PR of 20.4% following microsurgical salpingostomy and 0% after cuff neostomy (42).

Fimbrioplasty and Neosalpingostomy

These terms have created much controversy. In 1977, the Ninth World Congress of Fertility and Sterility defined fimbrioplasty as: a) deagglutination, dilatation, or both, of the fimbrae, b) by incision of peritoneal ring, and c) by incision of tubal wall. Neosalpingostomy was defined as creation of a new ostium that may be: a) terminal, b) mid-ampullary (medial), and c) isthmic (including linear salpingostomy) (41). Authors differed as to whether surgery on distal tubes determined to have remnants of the fimbriae after incision of the tubal wall constituted a fimbrioplasty or salpingostomy (41). The modified definition of fimbrioplasty by the Tenth World Congress (1980) of Fertility and Sterility as "serosal incision for completely occluded

tube" did not help (41). In reporting cases, Verhoven et al. (1983) (42) and Bateman et al. (1987) (41) used the term "fimbrioplasty" in cases of partial tubal obstruction with fimbriae present and salpingostomy in cases of complete tubal obstruction, regardless of the findings after incision. In complete tubal obstruction, no spillage occurred and if pin-point openings were present, the repairs were not considered as salpingostomy because these tubes usually had undergone less damage and offered the possibility of better results (43). From earlier reports, fimbrioplasty has always yielded better PRs than salpingostomies, as shown in the Tables XI and XII (43).

LAPAROSCOPY

Results of salpingostomy and fimbrioplasty done by laparoscopic surgery also give an edge to fimbrioplasty in terms of IUPs (Figs. 1,2). Lavergne et al., in 1996, of the 46 cases of laparoscopic surgery in which salpingostomy and fimbrioplasty were performed, 75% of the 18 patients pregnant were a result of fimbrioplasty (44). Table XIII is a summary of three studies that compared fimbrioplasties and salpingostomies.

Tubal Score

Many authors reported that the outcome of tubal surgery depends on the extent of tubal damage. Whereas IUPs are higher in tubal stages I and II, and fairly low in stage III, they are hopeless in stage IV. Dubuisson et al. (1994) (45), Filipini et al. (1996) (46), Kasia et al. (1997) (47), and many others stated that patients with tubal stage IV would benefit more from IVF-ET. Table XIV is a summary of the various findings.

CO_2 Laser in Laparoscopic and Micro-surgery

With the advent of CO_2 laser, IUP outcome of laparoscopic surgery is almost equal to that of modern microsurgery. CO_2 laser has the advantage of performing adhesiolysis by vaporisation. For neostomy, the tube can be sectioned without any bleeding and the surgeon can work both quickly and accurately (5,48,49). In 1991, Canis et al. operated on 87 patients, using a combination of laparoscopic surgery and CO_2 laser (50). The IUP outcomes per tubal stage, as observed in Table XV, were better than those of previous microsurgery; however, not all were statistically significant. Whereas these results were obtained with the CO_2 laser, subsequent increased familiarity with use of other modalities at laparoscopy raise the question of whether similar success would be achievable using these other techniques.

SALPINGECTOMY OR CONSERVATIVE SURGERY

In 1998, Aboulghar et al. were the first to mention how fluid in the uterine cavity before embryo transfer could be a possible hindrance for implantation (51). Hydrosalpinx fluid often has pH values of 8.45 to 8.65, significantly higher than the physiologic range, and at either the 100% or 10% concentration it has a significant embryo toxic effect (52). Anderson et al., in 1994, diagnosed hydrosalpinges by ultrasound and noted that those patients with hydrosalpinges had decreased pregnancy rates and increased miscarriage rates (53). However, a controversy exists regarding the benefits and disadvantages of salpingectomy or conservative management. Aspiration of the hydrosalpinx fluid has been tried (54), whereas others have proposed salpingectomy before referring the patient for in-vitro fertilization-embryo transfer (IVF-ET) (55).

Dechaud et al., in 1998, in a pilot study of 60 women who underwent IVF-ET, reported an implantation rate of 13.4% in women with salpingectomy and only 8.6% in those without salpingectomy (56). Additionally, the rate of ongoing pregnancies was higher (34%) in the salpingectomy group than that of the control group (18.7%). However, Bredkjaer et al. (1999), in a case control study, noted no difference in the rates of implantation and ongoing pregnancies between the two groups (57). Table XVI is a summary of both studies.

Van Voorhis et al., in 1998, carried out a study in which they assessed the differences in implantation rates between women with tubal disease who either had or had not had hydrosalpinges based on ultrasound diagnosis (54). They observed that implantation as well as the clinical pregnancy rates were reduced in women with hydrosalpinges, although these differences did not quite reach statistical significance. Their results, as well as those of similar studies, are summarised in Table XVII.

The negative effect of hydrosalpinges on implantation, as observed in the above studies, seems to be nullified when the hydrosalpinx is managed. It may be that surgical removal has an advantage over aspiration. Van Voorhis et al., in 1998, aspirated their cases, whereas Vandrome et al., in 1995, operated upon theirs (54,58). When these cases were compared with controls whose hydrosalpinges were intact, the implantation rate was still higher in the treated cases than the controls. However, both the implantation rate and ongoing pregnancy rate were higher in the surgically treated group than the aspirated group. More studies have to be carried out to determine whether this difference could be due to the incomplete removal of hydrosalpinx fluid by aspiration procedures.

The study carried out by Shelton et al., in 1996, is in line with the above studies, but is peculiar because it was a retrospective study in which the same patients were followed up by the

same team (55). When fresh and frozen embryo transfers were carried out in 15 patients who had hydrosalpinges, there was only one pregnancy, which ended in a miscarriage. However, after salpingectomy, fresh and frozen embryo transfers resulted in 9/15 (60%) pregnancies, of which there were 3 miscarriages and 6 (67%) ongoing pregnancies (59).

DISCUSSION

Green-Armytage (1959) quoted by Bateman et al. (1987) remarked that tubal disease was still the greatest bugbear of all infertility clinics (41). To date, Mr. Green-Armytage's quotation is still appropriate. Its magnitude can be quantified by the plethora of techniques and technique combinations used currently to treat this disease.

In the pre-antibiotic era of the 1930s, the pregnancy rates were frustrating (0% to 5%) (41). It gradually climbed to 20%-30% with microsurgery and lately to 50%-79% with the combined use of CO_2 laser techniques in both laparoscopic and laparotomy microsurgery. With the invention of the falloscope, a good proportion of the pathologic findings of tubal obstructions was determined not to be of extra-tubal, but of intraluminal origin (11). The tendency since then has been shifted toward endotubal surgery that, of course, has its own limits, or to the use of Assisted Reproductive Technologies.

In mid 1980s, when Platia and Kudy (1985) (60) and Confino et al. (1986) (61) suggested the possibility of intraluminal interventions, DeCherney 1987 was sceptical (62). Currently, apart from tubal spasms, transcervical tubal catheterization has been applied in dislodging intraluminal plugs, functional sphincterotomy, and intraluminal polypectomy (11).

This does suggest a transvaginal catheter approach toward proximal tubal occlusion is successful in achieving tubal patency in a large proportion of women, and allows pregnancy in many (16), although rates remain below those expected from conventional microsurgery. The patency rates have reached high levels (90%-97%) and the PR outcome, the prime concern of the surgery, also has climbed (50%) (17). The various techniques have their merits and demerits:

- Flouroscopic-guided catheterization has the advantage of being both diagnostic and therapeutic. The highly detailed image of the fallopian tube remains unsurpassed by sonography even when high resolution Doppler flow equipment is used (Stern et al., 1991) (63). However, this method exposes patients to radiation, the equipment is expensive and not easily available (64).
- Sonographically guided intracervical catheterization has the advantage over fluoroscopic procedures in that it is less expensive, readily available, can be used on an out-patient bases, and for the deposition of spermatozoa and gametes. It also is minimally invasive, diagnostic, and therapeutic. The human fallopian tube is a tortuous organ, which renders sonographic imaging rather difficult. Frequent movements of catheter tip requires continuous movement of the transducer, and thus requires a skilful reproductive sonographer familiar with genital anatomy and sonographic appearance of the catheter (64). Visualisation of microbubbles through the fallopian tube and into the cul de sac "lighting up" is a less equivocal sign of tubal patency (65).
- Balloon tuboplasty is equally minimally invasive, and can be used on an out-patient basis. It has the added advantage of achieving functional sphincterotomy. This is particularly useful because it delays the reformation of intraluminal plugs unlike the

other procedures that simply dislodge them (11).

- When transcervical tubal catheterization is performed under hysteroscopic guidance, the structure of the uterine cavity is seen and any abnormalities are noted.
- Transcervical tuboplasty combined with laparoscopy has the advantage of direct visualisation of pelvic structures and other related pathologies.

Although complications with the use of tubal catheterization procedures are few, some cases of perforation of the tube have been reported, especially when undue force is used to bypass fibrotic occlusions and salpingitis isthmica nodosa (59).

In China, a less-expensive method of transcervical tubal catheterization under hysteroscopic control has been developed (15,19). In the place of catheters, flexible plastic tubes of 1.4 OD were introduced at the utero-tubal ostia up to 1-5 mm into the tubal lumen. This was followed by hydrotubation over a period of three months. The global patency rate of 54% and PR of 24% were achieved. These results, although comparatively lower than the other more expensive methods of tubal catheterization, almost equate with those of invasive surgical techniques.

Many agents have been used in hydrotubation with the aim of maintaining tubal patency. In 1971, Grant used hydrotubation and had a PR of more than 40% in his series (18). Lian et al., in 1991, used the “Angelica" complex in hydrotubating women with proximal tubal obstructions and achieved a patency rate of 94.6% as well as a PR of 46.7% (24). Unfortunately, there are few reports so far on the use of this complex in hydrotubation. Otherwise, if these results could be reproducible hydrotubation, use of the "Angelica" complex as an adjuvant to transcervical tubal catheterization may be beneficial.

Laparoscopic and laparotomy microsurgical techniques in combination with CO_2 laser are used for treatment of tubal obstruction (5). However, preference of this technique, except for a selected group of patients, should be reconsidered. In a multicenter study, Confino et al. (1990) observed that a significant portion of their patients with proximal tubal obstructions form intraluminal plugs (11). If tubal occlusion is caused in many by intraluminal plug formation, microsurgical tubal reanastomosis would convert an apparently normal tube into a scarred tube (11).

In mid-tubal occlusions, tubal anastomosis can frequently be performed. Most of these operations used to be carried out by laparotomy with or without magnification, but currently, they also are carried out by microsurgical laparoscopy (1,35). Results of surgery seem to be more associated with the tubal length above the critical 3-cm length (25,26,66), and the previous method of surgical intervention (1,34), than to the type of reconstructive surgery opted for. The global PR outcome is fairly high and varies from 50% to almost 90% in laparotomy with or without magnification and laparoscopic surgery (1,25,33,34). The Pomeroy, Uchida, fallopian ring, and Hulka methods of ligation have the highest reversal success PR outcome. The recently developed laparoscopic "one" (Dubuisson, 1995), "two" (Barjio et al., 1999), and "three" (Reich et al., 1993) stitches techniques have facilitated laparoscopic microsurgery (38-40).

In treatment of distal occlusion, almost all the studies have shown that hydrosalpinx, the “chronically ill” fallopian tube, or both, are associated with significant low rates of implantation and high rates of pregnancy loss. Irrespective of the tubal score, the pregnancy outcome is better with: (i) fimbrioplasty than neosalpingostomy (41,43,47), (ii) Salpingectomy than chronically ill intact tube (57,58), (iii) diseased tube without hydrosalpinx than a tube with hydrosalpinx (53,54,58,66-68), (iv) aspirated hydrosalpinx than non-aspirated (54), and (v) surgically treated hydrosalpinx than an aspirated hydrosalpinx (58). The above findings apply to both cases of

normal pregnancy and IVF-ET.

From the above observations, it would be logical to go in for the most profitable surgical procedures, which in our opinion would be fimbrioplasty for the less-damaged tubes and surgical removal of the more damaged tubes before referral for IVF-ET. However, the fact remains that cases of intrauterine pregnancies have been reported following neosalpingostomy in patients who have had several failed trials of IVF-ET (56). Also, the fact that surgical removal of diseased tubes may not be accompanied by positive IVF-ET results, therefore, preventive salpingectomy should not be routine. A better understanding of the actions of the hydrosalpinx fluid may be the solution of this problem.

Aboulghar et al., in 1998, observed fluid accumulation in the uterine cavity during embryo transfer, and Anderson et al., in 1994, sonographically diagnosed hydrosalpinx and observed its association with low rates of implantation and high pregnancy loss (51,53). Following these findings, many studies have confirmed this association. Mukeherjee, in 1996, demonstrated its significant embryotoxic nature (52). Arrighi et al., in 2001, demonstrated that hydrosalpinx fluid (HSF) affects fertilization, as determined by the count of 2-cell murine embryos (69). In the same study, preincubation of spermatozoa with HSF during capacitation significantly lowered the percentage of 2-cell embryos. In contrast, preincubation of ovulated oocytes surrounded by their cumulus cells with HSF before IVF did not impede first cleavage. In a complementary work, El-Mowafi et al., in 2001, demonstrated that HSF is embryotoxic and has a deleterious effect on hatching, implantation, and outgrowth of the mouse blastocysts (70). The mechanism by which the hydrosalpinx fluid negatively affects implantation is not yet known. The proposed mechanisms by which hydrosalpinx may exert a negative impact on IVF success include: (i) reflux of hydrosalpinx fluid into the uterine cavity, (ii) irreversible endometrial damage, (iii) release of intra-uterine cytokines, prostaglandins, leukotrienes, and other inflammatory

compounds directly into the endometrium, or by way of the circulatory or lymphatic system, (iv) delayed hypersensitivity responses secondary to increased production of a 57-Kd heat shock protein leading to pregnancy loss, or (v) chronic endometritis caused by chlamydia trachomatis. All of the above mechanisms may potentially act by altering endometrial receptivity (6).

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Table I. Falloscopic Classification and Localisation of Tubal Lumen Disease (20)

	Right Tube				**Left tube**			
Site of Disease	Intramural	Isthmic	Ampullary	Fimbial	Intramural	Isthmic	Ampullary	Fimbial
Patency Patent----------1 Stenosis---------2 Obstruction-----3								
Epithelium Normal----------1 Pale, Atrophic-- 2 Flat,Featureless-3								
Vascularity Normal----------1 Intermediate-----2 Poor, pallor------3								
Adhesions None----------1 Thin, weblike---2 Thick----------3 Hydrosalpinx---3								
Dilatation None----------1 Moderate--------2 Hydrosalpinx---3								
Other---------2-3								
Cumulative score								
TOTAL SCORE	Right Tube = (Normal=20)				Left Tube = (Normal=20)			

Table II: Relationship of Tubal Score and Subsequent Pregnancy Rates (20)

Fallopian Tube Disease	**Falloscopy Score**	**12 months PR**
Healthy tube	Score = 20	21%
Mild/moderate disease	Score = 21-30	9%
Severe disease	Score > 30	0%

PR = pregnancy rate

Table III. Fluoroscopic-Guided Transcervical Catheter Salpingoplasty with Coaxial Catheter and Guidewire

Reference	Number	Patency %	Intrauterine Pregnancy %	Ectopic Pregnancy %	Observation
Martensson et al.(1993)[71]	10	61.5	50	10	4 months
Lang and Dunaway, (1994) [72] • Failed reversal surgery (4 had fistulas) • Failed tuboplasty • Total	7 12 19	 43 100 71.5	16	0	6 months

Table IV. Fluoroscopic-Guided Transcervical Balloon Tuboplasty

Reference	Number	Patency %	Intrauterine Pregnancy %	Ectopic Pregnancy %	Observation
Confino et al. (1990) [11]	77	92	27.2	1.3	12 months follow up 5 re-occlusions

Table V. Laparoscopic-Guided Transvaginal Catheterization Followed by Ultrasonographic-Guided Hydrotubation to Ascertain Patency

Reference	Number	Patency %	Intrauterine Pregnancy %	Ectopic Pregnancy %
Lisse and Sydow (1999)[21]	19	84.2	26.3	0

Table VI. Hysteroscopic, Laparoscopic and Fluoroscopic Guidewire Cannulation and Direct Balloon Tuboplasty (DBT)

Reference	Number	Patency %	Observation
Kerin et al. (1990) [17] • Non-obstructive cases • Stenosis • SIN • Fibrotic obstruction • Total	 10 15 2 5 32	 60 40 50 0 41	Partial perforation of the tubal wall in one case of SIN and two complete isthmic perforations.

SIN = Salpingitis isthmica nodosa

Table VII: Hysteroscopic-Guided Falloscopy with Linear Eversion Catheter (LEC)

Reference	Number	Patency %	Observation
Lee (1998) [28] Interstitial occlusion	5	60	One case of perforation to the ampulla

Table VIII. Non-Hysteroscopic-Guided Falloscopy with LEC

Reference	Number	Patency %	Intrauterine Pregnancy %	Ectopic Pregnancy %	Observation
Sueoka et al. (1998) [73]	50	85.3	22	0	2 months follow up 19.6% had re-occlusions within 3 months

Table IX. Ultrasound-Guided Transcervical Tuboplasty

Reference	Number	Patency %	Intrauterine Pregnancy %	Ectopic Pregnancy %	Observation
Stern et al. (1993)[63]	30	96	38	0	1 year follow up

Table X. Ultrasound-Guided Transcervical Balloon Tuboplasty (TBT) Followed by Confirmation of Tip of Catheter by Fluoroscopy

Reference	Number	Patency %	Intrauterine Pregnancy %	Ectopic Pregnancy %	Observation
Confino et al. (1992) [64]	4	100	25	0	1 month follow up

Table XI. Results of Salpingostomy

Reference	Number of Patients	Term Pregnancy (%)
Mulligan (1966) [74]	45	8
Garcia (1968) [75]	25	8
Rock et al. (1978) [76]	18	6
DeCherney and Kase (1981) [77]	9	0
Wallach et al. (1983) [78]	24	8

Table XII. Results of Fimbrioplasty

Reference	Number of Patients	Term Pregnancy (%)
Siegler and Kontopoulos (1979) [79]	20	35
Fayez and Suliman (1982) [80]	25	40
Frantzen and Schlösser (1983) [81]	49	22
Patton (1982) [82]	35	60
Donnez and Casanas-Roux (1986) [83]	132	60

Table XIII: Fimbrioplasty Compared with Salpingostomy

Reference	Fimbrioplasty		Salpingostomy	
	Number	IUP (%)	Number	IUP (%)
Mettler et al. (1979) [84]	51	31	38	26
Fayez (1983) [85]	14	21	19	0
Kasia et al. (1997) [47]	108	33	86	11

Table XIV. Variation of IUP Rates with Tubal Score

Reference	**Tubal Score**			
	I	**II**	**III**	**IV**
Dubuisson et al. (1994) [45]	9/15 (60%)	15/29 (51.7%)	2/16 (12.5%)	0/21 (0%)
Filipini et al. (1996) [46]	12/21 (51%)	19/49 (38.7%)	3/22 (13.6%)	0/12 (0%)
Kasia et al. (1997) [47]	26/78 (33.3%)	15/46 (32.6%)	4/47 (8.5%)	0/23 (0%)

Table XV. CO_2 Laser Laparoscopic Surgery versus Microsurgery

Tubal Score	Laparoscopic Surgery		Microsurgery	
	Number 87	**IUP (%) 33**	**Number 76**	**IUP (%) 30**
I	32	50	12	67
II	37	32	30	37
III	12	8	21	14
IV	6	0	13	8

Table XVI. Salpingectomy versus No Salpingectomy before ICF-ET

Reference	Salpingectomy			No Salpingectomy		
	Number	Implantation Rate	Ongoing Pregnancy	Number	Implantation Rate	Ongoing Pregnancy
Dechaud et al. (1998) [56]	30	13.4%	34.2%	30	8.6%	18.7%
Bredkjaer et al. 1999) [57]	139	19%	21.7%	139	21%	21.6%

Table XVII. Hydrosalpinx Compared with No Hydrosalpinx in IVF-ET

Reference	Hydrosalpinx			No Hydrosalpinx		
	Number	Implantation Rate (%)	Ongoing Pregnancy (%)	Number	Implantation Rate (%)	Ongoing Pregnancy (%)
Anderson et al. (1994) [53]	62	3	30	493	10	64
Vandrome et al. (1995) [58]	37	4	100	41	11	86
Fleming and Hull (1996) [67]	79	9	83	198	15	93
Kartz et al. (1996) [68]	79	4	56	812	12	69
Sharara et al. (1996) [86]	63	10	89	60	13	91
Van Voorhis et al.(1998) [54]	34	18	15	124	37	34

Table XVIII. Hydrosalpinx Treated versus Untreated Hydrosalpinges in IVF-ET

Reference	Hydrosalpinx-Treated			Hydrosalpinx Untreated		
	Number	Pregnancy Rate	Ongoing Pregnancy	Number	Pregnancy Rate	Ongoing Pregnancy
By aspiration Van Voorhis et al. (1998) [54]	16	31%	31%	18	5%	0%
Surgical treatment Vandrome et al. (1995)[58]	22	73%	81%	37	19%	100%

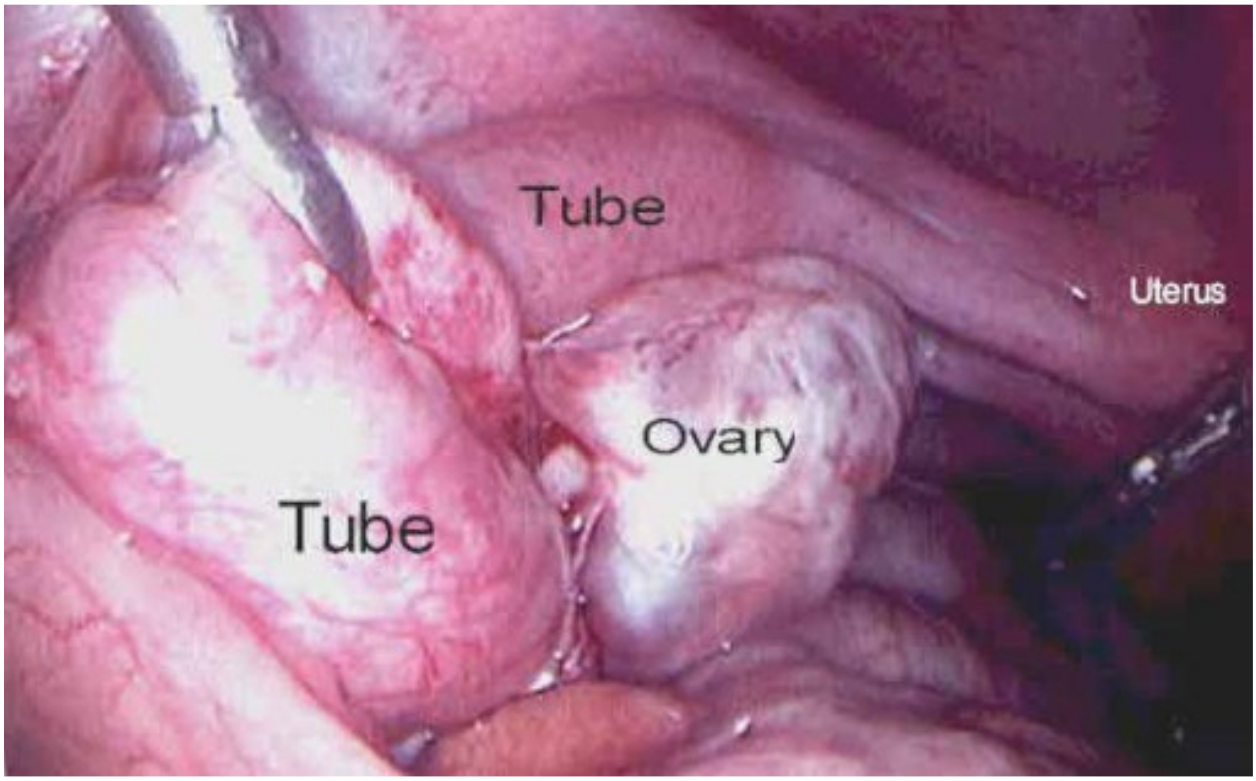

Figure 1: Hydrosalpinx

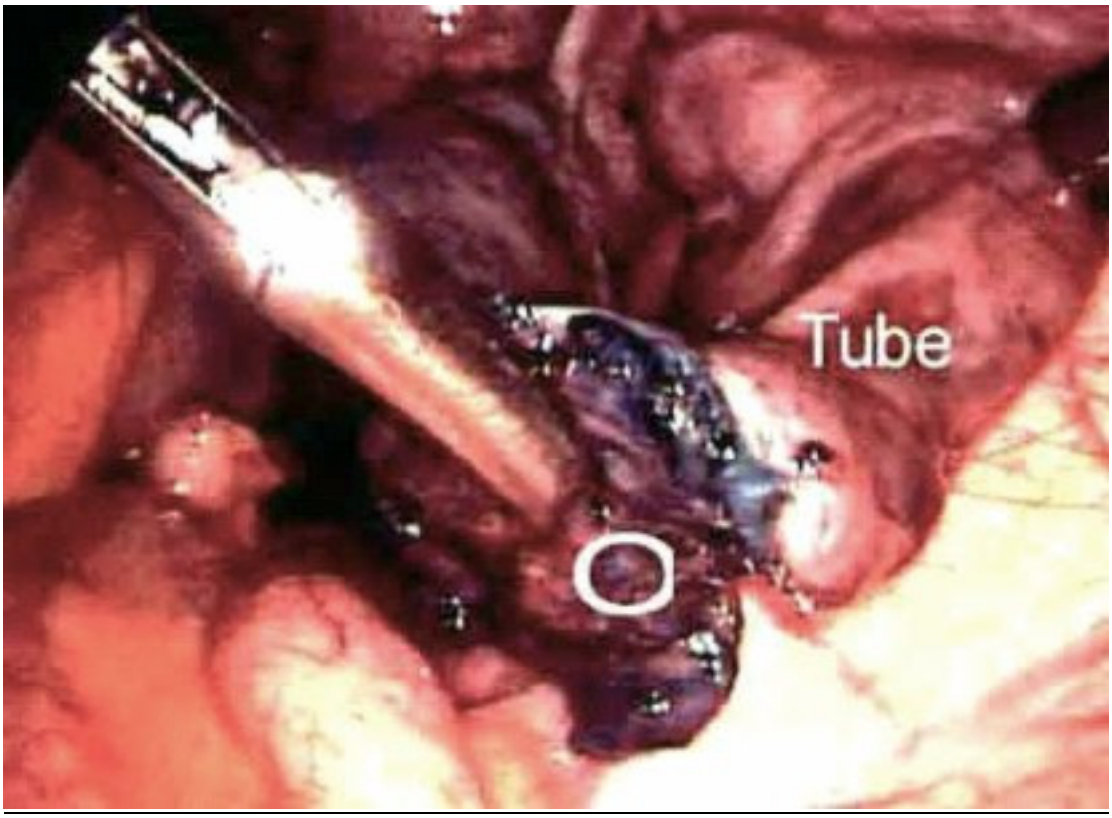

Figure 2: Laparoscopic salpingostomy