MINIMAL ACCESS PROCEDURES IN THE MANAGEMENT OF TUBAL INFERTILITY

DR MOHAMED AS. M.D, MRCOG. D.MAS
GYNAECOLOGICAL SPECIALIST AND LAPAROSCOPIC SURGEON
MEMBER OF WORLD ASSOCIATION OF LAPAROSCOPIC SURGEON

Project submitted towards completion of Diploma in Minimal Access Surgery, Laparoscopy Hospital, India 110018

ABSTRACT

Infertility has always been defined with respect to a number of parameters prominent amongst which are time, causes, treatment cost and socio-cultural implications. The most widely accepted practical classifications distinguishes between primary and secondary infertilities with a further sub classification into 3 clearly defined groups that include ovulatory dysfunction, fallopian tube compromise , male factor (sperm function and delivery disorder) alongside an ambiguous and controversial group labeled as "unexplained infertility". Recent technological developments in the fields of optics, video-imaging and miniaturized surgical instruments, have lead to the emergence of minimal access procedures, with wide and varied applications in the field of gynaecology. The skill in its different forms and various combination modalities is widely applied in the management of the infertile couple especially those with tubal infertility.

The economic and safety records of endoscopic procedures are well documented in other surgical acts. Gynaecology in general and tubal infertility in particular, does not seem to constitute an exception, more so when their cost-effective ratio is considered alongside results. The different forms of endoscopic procedures have been shown to de-mystify and redefine the bounds of "unexplained infertility" by producing new diagnostic evidence. Novel minimal access surgical procedures have been shown to play not only a preventive but also a curative role in tubo-peritoneal infertility as well as other forms of infertility. In skilled hands, the various forms of endoscopic procedures can be combined in different ways to improve on the diagnosis and treatment afflicted patients. This management style referred to by some authors as "fertiloscopy" judiciously blends the use of laparoscopy, hysteroscopy, salpingoscopy, fimbroscopy and chromotubation with other conventional infertility work-up procedures to resolve infertility problems with very promising results.

Infertility, its work-up and treatment are quite often time consuming with all the consequences, economic, social and particularly psychological attached to it. The ergonomics' of infertility management has developed over time and has come up with the one-stop shop model for infertile couples. Minimal access procedures are apparently set to play a central and determinant role. With this in mind, the need to overview the path covered this far and also ponder on future orientations in view of improving on results can not be over emphasized.

AIM OF STUDY

In this study, we intended to high-light the capital and central role that minimal access or endoscopic procedures play in the management of tubal infertily as well as demonstrate the positive impact it has both in the fight against infertility and redefining the classification of the pathology.

INDICATORS

Our indicators include:

1. The different forms of minimal access procedures: Laparoscopy, hysteroscopy, salpingoscopy, fimbroscopy with or without enhancement procedures like chromotubation.
2. The different categories of infertility: primary infertility, secondary infertility, ovarian dysfunction, tubal or tubo-peritoneal infertility, male factor or sperm delivery disorder, unexplained infertility
3. Roles played by minimal access procedures:

   - Diagnostic
   - Treatment: preventive and/or curative.

1. Advantages of minimal access procedures.
2. Some results of minimal access procedures

METHODOLOGY

Materials: The study was carried out through a literature search using the information technology installations of the Laparoscopy Hospital, Tilak Nagar, New Delhi. Standard stationary was also provided by the the resource centre of the hospital.
Time: The study was carried out during a period of one week between July 12th 2007 and July 19th 2007.

Data collection: All the publications used in the current study was accessed from the electronic (virtual) library using the following search engines: Google, Springer online, Pubmed and other linked references. Publications used were searched for using the following key words: tubal infertility, tubo-peritoneal infertility, laparoscopy, endoscopy, management.

INTRODUCTION

MINIMAL ACCESS PROCEDURE

Minimal access procedures (also referred to as endoscopy) applied in the management of tubal infertility are based on the same principles of endoscopy in which a working space is created inside the body milieu through a miniature access route and is kept tighly separated from the surrounding atmosphere. This space is usually created using a fluid medium which can be gaseous or liquid. The most common gas used is carbon dioxide but others include helium, nitrous oxide and even air. Some liquid mediums used include normal saline, Ringer lactate, glycine and dextran.. The visual interphase between the operator and the working space is the telescope or endoscope whose form, size and nomenclature varies with the organ and procedures concerned.

In the uterus, the fluid milieu used is depends on whether the procedure is diagnostic or surgical and the endoscope used is the hysteroscope. The procedure is called hysteroscopy. To eplore the oviducts, a telescope adapted to the dimensions of the tube is used and the procedure is known as salpingoscopy or falloposcopy. The operation is said to be antegrade if access into the tube is from the proximal pole [1, 2]. When access is from the distal end (retrograde), the term

fimbroscopy is used especially if exploration is limited to the distal third of the tube. A necessary prerequisite for antegrade tuboscopy is hysteroscopy while retrograde scopy is possible with coelioscopy.

The intra-abdominal genital organs are most often accessed through the trans-abdominally created pneumoperitoneum; transvaginal pneumoperitoneum is also possible but rarely used. The gas used for laparoscopy (coelioscopy) is most often carbon dioxide. Under exceptional conditions, ordinary air can be used during "gas-less" laparoscopy. Here the endoscope used is the laparoscope.

The various procedures can be carried out in isolation or in different combinations depending on the indications. Other complementary procedures can be associated in function of needs. Some examples include chromotubation , organ sampling, biopsy etc.
Adapted working (manipulation) instruments have access to the endospace either through adapted ports built into the telescopes or through air-tight working ports similar to that of the telescope. This ergonomic design of the endoscopic procedure is the basis of its advantages and rarely (but possibly) disadvantages in association with the skills and proficiency of the operators.

INFERTILITY

Defined as the inability of a couple to conceive after one year of unprotected and adequate sexual intercourse, it is a public health problem affecting between 10 to 15% of couples. It is either primary in which case the couple/ woman has never conceived before or it is secondary with prove of prior conception. Depending on the causes, infertility is classified to include ovulatory dysfunction (30%), fallopian tube compromise (30-40%), defects of sperm function or delivery[male factor] (30%) and "unexplained infertility" (10%)[2,3]. With recent advances in endoscopic procedures and other endoscopic-assisted procedures, this latter group is becoming more and more controversial and is dwindling in significance to the benefit of tubo-peritoneal infertility.

TUBAL INFERTILITY

Tubo-peritoneal factors make up the most important single group of infertility in the couple. It accounts for up to 40% of infertility cases englobing a heterogenous group of diseases with very varied and diverse aetiologies.

Pelvi-peritoneal adhesions (mostly sequels of prior infections) constitute the single most common class of tubal pathology responsible for tubal infertility [4]. Other conditions include endometriosis, hydrosalpinx and proximal tube obstruction due to complications of endoluminal salpingitis. Bilateral tubal ligation carried out for definitive family planning can constitute a special category of tubal infertility incase of the need for reversal of tubal ligation. Rarely does isolated external mechanical compression of the tube give rise to infertility.

Lesions affecting the tube are located either inside the tube (endoluminal), the smooth muscle walls (intramural) or compromise the tubes externally(peri-tubal or pelvi-peritoneal). Their common pathogenesis is that they compromise the anatomic and physiological functions of ovum pick-up, fertilization and zygote transport between the ovary and the uterus in the normal process of procreation [5, 6]. Some pathologies that cause tubal infertility, compromise tubal patency without alteraring the gsos anatomy of the tube. The lesions in this case are endoluminal resulting most of the time from previous and repeated episodes of poorly managed acute or chronic salpingitis leading to scarring and closure of the tubes. *Chlamydia trachomatis*

infection is the most widely reported infectious agent responsible for tubal obstruction. Other less frequent pathogens include *T. pallodium* and tubal tuberculosis. Non-infectious pathologies have also been implicated in endoluminal tubal occlusions. These include: contraceptive tubal occlusion using the Essure technique, lost IUD lodged in the tube, conservative management of prior tubal gestation. In expectant management, spontaneous pregnancy regression occurs followed by endoluminal reorganization that occludes the tube. Medical treatment using methotrexate in either systemic or local application mode has been reported with high rates of occlusion due the persistence of trophoblastic tissue that acts like a foreign body. Laparoscopic salpingostomy have been reported to give better results with high rates of tubal patency and subsequent intra-uterine pregnancy rates. Poorly managed cases however can cause occlusion due to incomplete trophoblastic detersion or poor haemostasis during surgery [7,8]. Other pathologies without occluding the tube compromise its functional state by destroying the contractile capacity of the smooth muscle walls and the ciliary mechanism of the mucosae. Such is the case with chlamydia and syphilitic salpingitis. They provoke localized strictures along the length of the tube with loss of the tubal rugae essential for tubal peristalsis, a function very vital for ovum up-pick and transport. Neglected cases end up with nodular segmental chronic inflammatory degeneration of the tube walls known as salpingitis isthmica nodosa [9, 10]. Extra-tubal inflammatory conditions contribute a majority share of tubal infertility. These are most often the aftermath of ascending infections from the lower genital tract through the fallopian tube themselves or through uterine perforations as can occur during septic criminal abortion procedures. Pathologies of intra-abdominal origin like peritonitis, cholecystitis, and appendicitis among others have been known to cause tubo-peritoneal adhesions. Prior abdomino-pelvic surgery (Ex: myomectomy) through open abdominal procedures can cause various degrees of post-operative adhesions that can entangle, kink or compress and occlude the tubes [6]. Endometriosis is yet another cause of tubal infertility that comes second only to infectious salpingitis[11].

A combination of endoluminal tubal occlusion and extra-tubal adhesions would give rise to hydrosalpinx and pyosalpinx in the case of an on-going infection or its complication. Women seeking reversal of tubal ligation constitute a special group of tubal infertility. Knowledge of the type and timing of their contraceptive procedure is important in deciding on how to manage such cases 12,13].

MANAGEMENT OF TUBAL INFERTILITY AND THE ROLE OF MINIMAL ACCESS PROCEDURES

DIAGNOSIS:

A crucial point in the work-up of infertility is the investigation for potential tubal disease [14]. Therapeutic outcome is directly dependent on how adapted treatment is to the disease condition. The precision and accuracy of diagnosis are thus very indispensable if satisfactory and cost-effective therapeutic results are the prime objectives. To achieve these goals, proper diagnosis has to be done at two levels namely:

1) Distinguish tubal infertility from the others: ovarian dysfunction, male factor and unexplained cases.
2) Clearly establish the anatomic and functional description of the type of tubal compromise involved.

Such an exercise requires a methodic approach with the use of tested and proven procedures in the hands of an astute professional team that includes the endoscopist (minimal access surgeon).

Diagnosis is both clinical and para-clinical. Clinically, the first step is to determine whether it is primary or secondary. The pertinence, gravity and urgency of the situation are also evaluated at this point. This is relevant in order to come out with a management time table with the participation of the patient. A documented comprehensive and detailed history of the couple is obtained. Pertinent points of the history include the presenting complaint and other associated factors, the duration of infertility, age of the woman, past obstetric and gynaecological facts and figures, medical and surgical history as well as details of any previous attempted treatments. These are some of the elements of the tubal scoring system.

Important landmarks suggestive of tubal infertility that have to be elicited include: history of genito-urinary infection, low abdominal pains, any previous uterine manipulations, a contraceptive history (IUD , tubal ligation, use of ESSURE system), previous abdomino-pelvic surgery and menstrual characteristics. An evaluation of the male partner is a necessary complement particularly with respect to fertility and genital infection [7,8].

Physical examination of the woman would insist on the genitor-urinary system, the abdomino-pelvic zone, with its anatomy and any elicited signs and symptoms.

Clinical evaluation lacks the ability to detect specific and detailed signs related to tubal pathology except in cases of huge hydrosalpinx. It is a highly subjective exercise that depends a lot on the skills and experience of the examiner and the idiosyncrasies of the patient. The sensitivity, specificity and thus the positive predictive value of clinical evaluation of of tubal compromise has been shown to be low 34, 15,16,17, 4, 19].

Boilogical work-up for tubal factor infertility for long has been centred on the serogical manifestations of chlamydia infection. The condition undoubtedly is known to be the most prevalent cause of tubal damage but is not the only one. The others do not have reliable markers and besides, the specificity and sensitivity of Chlamydia serology is not a reliable measure of tubal damage just like the positive diagnosis itself. Endometriosis is a well known cause of tubal compromise with no biological marker. Syphilis like Chlamydia has markers with even lower predictive values [22,11, 23,24].

Until the very recent past (within the past two decades), HSG has enjoyed an unchallenged monopoly in the morphological and patency assessment of the fallopian tube for infertility work-up. Complimentary procedures like chromopertubaton and hydrotubation under were not part of the investigations. It was considered the gold standard in the diagnosis tubal patency for a long time inspite of its shortcomings, risks, inconveniences and low predictive values. It was an invasive procedure that limited itself on information on the static morphology of the tube with very little on the peri-tubal area and structures. Findings were limited to the macroscopic aspect of the endometrial cavity and the tubal lumen. The histological and/or functional status of the tubal mucosae could not be appreciated. Another handicap was the use of uncalibrated and often high injection pressure during contrast administration. Excercive pressure coupled with canalization errors often lead to extravasation accidents and incidents with resultant false positive results in the best of cases or even mortality cases in extreme cases [11, 25]. Swart et al (1996) reported that HSG was of limited use in the diagnosis of distal tubal obstruction and hydrosalpinx and has no value in the detection of peritubal adhesions[26,]

Developments within the past two decades in the domain of optics, vedio-imaging and endoscopy have completely changed the diagnostic approach for tubal infertility. The tube can now be examined directly in real time under magnification and in its natural habitat under physiological conditions contrary to HSG [27]. Exploration of the tube is now more extensive with more dynamic investigative manouvres and less risks, incidents and accidents. This is partly due to the fact that investigations most often are carried out under improoved anaesthesia. Accesory and complementary procedures like chromotubation under direct vision have become safer, producing more information on the functional status of the oviducts.

The advent of proper instrumentation and techniques provided the critical catalyst in making endoscopic diagnosis such an invaluable tool as it is today in the management of tubal infertility. Various forms of endoscopic gadgets have seen the light of day: hysteroscopes are available to explore the uterine cavity and the proximal (uterine) ostium; salpingoscopy is now available to do a dynamic exploration of the fallopian tube along its whole length from either direction using either the rigid or flexible falloscope. The external aspect of the tube and its regional anatomy can be viewed from different angles with the aid of the laparoscope while at the same time monitoring the other procedures to avoid accidents and incidents. Chromotubation carried out under direct and magnified vision has since replaced contrast injection during HSG. The ability to simultaneously carry out the different forms of genital endoscopic examination allowed for a more detailed, complete and credible diagnosis [28, 1,5,29, 30]

Magnification in endoscopic diagnosis has significantly reduced inter-observer variation in describing lesions unlike in clinical and biological investigations and HSG [31]. All of the above characteristics and inherent advantages has positioned endoscopy as the gold standard in the diagnostic management of tubal infertility [32,14]. Catalano GF et al using salpingoscopy showed that the state of the tubal mucosa was the most important prognostic factor for fertility with rates ranging between 60 and 70% [33]

Endoscopy has also been of tremendous assistance to biological diagnosis by offering the possibility of more precise and targeted sampling of sites and suspected lesions. Biopsies can be made of lesions suspicious of endometriosis, TB among many other possibilities. Different types of tissues and specimens have been taken for histology and various immuno-histochemical analysis in order to establish or confirm clinical or biological diagnosis [34, 35,36,37,38]. Research of this nature has lead to a better understanding and diagnosis of cases formerly classified as ‘unspecified infertility’. Most cases have been found to be undiagnosed tubo-peritoneal infertility such as asymptomatic tubal or peritubal TB and endometriosis [36,37,5, 39,38].

Improovements in diagnosis has come along with better case definition, staging and classification in tubal infertility. Biological, anatomic and more importantly functional lesions can be well defined. This allows for an appropriate therapeutic decision with the goal of optimizing outcome at the best cost-effective ratio and in record time.

TUBAL SCORING

Over the years, different therapeutic results have been registered with different presentations of tubal infertility. To optimize and harmonise management protocols, different authors and schools have come up with different scoring systems as a useful tool in the evaluation of tubal and adnexal damage. Anatomic and functional disorders are the main determinants in all these systems. Once more, minimal access procedures are seen to have an important role to play in all

the classification systems irrespective of the authors. In addition to anatomy and functional parameters, other patient related parameters having an impact on reproductive health are included in all the systems. This is so because the ultimate goal in the management is to achieve pregnancy and not just restoring tubal function. Some of the prominent patient related factors include age, ovarian reserve and other morbit conditions that can affect fertility. Therapeutic decisions are taken in function of these score. Tubal scores of class III and IV are more suitable for IVF-ET while some studies have demonstrated that class I and II score especially in younger patients can benefit from alternative managements including tubal microsurgical reconstruction [7, 14, 25,40,31].

TREATMENT OF TUBAL INFERTILITY

The primary objective of treatment in tubal infertility is to preserve 'intra-uterine fertility' at or as close to normal rates as much as possible. This can be achieved by conserving or re-establishing tubal morphology and function in particular ad-intergrum. Other goals include the quest for patient confort by eliminating morbid conditions like pain, fever and psycho-social disorders. In some cases the treatment of aetiological factors reverses tubal compromise; an example is the treatment of some classes (I&II) of endometriosis.

Treatment programmes are primary, secondary or tertiary. Primary programmes are focused on preventive measures against tubal lesions. They include:

1. Preventive measures against genital and pelvi-peritoneal infections known to be the major causes of peri-tubal adhesions and occlusions [4]. Chew S et al reported a 33% fertility rate following laparoscopic adhesiolysis[18]
2. Prompt and appropriate management of such infections: Early use of laparoscopy in the management of acute PID has been reported to be beneficial in preventing occlusions and adhesion formation [38].
3. Measures against adhesion-prone pelvi-peritoneal surgery: Surgery should be absolutely necessary and as much as possible, surgical techniques used should be proven not to be adhesiogenic. Endoscopic surgery is the perfect example. Other methods include the use of adhesion prevention procedures whenever possible [41, 42,43, 4].
4. Preventive second-look laparoscopy has been reported to be of some value [19].
5. Laparoscopic surgical treatment of endometriosis associated infertility has been reported high success rates[20,21]
6. The development and implementation of a good family planning programme would limit unnecessary and ill-advised tubal occlusion interventions with risks of request for tubal reversion.
7. Tubal surgery should be carried out with minimally invasive techniques as provided for by endoscopic procedures in order to increase reversal success rates [44,49].

Treatment of already established tubal compromise constitutes second level programmes. These include:

1. Laparoscopic adhesiolysis as an elective procedure or during second-look.
2. Tubal recanalisation(endoluminal) without resection. Several methods have been used with varying degrees of success. Some include:- tubal insufflation, flushing, pressure hydrotubation, chromopertubation, falloscopic dilatation and recalibration recanalisation[46].

3. Tubal re-anastomosis which is almost always accompanied by resection of the occlusion zone. The availability of appropriate microsurgical technology including laparoscopy and the use of atraumatic (glass) manipulators for the tubes has contributed a lot to the success rates of this operation. Many studies have reported good fertility outcome rates and low ectopic pregnancy rates in tubal reversal in laparoscopy assisted tubal reanastomosis[47,48 44, 49, 8].

Measures that seek to bypass an irreversibly damaged tube or call for an intentional ellimiation of the tube to increase chances of conception make up the tertiary group of tubal infertility treatment. IVF with embryo transfer constitute the last resort in case of an irrecoverable tube and is often associated with ovarian stimulation. Success rates of IVF with pathological tubes (salpingitis, hydrosalpinx) in place are significantly lower than after salpingectomy which preferably should be done through laparoscopy prior to the procedure[50]. Diseased tubes seem to produce an inflammatory factor that compromises pregnancy survival similar to that seen in endometriosis. Laparoscopy is equally valuable in treating tubal infertlity in this case as a convinient and safe method of oocyte harvest [51].

DISCUSSIONS

Infertility has a very important impact on the health of the couple and by extension, that of the community through its effects on the social, psychological, economic and cultural realm of life [45] It is a public health problem especially in developing countries affecting 10-15% of the population of reproductive age. Tubal disease alone accounts for up to 40% of female infertility [14, 9, 3, 52, 53]. The prevalence of aetiologic factors in afflicted milieus is so high (and still increasing) such that there is a real need to develop practical and affordable cost-effective strategies to tackle the problem. The main causes of tubal infertility fall under three main groups namely: PID of various origins, pelvic endometriosis and the complications of abdomino-pelvic surgery [41].Effective control measures depend on early and unequivocal diagnosis, proper classification of disease and prompt and effective treatment. All these requirements need to be accessible and affordable to any positive impact on the couple and community.

The main diagnostic methods in use ever since the definition of the entity consist of clinical evaluation, biological work-up, HSG and sonoHSG [22]. All these approaches have shown various degrees and forms of limitations with low sensitivity and specificity rates, low predictive values [54]. Quite often, they are very costly. Some of them like HSG have important disadvantages such as gonadal x-ray irradiation risk and hypersensitivity reactions. Practically all these methods can not give adequate information on the several aspects of tubal infertility that include pelvic pathology (Ex. Endometriosis), tubal occlusion, peritubal adhesion and endoluminal microlesions[22, 55, 56]. The extent and severity of lesions can not be adequately assessed by all thes methods. Certain pathologies with high tubal infertility potentials like endometriosis can only be diagnose objectively using laparoscopy [55]. Basically all the diagnostic methods are handicapped by various degrees of inter-observer variations [22, 31]. With the exception of HSG, all the diagnostic procedures are carried out a considerable length of time before any therapeutic decision is taken thereby delaying treatment. The passage of contrast medium under pressure during HSG has been shown to have some therapeutic effects on some categories of tubal occlusion [56,57]. These observations lead to the use of oil-based and antibiotic-prepared solutions for tubal flushing and hydrotubation as initial treatment in some cases of infertility. The results were however not very encouraging [57].

The advent of endoscopy came along with the possibility of diagnosis under direct view and magnification at close range. Dynamic exploration has become possible with instantaneous results as opposed to the other forms of diagnostic procedures. Time was needed to process X-ray films before interpretation and results of biological investigations might take days to be available. Delays between diagnosis and treatment no longer depend on on delays in diagnostic results. Endoscopic diagnostic procedures can be applied to all phase of tubal disease with potential risk of infertility from the acute to the chronic and consolidated state [17]. With endoscopy, endoluminal, mural and extre-tubal lesions can be simultaneously explored with a better diagnostic mapping of lesions [29]. Tubal investigations are more exhaustively done within a shorter time lapse during which time complementary procedures can be carried out to improve on clinical and biological diagnosis. This leads to better diagnosis, gain in time, earlier therapeutic decision, cut in costs and patient convenience. All these advantages justify the one-stop shop model of infertility management being put forth by some authors [60,60,61, 62].

Practically, all forms of minimal access procedures valid for tubal infertility diagnosis can be associated with therapeutic measures simultaneously. Hysteroscopy can serve as a means of proximal tubal (ostium) occlusion treatment. Falloposcopy in itself can recanalise some minor case of occlusion or can serve as a guide to direct tubal catheteric recanalisation under laparoscopic guidance [61,62].

Basically, there is an across the board consensus on the positive impact of the surgical management of severe tubal pathologies. There is however an ongoing debate over the advantages of laparoscopic interventions over open surgery in terms of intrauterine conception rates. Some studies have reported no significant advantage [ ] but a vast majority have found a relative advantage [44,48] while a few other have reported a clear margin in favour of operative laparoscopy [8,45, 47,7]. In a meta-analysis, Ahmed et al showed that there was a significant advantage of laparoscopy over laparotomy in distal tubal surgery [63]. The debate is however settled in favour of operative laparoscopy by the other nonspecific advantages of minimal access procedures. These include: safety, reduced cost, reduced rate of transfusion, reduced convalescence time and hospitalisaation days, improved cosmetic effects and patient satisfaction [1, 59 64]. Hawkins and associates did a comparative study of the costs of tubal anastomois and found that open surgery was almost twice as expensive as the laparoscopic procedure[66].

Through endoscopy, adhesiolysis, surgical tubal anastomosis, neosalpingostomy and endomeriotic surgery can be performsd [1, 42]. In extreme cases only fit for IVF, coeleoscopy has been found to be advantageous over other methods of oocyte retrieval [51].

The diagnostic and therapeutic advantages of minimal access procedures have been boosted by developments in the domain of micromanipulation of internal organs made possible by advances in miniaturization of endoscopic surgical instruments [10]. Technology is yet to say its last word in minimal access procedures and by extension, to endoscopic management of tubal infertility. Robotic endoscopy and N.O.T.E.S has already been performed with some degree of success and research is on-going. Apparently, the main limiting factor on the that minimal access procedures can play in tubal infertility and gynaecology in general is the ability of gynaecologic endoscopists to keep pace with advances in relevant technology through constant training and research [7,67]

CONCLUSION

Minimal access procedures can constitute a hub around which a one-stop shop formula can be developed to better manage tubal infertility in a more rationale way. The key in developing this concept ideally lies in the ability of the endoscopic surgeon handling tubal infertility among other things to master both the instruments and techniques of laparoscopy so as to acquire such justifiable confidence that will enable him to accomplish the objectives of minimally invasive procedures. The objectives of applying the endoscopic approach using all its obvious advantages over open techniques is improved diagnosis, better treatment options, better patient care, faster recovery, and reduced healthcare cost.

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