Controversies in the modern management of hydrosalpinx

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The management of hydrosalpinx is a difficult clinical problem. Surgical treatment includes fimbrioplasty for patients with fimbrial obstruction and salpingostomy to fashion a stoma in the distal Fallopian tube in patients with a damaged fimbrial end. Surgery is only suitable for a small thin-walled hydrosalpinx with healthy mucosa. These operations can be performed via laparoscopy or open microsurgery. The proper selection of patients for surgical treatment and of the type of surgical technique are essential to achieve good results. The results of open microsurgery and laparoscopic surgery are summarized. In general, the prognosis of surgery is poor; however, in well selected cases, good results can be achieved by an experienced surgeon. In-vitro fertilization (IVF) is the main line of treatment for infertility caused by hydrosalpinx. In 1991, our group was the first to report on fluid accumulation in the uterine cavity before embryo transfer as a possible hindrance for implantation. Later, several publications reported an association between patients with hydrosalpinx and a reduced pregnancy rate when treated by IVF. The cause of a low pregnancy rate could be due to mechanical, chemical or toxic effects of the tubal fluid on the endometrium preventing implantation. All these mechanisms are reviewed in detail. The literature is controversial concerning the effect of transvaginal aspiration of hydrosalpinx on the outcome of IVF. Several reports suggest that surgical correction of the hydrosalpinx may improve the outcome of IVF. Further studies are required to verify this assumption and to find out the most suitable surgical procedure and if there is a subgroup of patients who could benefit most from salpingectomy.

Key words: fimbrioplasty/hydrosalpinx/pregnancy rate/salpingectomy/salpingostomy

Introduction

Hydrosalpinx is a chronic pathological condition of the Fallopian tube, and is a major cause of infertility. In most patients, the fimbriated end of the tube adjacent to the ovary is occluded and the distal half of the tube is distended with fluid (Woodruff and Pauerstein, 1969). The occlusion usually occurs secondary to pelvic inflammatory disease, and may sometimes result from fimbrial serosal obstruction following an adjacent appendicular inflammation (Puttemans and Brosens, 1996). Distal occlusion may be the result of endometriosis (Nezhat et al., 1990; Heylen et al., 1995).

The incidence of hydrosalpinx in tubal factor infertility patients treated by in-vitro fertilization (IVF) varies according to the diagnostic tool used. Based on hysterosalpingography, the incidence ranged from 26 to 30% (Strandell et al., 1994; Blazar et al., 1997; Murray et al., 1998). On the other hand, when ultrasonography was used for the diagnosis, the incidence ranged from 10 to 13% (Andersen et al., 1994; Katz et al., 1996).

The diagnosis of hydrosalpinx is usually made by hysterosalpingography, showing a distended tube with obstructed fimbria. However, it should be noted that the size of the hydrosalpinx diagnosed by hysteroscopy shows an...
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The same surgical approach is performed using laparotomy or laparoscopy.

The tube is opened through a Stellate or cruciate incision in the avascular area. The neosalpingostomy is maintained by suturing back the newly created ostium to the adjacent mesosalpinx. The perals of the neosalpingostomy may similarly be everted using a defocused laser beam applied to the serosal surface to flower the distal end, and meticulous homeostasis is maintained to minimize adhesion formation. Care is taken to avoid tissue desiccation and to avoid creating raw surfaces (Sauer, 1997).

Donnez and Casanas-Roux (1986) studied the prognostic factors of fimbrial microsurgery. They operated upon 257 women and found out that, after fimbrioplasty for occlusion of degree I and salpingostomy for degree II, the term pregnancy rate was >50%. After salpingostomy for occlusion of degrees III and IV, the term pregnancy rates were respectively 25 and 22%. These results suggested that the outcome of surgery for distal tubal occlusions is related to the tubal morphological findings.

Preoperative patient selection is an essential step for successful surgery for distal tubal occlusion. The extent and the degree of tubal damage as assessed by hysterosalpingography and laparoscopy is the most important single factor for achieving a good pregnancy rate. Exclusion of certain pathological conditions, such as tuberculosis, is important. The age of the patient has a great impact on choosing the line of treatment. There is a tendency to perform surgery in younger age groups, as IVF can be used if no pregnancy follows surgery. Couples with male factor should be excluded, as any suspicion of a male problem will tip the balance in favour of assisted reproduction.

The main advantage of laparoscopic surgery over microsurgery in the treatment of hydrosalpinx is that the laparotomy incision is avoided, leading to less postoperative discomfort and pain for the patient, shorter hospitalization time, lower hospital cost and quicker resumption of normal activities (Gomel, 1995). Table I summarizes the pregnancy rate in patients with hydrosalpinx treated by surgery.

Audebert et al. (1998), in a prospective study, reported a 51% clinical pregnancy rate and a 23% ectopic pregnancy rate in 35 patients with severe fimbrial occlusion treated by laparoscopic fimbrioplasty.

It seems that the reproductive outcome after laparoscopic surgery is similar to that of open microsurgery, although a prospective, randomized comparison of the two procedures has not yet been performed. Furthermore, the use of lasers does not appear to have a major impact on the results, although further studies are needed to address this issue (Tarlatzis and Grimbizis, 1997).

Surgical treatment of hydrosalpinx

Various treatments have been proposed for patients suffering from distal tubal infertility. Fimbrioplasty is indicated in patients with fimbrial occlusion usually with concurrent periadnexal adhesions. Any fibrous tissue covering the terminal end of the tube is incised or excised, and the agglutinated fimbria is freed (Gomel and Wang, 1994).

Salpingostomy is the procedure whereby a stoma is fashioned in the distal Fallopian tube using scissors, electrosurgery or laser (Hamilton et al., 1986; Gomel, 1994).

The artificially distended tube. Sonohysterosalpingography using echogenic fluid medium is also useful in the diagnosis of hydrosalpinx (Heikkinen et al., 1995).

It is not usually difficult to diagnose a hydrosalpinx by vaginal ultrasound (US). However, it seems that less than half of hydrosalpinges are large enough to be noticed by vaginal US. Atri et al. (1994) were able to diagnose hydrosalpinx by US in only 34% of patients diagnosed by hysterosalpingography.

Laparoscopy is an important tool not only for diagnosis of hydrosalpinx, but mainly for choosing suitable cases for laparoscopic or open microsurgery. An outline of the diagnostic stages leading up to treatment is shown in Figure 1.

**Figure 1.** Stages in the diagnosis and pretreatment of hydrosalpinx. PID = pelvic inflammatory disease; US = ultrasound.
Table I. Results of surgery for distal tubal occlusion

<table>
<thead>
<tr>
<th>Reference</th>
<th>Procedure</th>
<th>No. of patients</th>
<th>No. (%) clinical intrauterine pregnancies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tulandi et al. (1984)</td>
<td>Open microsurgery</td>
<td>45</td>
<td>10 (22)</td>
</tr>
<tr>
<td>Boer-Meisel et al. (1986)</td>
<td>Open microsurgery</td>
<td>108</td>
<td>28 (25.9)</td>
</tr>
<tr>
<td>Dubuisson et al. (1990)</td>
<td>Laparoscopic surgery</td>
<td>65</td>
<td>18 (27.7)</td>
</tr>
<tr>
<td>Aubert et al. (1991)</td>
<td>Open microsurgery</td>
<td>211</td>
<td>65 (30.8)</td>
</tr>
<tr>
<td>Aubert et al. (1991)</td>
<td>Laparoscopic surgery</td>
<td>55</td>
<td>8 (14.5)</td>
</tr>
<tr>
<td>Canis et al. (1991)</td>
<td>Laparoscopic surgery</td>
<td>87</td>
<td>29 (33)</td>
</tr>
<tr>
<td>Audebert et al. (1998)</td>
<td>Laparoscopic surgery</td>
<td>35</td>
<td>18 (51.4)</td>
</tr>
</tbody>
</table>

Table II. Effect of hydrosalpinx on in-vitro fertilization/embryo transfer (ET) pregnancy rate

<table>
<thead>
<tr>
<th>Reference</th>
<th>Hydrosalpinx</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of patients/ET (%)</td>
<td>No. of patients/ET (%)</td>
</tr>
<tr>
<td>Strandell et al. (1994)</td>
<td>12/91 (13)</td>
<td>90/358 (25)</td>
</tr>
<tr>
<td>Anderson et al. (1994)</td>
<td>20/91 (21.9)</td>
<td>265/744 (35.6)</td>
</tr>
<tr>
<td>Kassabji et al. (1994)</td>
<td>43/234 (18)</td>
<td>70/233 (31)</td>
</tr>
<tr>
<td>Vandromme et al. (1995)</td>
<td>7/69 (10)</td>
<td>14/61 (23)</td>
</tr>
<tr>
<td>Sharara et al. (1996)</td>
<td>25/101 (25)</td>
<td>30/89 (33.7)</td>
</tr>
<tr>
<td>Katz et al. (1996)</td>
<td>16/95 (17)</td>
<td>467/1268 (37)</td>
</tr>
<tr>
<td>Freeman et al. (1998)</td>
<td>13/45 (29)</td>
<td>51/88 (58)</td>
</tr>
<tr>
<td>Murray et al. (1998)</td>
<td>4/47 (9)</td>
<td>44/145 (30)</td>
</tr>
</tbody>
</table>

Based on salpingoscopy examination (Puttemans and Brosens, 1996) the hydrosalpinx can be classified into hydrosalpinx simplex, represented by a thin-walled hydrosalpinx with flattened mucosal folds without mucosal adhesions, and hydrosalpinx follicularis, which is a thin-walled hydrosalpinx with mucosal adhesions. A third variety is the thick-walled hydrosalpinx with absent mucosal folds.

Women with extensive tubal damage, as evidenced by extensive adhesions and dilated tube beyond 3 cm, are not suitable for surgical treatment (Sauer, 1997). Women with both distal and proximal tubal disease should not undergo surgical repair (Dodson et al., 1986).

Vasquez et al. (1995) identified a subgroup, comprising one-third of their patients, with thin-walled hydrosalpinx and reasonably healthy mucosa. In this subgroup, good results were achieved by surgery (Boer-Meisel et al., 1986). The majority of patients with hydrosalpinx have a relatively poor pregnancy rate after reconstructive surgery (Boer-Meisel et al., 1986; Gomel and Wang, 1994; Nezhat et al., 1992), although excellent results with surgical treatment of hydrosalpinx have been reported in small series by a few highly specialized surgeons (Dubuisson et al., 1990; Gomel and Wang, 1994). A pregnancy rate of 25–50% was reported following fimbrioplasty (Gomel, 1983; Dubuisson et al., 1990) and 15–30% following salpingostomy (Gomel and Wang, 1994).

The results of salpingostomy reported by expert groups appear to be much higher than the unpublished results of other infertility clinics. Alberta Health Care Claims Database (Dunphy et al., 1996) showed an overall cumulative live birth rate of 11.7% in >500 consecutive patients after 5 years of follow up.

It seems that well-selected cases treated by experienced microsurgeons may benefit from surgical treatment, but, as a whole, the population of women with severe tubal disease benefits little from surgical treatment (Sauer, 1997).

It is believed that the most important factors determining the outcome after surgical correction are the condition of the endosalpinx, the amount of tubal dilation, the condition of the tubal wall and the presence of adhesions.

Hydrosalpinx and pregnancy rate in IVF

Since the development of IVF technology, it has become the main line of treatment for tubal infertility caused by hydrosalpinx; however, it seems that the presence of hydrosalpinx adversely affects the results of IVF. Table II summarizes the effect of hydrosalpinx on the pregnancy rate in patients treated by IVF.

Oehninger et al. (1989) demonstrated that patients with tubo-ovarian disease present a decreased pregnancy rate per cycle and per transfer after IVF–embryo transfer when compared with patients with a previous tubal ligation.

Recent reports suggest that hydrosalpinx are associated with reduced pregnancy rates and increased miscarriage rates in patients undergoing IVF and embryo transfer (Andersen et al., 1994; Kassabji et al., 1994; Strandell et al., 1994; Sowter et al., 1997). Akman et al. (1996) reported that both pregnancy and implantation rates were significantly lower in patients with sonographically do-
cumented hydrosalpinges after transfer of cryopreserved thawed embryos during a natural cycle. Andersen et al. (1994) showed that the presence of a hydrosalpinx is associated with a reduced pregnancy rate (19.2 versus 32.6%), reduced implantation rate (2.9 versus 10.3%), reduced delivery rate per aspiration (5.8 versus 20.9%) and reduced delivery rate per embryo transfer (6.6 versus 22.8%). The pregnancy rate for patients with hydrosalpinx was only half that of patients with other tubal damage (Strandell et al., 1994). Furthermore, due to a tendency towards a higher pregnancy loss, the delivery rate for patients with a hydrosalpinx was only one-third of that for patients with other tubal lesions (Strandell et al., 1994).

Dubuisson et al. (1991) evaluated the risk factors for ectopic pregnancy after IVF and they concluded that the rate of ectopic pregnancy after IVF appears to be related to pre-existing tubal pathology.

Based on US diagnosis, Katz et al. (1996) noted the presence of hydrosalpinx in 118 cycles, whereas in 1648 cycles, there was no hydrosalpinx. The hydrosalpinx group displayed a significantly lower pregnancy rate per transfer (16.84 versus 36.83%) and a lower implantation rate (3.92 versus 11.53%) than the control group. Katz et al. (1996) concluded that the presence of hydrosalpinx adversely affected the outcome of IVF. The same findings had previously been described by Lejeune et al. (1991) and Andersen et al. (1994).

Wit et al. (1998), in a retrospective study, demonstrated that the cumulative chance of achieving an ongoing pregnancy after one or more IVF cycles was significantly reduced in the presence of an US-visible hydrosalpinx. In the presence of a hydrosalpinx not visible by US, the IVF outcome was not reduced.

Andersen et al. (1996) analysed clinical data, including sonographic assessment of induction, in a consecutive series of 38 IVF-treated patients with hydrosalpinges. They found that 42% of patients had a history of hysterosalpingography showed uterine cavity fluid distension and none of these patients obtained an ongoing intrauterine pregnancy after the IVF treatment. The authors stressed the need for a further exploration of the possibility that these patients do have a very unfavourable prognosis and should be operated on. A laparoscopy, most often resulting in salpingectomy, prior to IVF was suggested.

Shelton et al. (1996) observed the effects of salpingectomy in patients with hydrosalpinges who had undergone failed IVF–embryo transfer, and demonstrated a significant improvement in pregnancy and implantation rates after surgery. Sharara et al. (1996) indicated that prior treatment with antibiotics may improve IVF outcome in patients with hydrosalpinges.

The relationship between the number of replaced embryos and the outcome of IVF in patients with hydrosalpinges was investigated by Abd-el-Maeboud et al. (1998). They found that an increased number of replaced embryos counteracted the adverse effect of hydrosalpinges on IVF outcome.

Strandell et al. (1994) found that the size of the hydrosalpinx influenced the pregnancy rate in IVF. They found little difference in results in patients with slight distension of one or both tubes but a significant decrease in both pregnancy and delivery rates per transfer in individuals with marked tubal distension.

A few studies have not confirmed an effect of hydrosalpinx on pregnancy rate in IVF. Ng et al. (1997) evaluated the effect of hydrosalpinx on the outcome of IVF and reported that the mean implantation rate and clinical pregnancy rate were similar in patients with or without hydrosalpinx. There was no increase in the clinical abortion rate but ectopic pregnancies were more common in patients with hydrosalpinx and they concluded that hydrosalpinx did not adversely affect the implantation rates. Other studies showed that there was a trend for a higher implantation rate and ongoing pregnancy rate in the no-hydrosalpinx group compared to the hydrosalpinx group; however, this did not reach statistical significance (Sharara et al., 1996; Blazar et al., 1997).

Hydrosalpinx and pregnancy wastage

Andersen et al. (1994) reported that the presence of hydrosalpinx increased early pregnancy loss (70 versus 36%), and they postulated that this may be due to leakage of fluid into the uterine cavity, which may disturb the receptivity of the endometrium and/or the developing embryos. Sims et al. (1993) also found a significant increase in early pregnancy wastage in patients with a hydrosalpinx. It suggested that the presence of a tube persistently dilated by fluid is associated with a reduced chance of implantation and an increased risk of early pregnancy loss (Strandell et al., 1994).

Mechanism of reduced pregnancy rate in patients with hydrosalpinx

There is no definite explanation for the mechanism by which a hydrosalpinx exerts an adverse influence on development and/or implantation of embryos (Vandrome et al., 1995). The presence of hydrosalpinges is often preceded by a severe inflammatory process obstructing the distal end of the Fallopian tube. The continued inflamma-
tory process combined with the natural transitional cell mucous production produce a swollen non-functioning tube that often causes leakage of hydrosalpinx fluid into the uterine cavity (Vandrome et al., 1996).

In general, there is communication from the hydrosalpinx to the uterine cavity, and Mansour et al. (1991) were the first to report on fluid accumulation in the uterine cavity which is believed to impair implantation. Such transport of fluid is possible since salpingograms as well as some experimental data (Halbert and Patton, 1981) show that the uterine ostium of the tube need not be totally obstructed for a hydrosalpinx to occur. Mere distension of the uterine cavity, preventing appropriate contact of the embryo with the endometrial epithelium, might be enough to interfere with implantation (Vandrome et al., 1995).

The apparent disturbance in endometrial receptivity may be caused by several mechanisms. It may be mechanical, but it may also be due to altered chemical composition of the fluid from the hydrosalpinx (David et al., 1969). Another possibility is that a hydrosalpinx causes an inflammatory response which may be detrimental to the developing embryo and/or the endometrium (Andersen et al., 1994).

Murray et al. (1997) showed that the inhibitory effect of human hydrosalpingeal fluid on mouse preimplantation embryonic development is significantly reduced by the addition of lactate.

Beyler et al. (1997) evaluated in-vitro mouse embryo development in the presence of hydrosalpingeal fluid. A significant deleterious effect upon mouse embryo cleavage and development to the expanded and hatched blastocyst stage was found. Dilation of the hydrosalpingeal fluid to 30% concentrations with culture medium failed to negate this effect. Additional further experiments performed with culture under an oil overlay significantly reduced the embryotoxicity of the hydrosalpingeal fluid, suggesting that there may be a lipophilic factor that can impair embryo development.

Rawe et al. (1997) demonstrated that hydrosalpingeal fluid in culture medium affected embryo development in a dose-dependent fashion, but the injection of the fluid into the uterine horn did not affect embryo implantation.

Another hypothesis would be that toxic substances contained in hydrosalpinx fluid are able to drain into the uterine cavity. Evacuation of hydrosalpinx fluid into the uterus might, therefore, dilute endometrial secretions for these substances and generate an unfavourable uterine milieu (Vandrome et al., 1995).

It was shown that all samples of tubal fluid obtained from hydrosalpinges demonstrated a significant embryo toxic effect at either the 100% or 10% concentration (Mukherjee et al., 1996). Because the embryo toxicity was also demonstrated at the 1% dilution of hydrosalpinx fluid, subclinical fluid accumulation may be a potential source of IVF failure (Mukherjee et al., 1996). Furthermore, the authors suggested that procedures such as salpingectomy, or proximal tubal occlusion to circumvent the passage of hydrosalpinx fluid into the uterine cavity may have beneficial effects on the developmental environment for embryos in vivo.

A number of cellular elements involved in late inflammatory reaction, such as macrophages, plasmocytes and other wandering cell types infiltrating the tubal wall (David et al., 1969), might release cytokines, prostaglandins, leukotrienes and other compounds which could be deleterious to intrauterine eggs. In addition to, or instead of, a direct embryotoxic effect, the establishment of endometrial receptivity might be disturbed through the presence of a hydrosalpinx (Vandrome et al., 1995).

A direct effect of Chlamydia trachomatis, or the indirect effect of protein expression, may also affect endometrial receptivity (Sharara et al., 1996). There may be a direct flow of micro-organisms, debris and lymphocytes from the hydrosalpinx into the uterus, and this detritus may exert a detrimental effect on the endometrium and/or the embryo. Cytokines, prostaglandins and leukotrienes may also be transferred directly to the endometrium. Other possible interfering substances in the region are catecholamines and peptidergic transmitters, which are known to participate in the regulation of tubal and uterine motility (Owman et al., 1992).

Freeman et al. (1998) compared the effect of hydrosalpinx on pregnancy outcome in 348 IVF cycles and followed the development of untransferred embryos for 7 days to determine if hydrosalpinx affects oocyte quality or embryo development. The delivery rate per retrieval was significantly lower for patients with hydrosalpinx but was restored by surgical treatment to that of patients without hydrosalpinx. Hydrosalpinges may have a permanent negative influence on ovarian function, follicular development and oocyte quality.

Another hypothesis for the lower pregnancy rate with hydrosalpinx is that the endometrium is damaged simultaneously with the acute-phase damage of the tubes, leaving the endometrium with a permanently diminished capacity for implantation (Strandell et al., 1994). However, this hypothesis is not consistent with the improved pregnancy rates after salpingectomy. A further possibility is that ovarian function, follicular development and oocyte quality are negatively influenced by the presence of hydrosalpinges (Strandell et al., 1994); however, Blazar et al. (1997) showed that neither response to stimulation nor rate of fertilization was responsible for the diminished ongoing pregnancy rates observed in patients with hydrosalpinx. Therefore, it seems that the presence of a hydrosalpinx does not impair the number of embryos transferred but seems to impair the implantation process (Andersen et al., 1994).
Meyer et al. (1997) performed endometrial biopsies in all women during the window of implantation, and analysed them by conventional histological criteria and also stained for three integrin markers of endometrial receptivity (α1β1, α4β1 and αvβ3). Women with hydrosalpinges expressed significantly less αvβ3 integrin compared with controls. There was no difference in expression of α1β1 or α4β1 among the groups. A significantly greater number of cases had out-of-phase histology and missing αvβ3 (type I defects) and absent integrin expression despite normal histological maturation (type II) defects compared with controls. Of 20 women with impaired endometrial receptivity who were also biopsied after hydrosalpinx surgery, 70% demonstrated increased αvβ3 expression. Using markers of endometrial receptivity, this study demonstrated that inflammatory hydrosalpinges had an adverse effect on endometrial receptivity, which in some cases could be overcome by surgical treatment of the hydrosalpinx (Meyer et al., 1997). One might postulate that, in the future, endometrial biopsy in the mid-luteal phase to detect Vβ3 integrin could be used to assist in selecting patients with hydrosalpinx who would benefit from salpingectomy (Blazar et al., 1997).

The role of salpingectomy and other procedures to circumvent passage of hydrosalpinx fluid into the uterus

Salpingectomy or proximal occlusion theoretically would improve conditions for implantation and embryogenesis (Table III summarizes the effect of salpingectomy on the pregnancy rate in patients with hydrosalpinges treated by IVF). Several reports have demonstrated increased implantation rates and decreased miscarriage rates after surgical extirpation, drainage, or proximal ligation of hydrosalpinges (Kassabji et al., 1994; Vandromme et al., 1995; Shelton et al., 1996). Vandromme et al. (1995) noted an overall difference in pregnancy rate of 28% by comparing IVF cycles in women with hydrosalpinges to cycles performed after surgical correction. Comparisons were made between 69 IVF cycles in 37 patients with hydrosalpinges (hydrosalpinx group) and 67 IVF cycles in 41 patients without tubes or who had been surgically sterilized (control group). Twenty-two patients carrying hydrosalpinges underwent salpingectomy or salpingoplasty (operated group); they then underwent 42 IVF trials. In the hydrosalpinx group, the pregnancy rate per oocyte retrieval was 10.1%. In the control group, the corresponding pregnancy rates were 23.0 and 21.3% respectively. The implantation rate per embryo was 4.2% for clinical and ongoing pregnancies in the hydrosalpinx group and 11.0 and 10.4% respectively in the control group. The operated group had a pregnancy rate of 38.1% for clinical pregnancies with an implantation rate of 17.4%. Pregnancy and implantation rates were statistically lower in the hydrosalpinx group as compared with controls and with the operated group. The differences between the control and operated groups were insignificant (Vandromme et al., 1995). These data show that the presence of a hydrosalpinx entails a poor prognosis for IVF treatment. It appears, moreover, from this work, that surgical correction by ablation of diseased tubes or salpingoplasty restores normal chances of success for these patients (Vandromme et al., 1995). It was also noticed that some patients with hydrosalpinx failed to become pregnant after three IVF-embryo transfer attempts, but succeeded in becoming pregnant at an attempt immediately after a salpingectomy (Strandell et al., 1994).

In a prospective randomized study, Dechaud et al. (1998) evaluated implantation and pregnancy rates in patients with severe tubal factor infertility who were undergoing IVF; patients who had undergone salpingectomy were compared with those who had not. There were higher implantation and pregnancy rates in patients with previous salpingectomy; however, the difference did not reach the level of significance, possibly because of the small sample size.

On the other hand, Shelton et al. (1996) showed that patients with hydrosalpinges undergoing natural cycle IVF ± embryo transfer did not exhibit poor outcomes in regard to their pregnancy or miscarriage rates. The authors concluded that, although salpingectomy or aspiration to drain fluid have increasingly been suggested in an effort to improve pregnancy rates, efficacy is difficult to assess since the studies are preliminary. Sowter et al. (1997), in a pilot study in 237 cycles in women with hydrosalpinges, found that hydrosalpinx is associated with a marked reduc-
sion in implantation rates and that surgical drainage appeared to offer no benefit.

It has also been suggested (Strandell et al., 1994) that salpingectomy may cause a reduction of the ovarian vascularization, entailing difficult stimulation and formation of follicular cysts. However, Russel et al. (1991) showed that the number of oocytes retrieved and other stimulation parameters were similar in the hydrosalpinx and operated groups. A group of 15 patients who had previously undergone failed IVF attempts and had unilateral or bilateral hydrosalpinx was subjected to an operative laparoscopy with excision of the affected tube(s) and there was no statistically significant difference between the number of mature eggs retrieved, peak oestradiol concentration, number of days to human chorionic gonadotrophin administration, or number of pre-zygotes frozen in the stimulated cycles pre- versus post-salpingectomy (Shelton et al., 1996). This was also suggested by Verhulst et al. (1994), who reported that bilateral salpingectomy had no detrimental effect on ovarian performance during IVF and embryo transfer treatment, nor on the outcome.

Mukherje et al. (1996) reported that the osmolarity of the hydrosalpinx fluid was similar to that of serum; however, the pH of the fluid was noted to be alkaline. The clinical effect of this elevation in pH remains unclear. Mukherje et al. stated that further biochemical analysis of fluid and continued bioassays may help define which dilated Fallopian tubes warrant surgical extirpation; however, they did not specify the types of assays that should be used.

In a retrospective study, Murray et al. (1998) found that patients with hydrosalpinges had significantly decreased implantation and pregnancy rates compared with patients with tubal factor infertility without hydrosalpinges. Murray et al. also reported that surgical correction of hydrosalpinges improved implantation and pregnancy rates. The type of surgery performed did not affect the success rates.

The data available in the literature strongly suggest that surgery for hydrosalpinx improves the pregnancy rate in IVF. This was further emphasized by Meyer et al. (1997), who observed dramatic improvement in endometrial receptivity as assessed by the presence of the αvβ3 integrin and histological dating after surgical treatment of hydrosalpinges.

Nackley and Muasher (1998) reviewed the significance of hydrosalpinx in IVF and concluded that the presence of a hydrosalpinx has a negative effect on IVF ± embryo transfer because of the suspected embryotoxicity of the hydrosalpingeal fluid; in addition, they concluded that surgical removal of the hydrosalpinx has been shown to improve IVF ± embryo transfer rates.

Surgery is not without risk, and the need to avoid the practice of indiscriminant salpingectomy in all women with hydrosalpinges who are considering IVF makes the ability to identify women at risk for suboptimal IVF success increasingly important (Blazar et al., 1997).

Salpingectomy may also carry the risk of the rare complications of interstitial pregnancy, which creates diagnostic and treatment difficulties (Raziel et al., 1989). Abdominal pregnancy following IVF after bilateral salpingectomy is another rare complication which has been reported (Fisch et al., 1996).

Salpingectomy can be performed laparoscopically; however, this may be extremely difficult in patients with extensive pelvic adhesions. In this group the medial end of the tube could be cauterized and divided, or could be occluded by a clip. The distal part of the tube could be opened widely to allow complete drainage. Opponents to prophylactic salpingectomy of hydrosalpinges have suggested the use of preoperative salpingoscopy in the IVF candidate, and it has also mentioned that the decision to perform preventive salpingectomy should not be taken without the demonstration of the presence of severe clinical pathology of the tubal mucosa associated with increased thickness of the tubal wall (Puttermans and Brosens, 1996). Hydrosalpinx with unhealthy tubal mucosa shown by salpingoscopy will be a strong point in favour of salpingectomy before IVF.

Mansour et al. (1991) was the first to report on aspiration through the cervix of fluid which accumulated in the uterine cavity before embryo transfer; however, pregnancy was not achieved in this series. Transvaginal aspiration of the tubal fluid was not successful as the tubes refilled within 2 days (Bloechle et al., 1997). The uterine cavity was evacuated via an embryo transfer catheter and three embryos were transferred. The serometra reappeared 3 days after embryo transfer. A pregnancy could not be achieved. This study suggests that the aspiration of hydrosalpinges and intraterine fluid accumulating during an IVF cycle is not beneficial. Aboulghar et al. (1990), in a controlled randomized study, evaluated the effect of transvaginal aspiration of hydrosalpinges before stimulation for IVF versus no aspiration and they reported the procedure did not improve the pregnancy rate. Cases have also been described where fluid from hydrosalpinges was aspirated transvaginally, and this procedure was followed by embryo transfer resulting in a successful pregnancy (Russel et al., 1991).

Van Voorhis et al. (1998) reported that hydrosalpinges diagnosed by ultrasound reduced the implantation rate, and clinical and ongoing pregnancy rates as compared to a control group. They also demonstrated that aspiration of the hydrosalpinges at the time of oocyte retrieval was asso-
associated with an improved pregnancy rate, and they suggested that aspiration may be an acceptable alternative to salpingectomy for these patients.

**Conclusions**

In general, surgical treatment of hydrosalpinx has a poor prognosis; however, well-selected cases with a healthy endosalpinx and Fallopian tubes with a small diameter have a good prognosis when the treatment is performed by experienced hands. The majority of patients with hydrosalpinges are usually treated by IVF. Recent evidence reviewed in this article strongly suggests that the presence of hydrosalpinx may have a deleterious effect on pregnancy rates in IVF. These data opened the door for possible surgical treatment of the hydrosalpinx before IVF. The value and the type of surgical treatment have to be verified by well designed studies, and the possible risks should be calculated against the benefits. If surgery will prove to be beneficial, does this apply to all patients with hydrosalpinx or only to a subgroup of patients yet to be defined? There is a large prospective ongoing multicentre Scandinavian study addressing this issue, and its results may help to clarify some of these points.

**References**


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