Laparoscopy-assisted intrapelvic sonography with a high-frequency, real-time miniature transducer for assessment of the Fallopian tube: a preliminary report

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Our purpose was to visualize normal and abnormal Fallopian tubes using laparoscopy-assisted intrapelvic sonography with a specially developed 20 MHz flexible catheter-based high-resolution, real-time miniature (2.4 mm outer diameter) ultrasound transducer in infertile women. A total of 21 women (20 infertile, one with unilateral hydrosalpinx, and one tubal pregnancy) were studied with pelvic saline effusion during laparoscopy. Fimbriae were clearly depicted with a cockscomb-like form in 95% of patients. All ampullae were visualized, and mucosal layers were clearly distinguished from muscle layers in 70% of patients. Scanty intratubal effusion was noted in 50% of patients, and tubal spastic findings were found in 10% of patients. In all, 60% of isthmuses were detected, and mucosal layers were distinguished from muscle layers in 30%. In the subject with hydrosalpinx, the tubal wall was thinner, and it was not possible to distinguish between muscle and mucosal layers. In the subject with a tubal pregnancy, the amniotic membrane and decidua were depicted more clearly than by transvaginal sonography. In conclusion, laparoscopy-assisted intrapelvic sonography with a high-frequency, real-time miniature transducer is useful for the visualization of normal and abnormal human Fallopian tubes using miniature ultrasound transducers (Goldberg et al., 1993; Giordano et al., 1994). However, image quality was poor because the frequency of the transducer used was 7.5 or 12.5 MHz. Moreover, the size of catheter used in those studies was relatively large (3 or 4.5 mm). The aim of this study was to determine whether laparoscopy-assisted intrapelvic sonography with a high-frequency, real-time miniature transducer is useful for the evaluation of Fallopian tubal texture.

Materials and methods

Women with primary infertility of unknown cause (n = 20) and intact tubal passages and one patient with a tubal pregnancy were studied using diagnostic and therapeutic laparoscopy with specially developed catheter-based, high-resolution, real-time miniature (2.4 mm in outer diameter) sonography transducers (20 MHz; Aloka AMP-PN20-08L, Aloka, Tokyo, Japan). The depth of penetration of the ultrasound beam is ~2 cm. This ultrasonic catheter is connected to an ultrasound device (Aloka SSD-550, Aloka). A motor in the main imaging device (Aloka ASU-100, Aloka, Tokyo, Japan) rotates the metal drive shaft at 900 r.p.m., resulting in a 360° real-time grey-scale image oriented perpendicularly to the long axis of the ultrasonic catheter. The study was approved by the local ethical committee of Tango Central Hospital, Japan, and standardized informed consent was obtained from each patient.

Prior to each procedure, transvaginal sonography was carried out in all subjects. Under general anaesthesia, after the first trocar (10 mm) was placed on the lower edge of the umbilicus, i.p. pressure was set at 12 mm Hg with CO2 gas, the second trocar (5 mm) was placed at the centre of abdomen below the midline, and the third trocar (5 mm) was placed lateral to the inferior epigastric artery at or below the level of the umbilicus. Both Fallopian tubes were completely soaked with sterile saline effusion. The ultrasonic catheter was then inserted into the peritoneal cavity through the second trocar, and the catheter was placed near the Fallopian tubes in the pelvic saline solution. Each tube was displaced using tubal forceps introduced through the third trocar to obtain optimal scanning sections.

Results

The catheter was easily introduced into the pelvic cavity through the trocar in all patients. The time taken for this

Introduction

As a consequence of improvements in ultrasound technology and with the advent of transvaginal sonography (TVS), the visualization and appreciation of the normal uterus and ovaries allow structural anomalies to be detected. The use of TVS in gynaecological diagnosis is limited by the physical properties of the transducer used as well as by the lack of sufficient acoustic interfaces (Timor-Tritsch and Rottem, 1987). Therefore, delicate tubal structures cannot be visualized adequately. The normal Fallopian tube is usually not seen by TVS unless some fluid surrounds it (Timor-Tritsch and Rottem, 1987).
Laparoscopy-assisted intrapelvic sonography and the Fallopian tube

Figure 1. Fimbrial end of Fallopian tube. C = catheter. Original magnification, ×2.

Figure 2. Cross section of ampulla (*). C = catheter; FT = Fallopian tube. Original magnification, ×2.

Figure 3. Spastic findings (arrows) were clearly noted. C = catheter; FT = Fallopian tube. Original magnification, ×2.

Figure 4. Longitudinal section of Fallopian tube. A = ampulla; C = catheter; I = isthmus; M = mucosal layer; ML = muscle layer. Original magnification, ×2.

procedure was about 10 min. No notable complications were encountered. Also there was no post-operative pain by this extension of diagnostic laparoscopy. The fimbriae were clearly depicted, showing a cockscomb-form in 95% of patients (Figure 1). All ampullae were visualized, and mucosal layers were clearly distinguished from muscle layers in 70% (Figure 2). Scanty intratubal effusion was noted in 50%, and spastic findings in 10% (Figure 3). In all, 60% of isthmuses were detected, and mucosal layers were distinguished from muscle layers in 30% (Figure 4). In one subject with hydrosalpinx, the tubal wall became thin, and muscle and mucosal layers could not be distinguished. In the subject with a tubal pregnancy, the amniotic membrane and decidua were depicted more clearly than by transvaginal sonography (Figure 5).

Discussion

The potential gynaecological applications of laparoscopy-assisted intrapelvic sonography for systematic examination of the Fallopian tube or detection of Fallopian pregnancy have been reported (Goldberg et al., 1993; Giordano et al., 1994).

However, the image quality was poor because the frequency of the transducer used was 7.5 or 12.5 MHz. Moreover, the size of catheter used in those studies was relatively large (3 or 4.5 mm). In the current study the sonographic frequency used was 20 MHz, and it was possible to visualize very fine Fallopian tube structures. However, the depth of penetration of the sonography beam is ~2 cm, which may be sufficient to evaluate the normal Fallopian tube, but examination of larger pathological tubes is markedly limited because of the shallow scanning range of the high-frequency transducer. Therefore, laparoscopy-assisted intrapelvic sonography with high-resolution transducers (20 MHz) may be suitable for visualization of normal Fallopian tubal texture or minimal disorders of the tube in patients with infertility of unknown cause.

Proximal, distal, and peritubal damage can be caused by a number of pathological processes such as inflammation, endometriosis and surgical trauma. The diagnosis of tubal occlusion relies primarily on hysterosalpingography, hysteroscopy and laparoscopy. A number of innovative diagnostic procedures such as sonosalpingography, Falloposcopy, and
selective salpingography improved our ability to accurately diagnose tubal pathology (Confino and Radwanska, 1992). However, tubal function, especially the assessment of endosalpinx is still difficult. In this study, laparoscopy-assisted intrapelvic sonography with a specially developed 20 MHz flexible catheter-based high-resolution, real-time miniature ultrasound transducer depicted clearly endosalpinx in many cases. Therefore, laparoscopy-assisted intrapelvic sonography with a high-frequency, real-time miniature transducer could be a valuable diagnostic modality for the assessment of tubal texture in tubal disorders, possibly in infertility practice. Unfortunately, in the current study, an in-vitro study could not be conducted to confirm that the different layers visualized with ultrasound corresponded with the histological/anatomical findings, because we could not obtain normal fresh specimens of the Fallopian tube after other surgery. Nor could we obtain any data on normal-looking tubes in women undergoing laparoscopic sterilization, because we had no such cases during this period.

With respect to the limitations of laparoscopy-assisted intrapelvic sonography using a high-frequency, real-time miniature transducer, this new technique appears to lack the manoeuvrability, depth of penetration, or field of view necessary to permit evaluation of virtually all common problems. These limitations are likely to be resolved as further technical advances are made.

References


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