Case report

Selective visualization of the Fallopian tube with magnetic resonance imaging

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Abstract

At present, X-ray hysterosalpingography is used commonly as a screening method for testing Fallopian tube patency, but the results are often unreliable due to mucous plugs or muscular contractions. Selective catheterization of the tubes under X-ray control is feasible, but is rarely used due to exposure of young individuals aiming for pregnancy to a high ionizing dose. Here, a case is described of a patient whose Fallopian tubes were selectively catheterized and visualized three-dimensionally under contrast-enhanced magnetic resonance imaging (MRI) guidance using a high-viscous gadoteric acid solution (Dotarem®). In this patient, bilateral peritubal adhesions caused a blockage of the fimbrial part of the tube leading to transuterine spilling of tubal fluid. Laparoscopy followed by bilateral salpingectomy was then performed, which confirmed the three-dimensional MRI images, and the excised specimens were examined histologically. The advantages of this novel technique include the avoidance of ionizing damage to the gonads and the potential for development of more elaborate interventional methods, such as ballooning and stenting. It is intended to develop contrast MRI further, both for improved non-invasive visualisation and for manipulative technology of the Fallopian tubes.

Keywords: Fallopian tube, HSG, imaging technique, magnetic resonance imaging, MRI, ultrasound

Introduction

As tubal occlusion is one of the most frequent causes of infertility, assessment of tubal patency is a cornerstone of the diagnostic evaluation of female infertility. The most widely-used methods are either diagnostic laparoscopy and tubal flushing with a blue dye or X-ray hysterosalpingography (HSG). At present, whereas the former is considered to be the gold standard, HSG is often used as a screening method in women at low risk of tubal pathology (Papaioannou et al., 2004). However, the use of X-ray HSG is burdened with several disadvantages and suffers from low diagnostic accuracy. Particularly, distal tubal pathology or the presence or absence of peritubal adhesions cannot be diagnosed reliably with HSG (Mol et al., 1996). One-side tubal pathology as detected with HSG is not associated with a significant reduction of fertility outcome and therefore does not justify a surgical procedure for confirmation (Mol et al., 1999).

Other screening methods for evaluation of the patency of the Fallopian tubes consist of hysterosalpingo-contrast-sonography (commonly denominated as HyCoSy) and the presence of positive Chlamydia antibody titres. Despite comparable diagnostic accuracy rates (HyCoSy: Strandell et al., 1999; Chlamydia antibody titres: Mol et al., 1997), HSG is still being performed in the majority of patients (Vijayanthi et al., 2004). In cases with unilateral tubal blockage in a conventional HSG, tubal catheterization followed by selective salpingography using X-ray monitoring has been used to demonstrate tubal patency (Lang et al., 2000; Papaioannou et al., 2002; Hayashi et al., 2003). However, this method has been confined to a few centres worldwide, mostly due to the hazard of ionizing damage to the gonads during prolonged radiographic investigations in women aiming for pregnancy (Perisinakis et al., 2003).
In recent years, the authors have developed magnetic resonance imaging (MRI) using a high-viscosity contrast solution made of gadoteric acid (Dotarem®) for visualization of both the uterine cavity and the Fallopian tubes (Wiesner et al., 2001; Unterweger et al., 2002). Experience has shown that the isthmic portion of the Fallopian tube can be made visible with MRI when a high-viscosity contrast solution is used. Here, the first case is described in which both Fallopian tubes are selectively catheterized and visualized with 3D magnetic resonance catheter tubography using an intra-luminally applied contrast solution.

Case report

In 2004, a 37-year-old woman presented at the Infertility Unit of the University Women’s Hospital of Basel, Switzerland together with her partner because of primary infertility. She reported to have had unprotected intercourse with her partner over a period of 35 months without pregnancy. During her subsequent examination, she was diagnosed with the polycystic ovarian syndrome. Her partner was found to have a normal physical condition and his seminal parameters were all within the normal limits as given by the World Health Organisation guidelines (WHO, 1999). Although a diagnostic laparoscopy was performed previously in another hospital in Switzerland, the condition of the Fallopian tubes was still unknown during her initial infertility diagnostic workup. An accidental vascular lesion during that laparoscopy had caused a massive intra-abdominal haemorrhage and at that time necessitated an emergency laparotomy to stop the bleeding. During the procedure, the patency of the Fallopian tubes was not assessed.

The patient, being reluctant to undergo another diagnostic laparoscopy for tubal patency assessment, agreed to participate in an ongoing clinical study at the Institute of Radiology and the Women’s Hospital of the University of Basel, Switzerland. This purely experimental study was set up as a feasibility study for the assessment of tubal patency with contrast MRI in a large cohort of infertile women and had been approved by the institutional review board.

A balloon catheter (Charriere 5, Rüsch, Kernen, Germany) was inserted transcervically into the uterine cavity and blocked with an inflated balloon. A quantity (20ml) of high-viscosity contrast solution was injected into the uterine cavity. The contrast solution consisted of a diluted and biologically inert Dotarem® solution (Acidum gadoteras DCl, 18.6 mmol/l, Guerbet, Paris, France) mixed with polyvidone (140 mg PVPC30) in order to increase its viscosity up to 100 mPars. During the injection of this contrast solution, MRI was performed with a 1.5 Tesla MR-unit (Avanto, Siemens, Erlangen, Germany). The morphology of the uterine cavity could be demonstrated and presented as a septate uterus. However, because of the septate form of the uterus, the tip of the intratubal balloon catheter became dislodged, so that neither of both Fallopian tubes was filled with the contrast dye.

One month later, following discussion with the patient, it was decided to perform a second catheterization. For this examination, two flexible transcervical catheters were used to selectively catheterize each of the Fallopian tubes (Jansen-Anderson, Cook, Mönchengladbach, Germany). During one single procedure, both catheters were positioned transcervically into each of the Fallopian tubes (Jansen et al., 1988). The correct position of the catheters was checked with transvaginal ultrasound. After positioning of the patient in the MRI device, 2 ml of the high-viscosity Dotarem® solution were injected simultaneously into both Janson-Anderson catheters. Again, during the injection of the contrast solution, dynamic MRI was performed with a 1.5 Tesla MR-unit (Avanto, Siemens, Erlangen, Germany).

The use of contrast MRI for the evaluation of the uterine morphology and the patency of the Fallopian tubes in infertile women, including the selective catheterisation of the Fallopian tubes, was presented to, and approved by, the local ethics committee and the patient signed an informed consent document for both procedures.

The lack of flow of the contrast solution from both Fallopian tubes into the peritoneal cavity, as visualized by selective 3D magnetic resonance catheter tubography, prompted us to advise the patient to undergo a hysterectomy and a laparoscopy. The possibility of resection of the uterine septum and of both Fallopian tubes was discussed with the patient. The latter was performed in November 2005. During this operation, the findings visualized with MRI were confirmed and both the septum and the Fallopian tubes were removed successfully. Subsequently, the excised tissues were examined in the Institute of Pathology of the University Hospital of Basel, Switzerland. After the removal of both Fallopian tubes, conventional IVF treatment led to the establishment of an ongoing singleton pregnancy.

Using selective transcervical tubal catheterisation followed by selective 3D magnetic resonance catheter tubography, it was possible to visualize both Fallopian tubes in an infertile patient with a septate uterus. In a preceding MRI hysterosalpingography trial, tubal patency could not be demonstrated, because the uterine septum dislodged the intratubal catheter thereby blocking the passage of the contrast solution into both Fallopian tubes. Within the context of a prospective feasibility trial, it was decided to demonstrate tubal patency in this patient by selective catheterization of the Fallopian tubes followed by MRI for the visualization of the tubal structures and their patency. Both Fallopian tubes were catheterized simultaneously with two Jansen-Anderson catheters and flushed with high-viscosity Dotarem®. Both Fallopian tubes were visualized with MRI by observing the passage of 2 ml of the Dotarem® solution with a defined viscosity (Figure 1). The flushing of the Fallopian tubes was performed without any need for analgesia. The intratubal lumen of both Fallopian tubes appeared dilated and the lack of passage of the contrast solution into the peritoneal cavity suggested distal tubal obstruction (Figure 1). Both procedures were well tolerated by the patient. Thereupon, a laparoscopy was performed, during which the condition of the Fallopian tubes, as originally visualized by contrast MRI, was confirmed (Figure 2). Both Fallopian tubes were surrounded by massive adhesions showing phimosis of its fimbrial portion and consecutive hydrosalpinx, necessitating their surgical removal in order to prevent retrograde spilling of intratubal fluid into the uterine cavity (Strandell et al., 2001). Particularly, the left tube was firmly embedded in adhesions causing a widening of the tubal lumen. The histological examination of the removed tubes confirmed the presence of massive peritubal adhesions (Figure 3).
Figure 1. (A) Standard pelvic magnetic resonance imaging in a 37-year-old woman. T2-w turbo spin echo sequences in transversal orientation (with fat saturation) demonstrate a septate uterus (arrow); (B) T2-w turbo spin echo sequence in para-coronar orientation after selective catheterisation of both Fallopian tubes with two catheters (triangles) with their tips positioned close to the intramural part of the Fallopian tubes (arrows); (C) 3D magnetic resonance catheter tubography after dynamic magnetic resonance hysterosalpingography with maximal intensity projection obtained during late injection of the contrast solution causing a significant dilatation of both Fallopian tubes (arrows) but without passage of the contrast solution into the peritoneal cavity.

Discussion

For the first time, two Fallopian tubes were visualized directly by selective 3D magnetic resonance catheter tubography and the bilateral distal tubal occlusion, as diagnosed correctly by this novel method, was confirmed later during laparoscopy and by the detailed histological examination of the excised tubal specimens. This sequence of events not only demonstrates the feasibility of visualization of the Fallopian tubes and tubal occlusion by the use of magnetic resonance hysterosalpingography, but also the access of the Fallopian tubes to catheterization within the context of MRI. Previously, the authors had already demonstrated that the uterine cavity, the Fallopian tubes and tubal occlusion can be made visible in magnetic resonance hysterosalpingography by using a highly viscous contrast solution (Wiesner et al., 2001; Unterweger et al., 2002). However, as presented, in certain cases of tubal occlusions, selective 3D magnetic resonance catheter tubography may become necessary for definition of the very exact site of tubal occlusion and to assist with decision-making regarding the further therapeutic approach.

Visualization of the uterus and the Fallopian tubes with contrast-enhanced MRI offers several advantages over conventional HSG. In MRI, the soft tissues surrounding the Fallopian tubes remain visible, so that the position of the Fallopian tube, and any abnormalities, can be examined in relation to its surroundings such as the ovary and the myometrium. The assessment of the Fallopian tube can be further improved by 3D reconstruction of both the tube and the surrounding pelvic structures, including the ovaries. In contrast to X-ray imaging, potential ionizing damage to the gonads is avoided.

Another candidate method for the evaluation of the patency of the Fallopian tubes which avoids X-ray imaging, is offered by vaginal 3D contrast sonography. In the past, lengthy and tortuous demonstration of the Fallopian tubes with 2D sonography was difficult. Recently, 3D contrast sonography has overcome this problem and a first prospective study demonstrating its feasibility was presented comparing 3D HyCoSyn with tubal patency testing in laparoscopy (Chan et al., 2005). Whether sonography or MRI will become the preferred method for Fallopian tube patency testing in the near future will depend on the quality of the imaging details of each method, the cost of the procedure and the access of the method for manipulation of the tubal structures with fine tools. When compared with sonography, MRI has the higher potential of producing broad images containing the detailed structures of both Fallopian tubes simultaneously and in relation to the neighbouring organs. These efforts are in keeping with a recent, general tendency in many fields of medicine to abandon the long-standing technology of conventional radiology and to develop more comprehensive 3D imaging based on sonography, computer tomography or MRI.

The authors hope that this report will provide the starting point for the development of more sophisticated interventions within the Fallopian tubes, such as tubal perfusion pressure monitoring, ballooning of the isthmic portion of the Fallopian tube or even distal stenting of a hydrosalpinx, making more invasive surgical procedures unnecessary.
Figure 2. The real-time condition of the Fallopian tubes as given by laparoscopy. Due to peritubal adhesions, connecting them with the ovaries and the colon, the Fallopian tubes could hardly be visualized. The white arrows indicate firm adhesions around the right ovary (A), round the right Fallopian tube (B), around the left ovary (C) and around the left Fallopian tube (D).

Figure 3. Histological examination of the excised specimen containing the fimbrial part of the left Fallopian tube, which was connected to the ovary through firm adhesions (arrow). The peritubal adhesions obstructed the release of tubal fluid into the peritoneal cavity, causing the spilling of the fluid through the uterine cavity as shown by serometra. The fimbrial obstruction caused by the peritubal adhesions was correctly visualized by 3D magnetic resonance of the catheterized Fallopian tubes.
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References


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