Reproductive BioMedicine Online (2011) 23, 53–62

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SYMPOSIUM: REPRODUCTIVE SURGERY
REVIEW

Current practice in tubal surgery and adhesion management: a review

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Abstract The diminished role of tubal surgery in infertile women following widespread access to IVF is now being reviewed as more patients and surgeons today consider tubal surgery as an effective alternative to assisted reproduction treatment in certain circumstances. The limitations of and lack of patient acceptance of assisted reproduction treatment for ethical and moral reasons have contributed to this change as well as advances in surgical techniques and instrument technology, notably developments in endoscopic surgery. Strategies in tubal surgery are largely unchanged but the mini-invasive nature of the endoscopic approach has added value because of less tissue trauma, better visualization of the operative field and more rapid healing, which make surgery using today's techniques an integral part of the treatment strategy in infertile couples.

KEYWORDS: adhesions, fertiloscopy, hydrosalpinx, laparoscopy, tubal surgery

Introduction

The almost universal availability of assisted reproduction treatment has led not only to a decline in the use of tubal surgery but also the number of skilled tubal surgeons that can undertake such procedures. Not surprisingly, leaders in assisted reproduction treatment have expressed their concern about this matter and some have thought it appropriate to write the obituary of tubal surgery (Feinberg et al., 2009).

Nevertheless, it is possible to identify several reasons to explain this situation and to argue that these two techniques are complementary and not competitive in the management of infertile couples (Bosteels et al., 2009; Gomel, 1983). This review explains why tubal surgery should be at least considered and discussed as an option before performing assisted reproduction treatment such as IVF.

Why IVF is not the only paradigm?

The contribution brought by assisted reproductive technologies, especially IVF for infertile couples as well as for other conditions such as genetic disorders, the transmission of

1472-6483/$ - see front matter
doi:10.1016/j.rbmo.2011.03.018

which can be avoided by the judicious use of assisted reproduction treatment, is not under dispute. The technique can be widely applied empirically and it is the only therapeutic option for many couples, given the cause of their infertility and their personal circumstances, notably the woman's age and or the husband's sperm characteristics.

However, it should be acknowledged that assisted reproduction treatment in its various forms is complex and demanding, not just physically but also psychologically, given that failure is more common than success. Such stress leads many couples to abandon IVF or assisted reproduction treatment if their first treatment does not lead to a successful outcome, namely pregnancy and live birth. Assisted reproduction treatment is also expensive, involves invasive procedures and carries particular risks such as ovarian hyperstimulation syndrome. In addition there is still some residual concern about a small excess of congenital abnormalities in the newborn, especially when intracytoplasmic sperm injection is used. Finally, assisted reproduction treatment continues to raise ethical or religious issues in some cultures, which add to the stress that infertile patients experience. Thus, one may argue that assisted reproduction treatment, notably IVF and related techniques, should be reserved specifically for couples where it is the best or the only option to conceive and that tubal and endoscopic surgery should not be relegated to a second-rank status.

Advantages of tubal surgery

In certain situations, tubal surgery may be the better therapeutic option in infertile patients especially if the cause of the infertility is considered to be solely due to tubal disease. Thus, there are advantages if the outcome of the tubal surgery is successful restoration or improvement of tubal anatomy: (i) the couple may conceive naturally and on more than one occasion; (ii) compared with the cost of IVF, tubal surgery is less costly; and (iii) there are no ethical issues to address. Nevertheless, tubal surgery should be offered only when a couple's chances of normal pregnancy and outcome are better than those of IVF, which this review argues is not an uncommon situation.

Disadvantages of tubal surgery

There are some specific aspects of tubal surgery which have led to the dramatic decline in its use in the last two decades.

Loss of surgical skills by specialists in reproductive medicine and surgery

In the early years of IVF, oocyte collection was exclusively performed by experienced reproductive surgeons using trans-umbilical laparoscopy until the early 1980s when ultrasound-guided oocyte collection was introduced. Initially, this was performed trans-abdominally or by the trans-vesical and trans-urethral routes, but the subsequent introduction of the vaginal approach quickly gained wide acceptance and eventually became universal. This major breakthrough and its popularity due to its simplicity and fast learning curve led to the lack of necessity for practitioners of reproductive medicine to learn or maintain the necessary surgical skills and techniques to be competent in undertaking reproductive surgery, especially for tubal disorders.

Inevitably, the techniques of tubal surgery, described so eloquently in the 1970s and later by authors such as Swolin (1967), Gomel (1977a,b) and Winston (1982), fell into disuse and were gradually abandoned in favour of the then-new IVF techniques, a process that was accelerated further by pressure from patients and others to whom IVF was the method of choice for having a child quickly and at the desired time.

Lack of training in tubal surgery

There followed a period when tubal surgery was practised by few proponents and was rarely an integral part of the training programmes in reproductive medicine and surgery. The consequence of this era was commented on by Watson et al. (1990), who emphasized how much the results of tubal surgery were a function of the caseload: 'the less a surgeon operated the worse the results. The reputation of the benefits of tubal surgery declined as it became common knowledge that it was not an easily accessible option as there were few trained surgeons and the few cases performed overall contributing to poor results cited, thus presenting justification for the protagonists of the ''universal IVF'' approach'.

Current considerations for tubal surgery and adhesion management

What is or should be the place of tubal surgery and adhesion management in infertility today? Can the teaching of tubal and related surgical techniques still be justified, especially at this time of rapid improvement in assisted reproduction treatment and its outcome? To answer these and other questions, issues such as definition of surgically treatable lesions and patient selection to name two should be addressed.

Definition of lesions

It is noteworthy that, despite the clarity in definitions of various tubal conditions and their treatment as well as the terminology used by the pioneers of microsurgery (Gomel, 1980; Mage et al., 1986; Winston and Margara, 1991), there has been non-compliance in using these principles by surgeons reporting their experience. Thus, it is timely to reinforce the importance of these early works. Surgeons should establish a clear distinction between incomplete obstruction (such as phimosis or fimbrial agglutination) where the treatment should be a fimbrioplasty, and total occlusion (such as hydrosalpinx) where the treatment is a salpingoneostomy (**Figure 1**). Furthermore, they should avoid using inappropriate or generalized, and so uninformative, terminology, such as salpingostomy instead of salpingoneostomy, for the treatment of hydrosalpinx. Similarly, more clarity is required when dealing with proximal tubal occlusion, where obstruction may be functional (spasm, mucosal plug) or organic (obliterative fibrosis, salpingitis isthmica nodosa, cornual polyps). The use of universally accepted terminology in describing tubal lesions and their treatment will

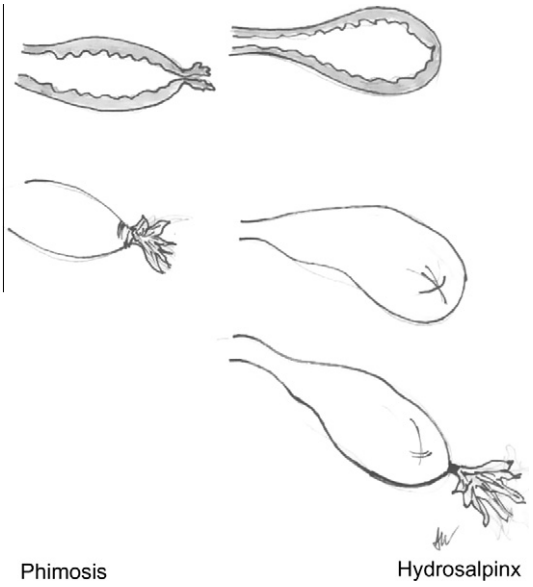

Figure 1 Distal lesions. Bottom right: the fimbria may still exist but with no communication with the ampulla, in this case it is a hydrosalpinx and not a phimosis.

facilitate a better understanding of the virtues and limitations of tubal surgery, as well as the ability to compare different procedures or alternatives in an accurate way.

Is it still useful to teach and learn tubal surgery in the era of IVF?

Many authors consider that tubal surgery is of no use today since the result of a trial comparing tubal surgery and IVF did not identify any advantages of tubal surgery except in cases of tubal anastomosis (Gomel and James, 1990). This is often true, but one may argue that the contrary is also true since no publications have been able to demonstrate that IVF is superior to tubal surgery in a prospective trial. Biases are numerous since the results of IVF differ from one centre to another or from one country to another (for example, IVF results are better in the USA than in Europe, which may be due to the embryo transfer policy) (Abdalla, 2010; Andersen et al., 2007; Gleicher et al., 2007; Society of Reproductive Medicine, 2008). The same may be true for tubal surgery where results depend on the surgeon and patient selection, despite the fact that even young surgeons are able to produce good results, providing that the teaching is adequate (Dunphy et al., 1997; Fratarelli et al., 2007).

Therefore, even if the comparisons and randomized controlled trials between the two methods are worth making, it seems logical to offer tubal surgery as a first alternative in favourable cases, to be followed by IVF if a pregnancy does not occur after some time, depending on the age of the patient, or when surgery fails (i.e. when tubal blockage is diagnosed again).

Patient selection

It is widely admitted that the key factors in the consideration of treatment options for any subfertile couple include the general health and age of the individual, as well as the results of assessments of male fertility and the uterine cavity and adjacent structures. This review is confined to consider four key parameters: (i) tubal permeability/patency; (ii) tubo-peritoneal environment; (iii) uterine cavity; and (iv) tubal mucosa.

Typically, two strategies are employed: non-invasive, such as hysterosalpingography (HSG), or ultrasonography, referred to as hystero-contrast-salpingography (HyCoSy); and invasive, such as trans-abdominal or trans-vaginal laparoscopy (fertiloscopy). The non-invasive methods have some limitations intrinsic to their dependence of visualization of liquid distending and passing through the uterine cavity and tubes, implying rather than observing the nature of the pathology should there not be a clear image of normal anatomy. In the meta-analysis of Swart and colleagues (1995), which included data from more than 4000 patients undergoing HSG in the assessment of tubal anatomy, the specificity was high but the sensitivity very low, leading to a false negative rate of 20—40% and a false positive rate of 15%. Similar limitations of HyCoSy were reported based on a study of 500 women (Hamilton et al., 1998).

Thus the comprehensive and accurate assessment of the internal genitalia require invasive, i.e. surgical techniques, the gold standard of which being until recently trans-abdominal diagnostic laparoscopy. Given that in the majority of subfertile women laparoscopic findings are likely to be normal, this procedure is not performed as a preamble to IVF, despite continuing reports advocating its use prior to deciding upon IVF in infertile women (Kahyaoglu et al., 2009; Moayeri et al., 2009; Tsuji et al., 2009). Furthermore, 10 years ago, the description of trans-vaginal hydrolaparoscopy (THL) by Gordts et al. (1998), soon followed by the description of fertiloscopy (Watrelot et al., 1999) (**Figures 2** and **3**), introduced the concept of a less invasive approach than trans-abdominal laparoscopy (Gordts et al., 2001). Subsequently, in a comparison with traditional trans-abdominal laparoscopy in a prospective multicentre trial (the FLY study; Watrelot et al., 2003), it was possible to conclude that the mini-invasive technique of 'fertiloscopy should be performed for infertile patients with no obvious pathology'.

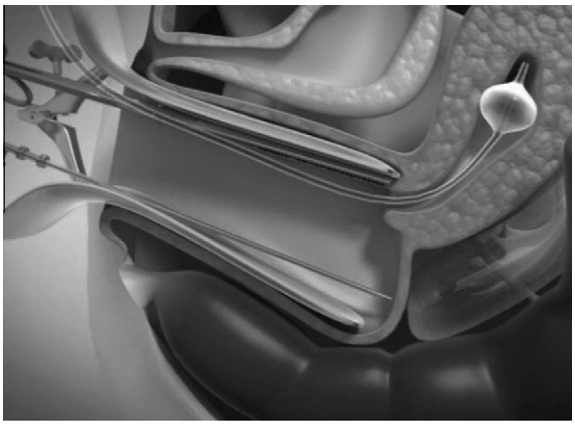

Figure 2 Principles of fertiloscopy: introduction of veres needle into the pouch of Douglas.

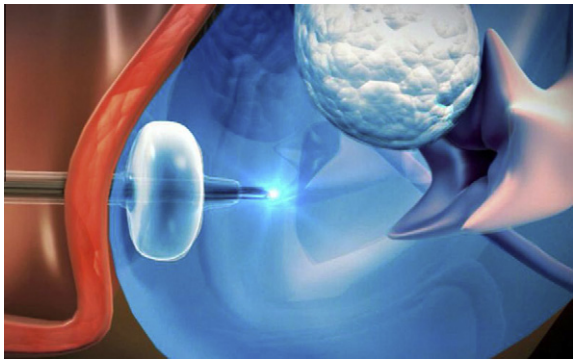

Figure 3 Principles of fertiloscopy: telescope in the pouch of Douglas, allowing the examination of genital structures. Note the balloon, which prevents an inadvertent exit from the pouch of Douglas.

Moreover, whatever the method of tubal assessment to be used, an accurate and comprehensive evaluation of the pelvis should comprise a salpingoscopy to assess the fourth parameter referred to above, namely the tubal mucosa (Watrelot, 2007; Watrelot and Dreyfus, 2008). Many studies have emphasized the importance of the condition of the tubal mucosa to establish a prognosis for tubal surgery, arguing that it is a key parameter in determining whether or not tubal surgery should be considered (De Bruyne et al., 1997; Marana et al., 2003; Vasquez et al., 1995). In practice, salpingoscopy is rarely performed routinely because it is difficult to do during laparoscopy for technical reasons: firstly, a second telescope with a cold light supply and an irrigation system are required; and secondly, the procedure in itself may damage the tube since a grasper is needed to stabilize the ampulla before entering the tube.

More recently, Watrelot et al. (2002, 2009) have proposed the routine use of salpingoscopy during fertiloscopy and have demonstrated that it can readily be performed routinely at this time as the endoscope is of small calibre (2.9 mm) and inserted through the pouch of Douglas in easy reach of the fimbriae, thus obviating the need for a second incision, a second endoscope and the routine grasping of the fimbria. By applying magnification during salpingoscopy, termed micro-salpingoscopy, the study centre has explored the conclusions drawn by Marconi and Quintana (1998) and concurs that microscopic evaluation of the tubal mucosa, notably the proportion of tubal cells with nuclei stained by the blue dye, provides additional information on tubal function. In practice, the study centre performs HyCoSy as the first tubal test (in this respect, the practice was changed from HSG to HyCoSy 2 years ago as the latter is better tolerated). If pelvic pathology seems evident, then a laparoscopy is proposed in order to complete the diagnosis and to treat the pathology if possible. In all other cases when HyCoSy is normal, and if no pregnancy occurs after 1 year (or 6 months for patients above 38 years), then the systematic performance of fertiloscopy before assisted reproduction treatment is proposed.

It is therefore possible to identify situations in which there is evidence of good prognosis as well as absolute contraindications for tubal surgery, such as bifocal lesions, tubal tuberculosis and distal ablation of the tubes. These latter cases are referred for assisted reproduction treatment.

Tubal lesions

It is important to distinguish between proximal tubal disease and distal tubal disease as the latter is often associated with the peritubal pathology such as adhesions. The number of publications in recent years is few compared with the plethora of publications in the 'golden years' of tubal surgery between 1977 and 1985. The principles of surgery described at that time are as true today as they were then, the only difference being today's use of endoscopy rather than laparotomy. The less invasive aspect of laparoscopy is in itself a major advance because of the better visualization of the operative field, less disruptive handling of tissues and faster healing, plus the advantage of greater patient acceptability.

Proximal tubal disease

The diagnosis of proximal tubal obstruction depends not only on the technique but also the operator and is affected by the presence of uni- or bilateral tubal spasm or the presence of debris or mucosal plugs, which results in an erroneously exaggerated number of cases reported. As the cause of proximal tubal obstruction will influence the intervention success rates, the need for accuracy in diagnosis cannot be emphasized enough and should be established by all means (endoscopy, cannulation, selective salpingography) without hesitating to combine these tests to obtain certainty about the kind of obstruction observed. The treatment and prognosis are totally different if the occlusion is organic (fibrosis, salpingitis isthmica nodosa) in comparison to functional (such as spasm or the presence of debris). Furthermore, in the presence of an abnormal contralateral tube, it is unclear that unilateral obstruction has any negative impact on fertility (Ahmad et al., 2006).

Two therapeutic approaches are proposed for bilateral proximal tubal obstruction, usually after selective salpingography which often helps to clarify the situation: either trans-cervical tubal cannulation or microsurgical excision of the segment of tube obstructed and tubo-cornual reanastomosis. The trans-cervical approach consists of identifying the tubal ostium (radiologically or at hysteroscopy; Thurmond et al., 1988; Tur-Kaspa, 2003; Tur-Kaspa et al., 2002) to insert a fine guide wire and applying pressure to overcome the obstruction. The limitation of this approach is dependent on the condition of the tube, the prognosis being good if the occlusion is due to debris or mucosal plug but not so if the obstruction is due to fibrosis. The latter cases may only be amenable to treatment by microsurgery as described above. Thus the trans-cervical approach is both potentially therapeutic and diagnostic. There have been no robust studies comparing the efficacy of these two approaches; however, Honore and colleagues (1999) suggested that microsurgery is better than radiological treatment to achieve tubal patency (47 versus 28.8%). Despite the apparent advantages of the microsurgical approach, its use has been neglected probably because of the surgical skill required (Diamond, 1978; Winston, 1977). It is argued that robotics will probably be useful in this situation (Degueldre et al., 2000).

Current practice seems to have evolved to first use the radiological approach and perform selective salpingography,

and then, if unsuccessful, to consider microsurgery or IVF as these two techniques may be used consecutively (Tomazevic et al., 1996).

Reversal of tubal sterilization

Reversal of tubal sterilization represents one of the best indications for tubal surgery. Here the tubes are normal except the iatrogenic obstruction, and the results depend on the length of the remaining tube after removal of the obstructed part and on the quality of surgery. The best reversal results are achieved when the tubal ligation has been performed by the application of clips on the middle part of the isthmus and worst when tubal ligation procedure has been performed distally with removal of the fimbrial end.

The modern procedure is to perform tubal segment excision and re-anastomosis by trans-abdominal laparoscopy. The one-stitch technique described by Dubuisson and Chapron (1998) is the easiest but doesn't seem to provide as good results as classical anastomosis identical to the one performed by laparotomy (Koh and Janik, 1999; Yoon et al., 1999).

Leading surgeons report an 83% pregnancy rate within 2 years (Koh and Janik, 1999). To anticipate such high success rates, several parameters should be taken into account, including the skill of the surgeon in microsurgery and/or in laparoscopy, the length of tube damaged by the tubal ligation and the age of the patient. It is notable that there are no prospective data comparing microsurgery and laparoscopy for reversal of tubal sterilization but results suggest that laparotomic microsurgery is better than laparoscopic microsurgery except probably in centres with extensive experience.

When the individual surgeon's caseload is limited, which is more often the case in Europe than in USA, reversal procedures by laparotomy lead to better results than laparoscopy. This is so in the study centre's series, describing a 72.4% pregnancy rate by laparotomy versus 37.5% by laparoscopy (**Table 1**; Watrelot, 2009a,b). The patient should be clearly informed of the alternatives with the respective results before choosing the method of anastomosis.

Robotic technology seems to offer the promise of improvements in outcome despite the paucity of publications (Vlahos et al., 2007), but if it is considered that all the results are a direct function of the quality of surgery, there should be few doubts that any tools or techniques which enhance accuracy in the procedure should increase the success rate. The only limitations today in the use of robotic technology are the cost of the equipment and the length of the learning curve.

It is difficult to compare the success of IVF with reversal of tubal sterilization while recognizing the major effect of the woman's age on ovarian function, i.e. fecundity. There are no prospective randomized trials for guidance but typically reversal of tubal sterilization is performed mostly around the age of 40 when IVF success declines rapidly (Hoffman et al., 2010). Therefore, tubal anastomosis restoring a normal tubal patency may lead to a cumulative pregnancy rate better than the chances offered by one or two IVF attempts. After the age of 42, the pregnancy rate after intrauterine insemination is superior to IVF, being respectively 8.1% and 4.7% (**Table 2**). If such data are confirmed, one would argue the case in favour of surgery.

Distal tubal disease

Incomplete distal tubal obstruction is referred to as phimosis (**Figures 1, 4** and **5**), while complete distal obstruction is called hydrosalpinx (**Figures 1** and **6**).

Phimosis

Incomplete or partial tubal obstruction is readily amenable to surgery since the tubal mucosa is not damaged in the vast majority of cases. Consequently, the results in terms of pregnancy are good if associated adhesions are not too extensive. For the surgeon, the skills to perform this technique well are relatively quickly and easily acquired, but

Table 2 Reported results for patients aged 41–43 years at Centre de Recherche et d'Etude de la Stérilité during 2006–2007.

	Intrauterine insemination	*IVF*
No. of patients	76	109
Pregnancies/transfer (%)	8.1	4.7

Data from M Chavrier et al., in MSRM symposium, Bordeaux 2010, personnal communication.
No more than two embryos were transferred at a time.

Table 1 Pregnancy rates after proximal surgery for patients treated at Centre de Recherche et d'Etude de la Stérilité between 1998 and 2005.

	Patients (n)	*Pregnancy* (n)	*Pregnancy rate* (%)	*Ectopic pregnancies* (n)
Tubo-cornual anastomosis (microsurgery)	36	20	55.6	1
Reversal of sterilization (microsurgery)	29	21	72.4	0
Reversal of sterilization (laparoscopy)	8	3	37.5	1
Total	73	44	60.3	2 (2.7%)

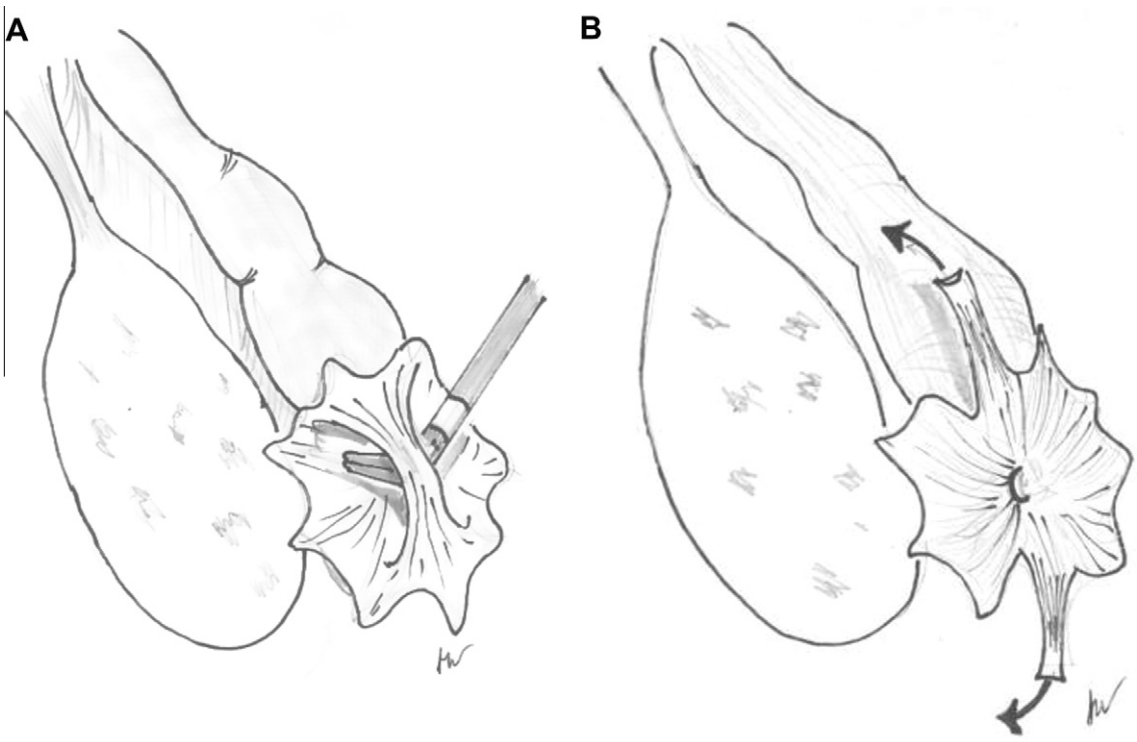

Figure 4 A special variety of phimosis: the 'bridge' adhesions should be carefully searched for since this non-obstructive lesion may impair oocyte retrieval. Treatment consists of: (**A**) carefully dividing the bridge; and then (**B**) fixing the eversion with two micro-sutures.

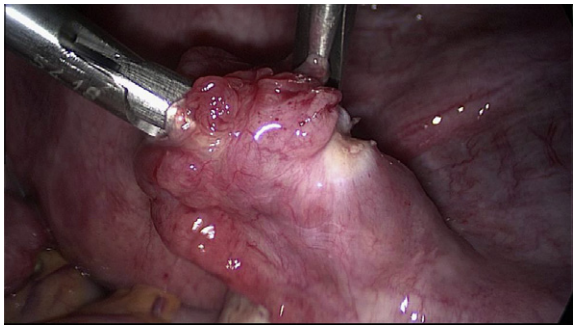

Figure 5 Typical aspect of phimosis.

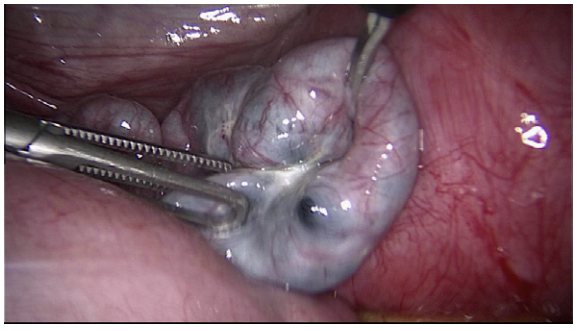

Figure 6 Hydrosalpinx filled with dye.

nevertheless require a good knowledge of the tubal anatomy and adjacent structures.

The few series published show no difference between open microsurgery and the laparoscopic technique (Audebert et al., 1998) and are consistent with the study centre's series (**Table 3**). The intrauterine pregnancy rates vary from 35% to 69% and most of the data were published before 2000 and are all retrospective (Dubuisson et al., 1990; Lavergne et al., 1996; Saleh and Dlugi, 1997).

Hydrosalpinx

Complete tubal obstruction must be diagnosed because if left untreated it may impair the result of IVF (Dechaud et al., 1998; Strandell et al., 1999), especially if the hydrosalpinges are evident at ultrasound examination because of distension to diameters of 2—4 cm (De Wit et al., 1998). Thus, surgeons are obliged to choose between a salpingostomy or a salpingectomy. The key factor here is considered to be the state of tubal mucosa rather than the size of the hydrosalpinx. The size of hydrosalpinx is irrelevant as the biggest hydrosalpinges are generally thin walled and of good prognosis for conservative treatment if the tubal mucosa is in relatively good condition. By contrast, small hydrosalpinges are often sclerotic and of poor prognosis but, as they do not adversely affect the results of IVF, salpingectomy can be avoided and these patients should be directly treated by IVF.

Patients are often reluctant to agree to salpingectomy even if clearly pathological and sometimes prefer to first undergo a salpingostomy and then a salpingectomy in cases of recurrence. A clear statement of the benefits and risks of such a patient-driven approach should be provided to patients who have a substantially increased risk of facing a second laparoscopy for salpingectomy. When there is a

Table 3 Pregnancy rates 1 year after distal surgery for patients treated at Centre de Recherche et d'Etude de la Stérilité.

	Microsurgery (1986—1998)	*Laparoscopy after salpingoscopy (1998—2008)*
Phimosis (fimbrioplasty)		
No. of cases	823	468
Pregnancies (*n*, %)	448 (54.4)	236 (50.4)
Hydrosalpinx (salpingostomy)		
No. of cases	489	247
Pregnancies (*n*, %)	89 (18.2)	119 (48.1)

Lost to follow-up are considered as failure.

solitary hydrosalpinx, the patient's acceptance to a unilateral salpingectomy is higher, especially if the contralateral tube looks normal or subnormal and easily able to be treated.

When salpingectomy is performed, this should be done by laparoscopy and the recommendation is to stay as close as possible to the tube when dissecting, to avoid any disturbance in the ovarian blood supply (Gelbaya et al., 2006).

In case of salpingostomy, the retrospective studies published show no difference between laparoscopy and microsurgery (Taylor et al., 2001). However, for tubal eversion procedures, microsuturing of the opened tube seems to be superior to the technique using a CO_2 laser or bipolar cautery, which may create sclerotic lesions on the ampulla with the risk of subsequent stenosis. The preferred technique is through laparoscopy, the everted tube being fixed by using fine sutures (5×0 or 6×0) (**Figure 7**).

Results of salpingostomy are dramatically affected by attention to the principles of patient selection (**Table 3**). The study centre's series shows that, if decided upon the findings of salpingoscopy, the results increase from 18.2% (no selection) to 48.1% (selection by salpingoscopy).

The pregnancy rate after fimbrioplasty remains stable irrespective of the technique and the selection principles used, whereas selection is the key in salpingostomy. The results, however, are similar whether it is performed by microsurgery or laparoscopy.

Adhesion management in tubal surgery

Pelvic adhesions are often seen associated with tubal lesions, there being three major categories of aetiology. Adhesions are seen: (i) following pelvic inflammatory disease, and it is in these cases that tubal lesions are almost always present; (ii) following abdominal or pelvic surgery, especially after myomectomy and ovarian cystectomy for benign teratoma; and (iii) in women with endometriosis.

As the ovary and fimbria are not covered by the peritoneum, they are often affected by adhesions. Similarly, the uterus is prone to be affected by adhesion formation. Thus any surgical procedure for infertility may require an initial adhesiolysis to improve access to the field of surgery and as such should be conducted according to the microsurgical principles (**Table 4**) even by laparoscopy.

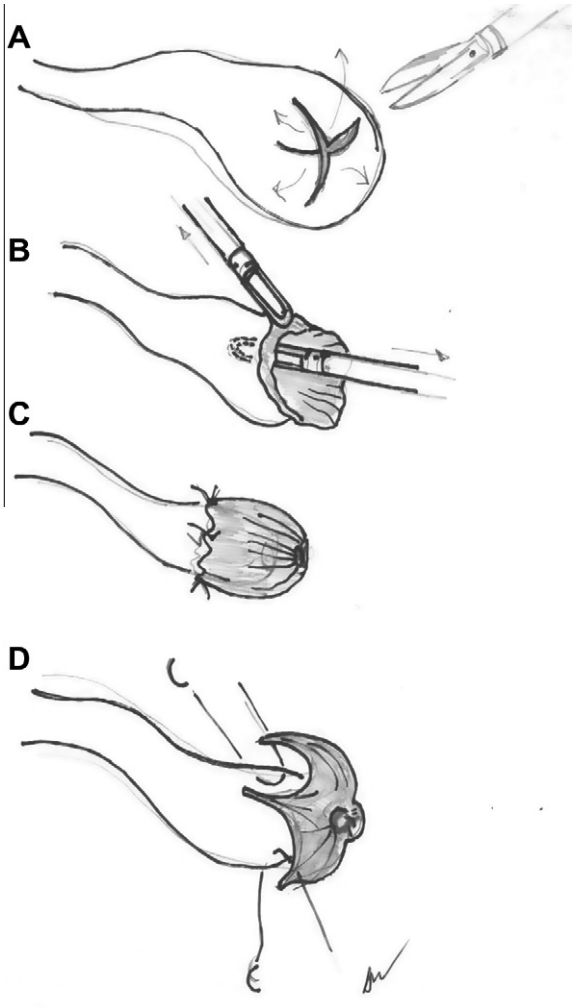

Figure 7 Salpingoneostomy. (**A**) Opening of the tube on the site of the previous ostium. (**B**) Mucosal eversion by two gentle atraumatic forceps to create a new mucosal cuff. (**C**) Cuff salpingoneostomy. (**D**) Racket-form salpingoneostomy (fixation with fine sutures). The choice between the two eversion techniques depends on the thickness of the tubal wall. Cuff salpingoneostomy should be preferred when it is possible (Winston and Margara, 1991).

Table 4 Principles of microsurgery.

Good magnification
Good light
Respect of the tube: 'no touch' technique
Meticulous haemostasis
Avoidance of peritoneal desiccation
Acute ovaro-salpingolysis
Use of fine microsurgical instrumentation
Use of microsuture

Derived from Winston and Margara (1991). All these principles may be adapted to laparoscopy today.

The results of adhesiolysis will be affected by the extent of adhesions, the type of adhesions (filmy or dense), the presence of inflammation (as seen in endometriosis) and the degree of tubal disease, if any. The early view that the use of laparoscopy would reduce or prevent adhesion formation is not entirely correct (Gutt et al., 2004). It was quickly demonstrated that the use of laparoscopy did not prevent adhesion formation and that even the use of CO_2, and thus desiccation of the peritoneum, could be an adverse factor (Erikoglu et al., 2005; Ott, 2004). Humidification and warming of CO_2 prior to insufflation has not been shown universally to have benefits and animal studies have shown that hypothermia was more beneficial than normal body temperature to reduce the ischaemia in the peritoneum exposed to hypoxia in the pneumoperitoneum (Binda et al., 2006). Adhesiolysis may also be performed by fertiloscopy or trans-vaginal endoscopy but the existing data are too few to draw firm conclusions from (Gordts et al., 2002).

There are different scoring systems for adhesions, such as that proposed by the American Fertility Society (1998), but in reality they are rarely used and the decision whether to treat is based upon the impression of the surgeon, which is dependent on their skill.

Post-operative adhesions continue to be a clinical dilemma, despite good surgical techniques performed by competent surgeons. Thus pharmacological agents have been devised to assist in reducing adhesion formation. To be efficient, any agent should be non-toxic, be easy to use (especially in laparoscopy) and remain for approximately 5 days in the peritoneal cavity to prevent contact between two injured peritoneal surfaces.

The search for effective anti-adhesive agents continues, irrespective of whether they are solid, liquid or gel, but Johnson and Watson (2003) in their Cochrane review stated that no agents were shown to improve the pregnancy rate. Nevertheless, strong arguments remain to do 'something' to avoid adhesion formation. Among the products proposed, several seem more promising, notably a liquid barrier, 4% iocodextrine (Adept; Baxter) (Brown et al., 2007; Di Zegera et al., 2002), which is reasonably cheap, safe and easy to use and should be tried when there is a risk of adhesions anywhere in the pelvis. In contrast, when there are susceptible specific sites, such as uterine scar after myomectomy and ovarian scar after cystectomy, a solid barrier such as Interceed (Johnson and Johnson; USA) or a gel barrier such as Hyalobarrier (Nordic Pharma; France) may also be proposed (Wallwiener et al., 2006).

It is appropriate to refer to the entrenched or traditional post-operative use of dexamethasone with its well-known risks of infection or delayed healing. Since tubal surgery is mostly performed by laparoscopy, and as these risks are minimal, the use of dexamethasone for a short post-operative period is still recommended (Querleu et al., 1989).

The prevention of and best management of adhesions in tubal surgery should be based on the microsurgical attitude during surgery. Agents for adhesion prevention should be considered to be only as an adjuvant, contributing to reducing the difficult problem of adhesions, whether as a recurrence or de-novo formation after surgery.

Conclusion: to a new paradigm of complementary tools?

The basic principles of tubal surgery and adhesion management were methodically described more than 20 years ago. This review argues that the real breakthrough has been the systematic inclusion of endoscopy (laparoscopy, but also hysteroscopy, THL and fertiloscopy) in the field of reproductive surgery.

It is the enhanced accuracy and the mini-invasiveness of endoscopic procedures which allow a consideration today of re-introduction of tubal surgery as a valid treatment option for certain subfertile couples. In this sense, tubal surgery does not intend to compete with IVF but to complement it, given that the common goal of all reproductive doctors is to assist couples to have a normal live birth.

There are many fertility problems which can only be successfully addressed by IVF/intracytoplasmic sperm injection and related techniques, but the many patients who may benefit from surgical treatment should be offered this alternative.

Inappropriate surgery will decrease the chances of the patient by delaying IVF, so such decisions should only be made in consideration of all aspects of the couple's circumstances. Often, there are no clear answers and today's older patients correctly do not wish to delay any treatment strategy. In women in whom there is no evidence of low ovarian reserve and who have undergone tubal surgery, it is probably logical to delay IVF for 1 year if under 35 and then a 6-month period should be allowed, keeping in mind that, even if IVF is practised and fails, these patients have still some chance of spontaneous pregnancy.

Finally, all IVF centres should include an active reproductive surgeon who is available to discuss the best surgical options for all patients.

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Declaration: The authors report no financial or commercial conflicts of interest.

Received 23 June 2010; refereed 13 March 2011; accepted 22 March 2011.