OUTSTANDING CONTRIBUTION

Endoscopic visualization of the process of fimbrial ovum retrieval in the human

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The process of ovum retrieval by the fimbriae in the human still remains elusive. Animal studies have suggested that ova can be ‘sucked’ into the oviduct by negative pressure caused by muscular contractions of the tube, while laparoscopic observations in women have indicated a close relationship between fimbriae and the ovulating ovary. Here, a case is described in which the process of ovum retrieval was observed directly using a new endoscopic technique, called transvaginal hydrolaparoscopy. The access is through the posterior fornix of the vagina and saline is used for distension. The tubo-ovarian structures during the process of ovum retrieval were visualized under fluid. The fimbriae on the ovulatory side appeared congested and tumescent and showed pulsatile movements synchronous with the heartbeat. The cumulus mass was adherent to the fimbriae and released from the site of rupture by the sweeping movements of the fimbriae until it disappeared between the rigid fimbrial folds. To the best of our knowledge this is the first direct observation of the process of ovum retrieval in the human. Vascular congestion causing erection and pulsatile movements of the fimbriae play a role in the retrieval of the ovum. The retrieval process from the site of rupture is slow and transport is achieved by ciliary activity only. The fimbrial changes are apparently controlled by the ovulatory ovary.

Keywords: ciliary activity/fimbriae/laparoscopy/ovum retrieval

Introduction

At the moment of ovulation the follicular fluid and the cumulus oophorus are released from the follicular environment. How the cumulus oophorus is picked up by the fimbriae in the human is unknown. Studies in rabbits have suggested that ova could be ‘sucked’ into the oviduct, a theory that was further supported by the report of a negative pressure caused by tubal contractions (Maia and Coutinho, 1970). This was refuted, however, by experiments in which oviducts were ligated at the base of the fimbriae (Clew and Mastroianni, 1958) and contractibility was blocked by propanol (Halbert et al., 1976). In women, Edwards and Steptoe (1975) observed at laparoscopy that blood vessels in the fimbriae became engorged at ovulation to form a type of erectile tissue and that extensions from the fimbriae became arranged over the ovulating follicle. They suggested that ovum retrieval is controlled by muscular contractions. The precise process of the entrapment of the oocyte by the fimbriae at the moment of its release has to the best of our knowledge never been observed in vivo in the human.

Laparoscopy is not the ideal technique to explore the tubo-ovarian structures and ovum retrieval process. Firstly, the transumbilical access does not provide the optimal angle of view for the tubo-ovarian structures. Therefore manipulation is required to expose the full ovarian surface and the fimbriae, which are usually lying in the fossa ovarica in contact with the caudal pole of the ovary. Secondly, structures such as tubal mucosal folds and filmy adhesions are difficult to visualize in the presence of positive intraperitoneal pressure (Brosens, 1996). We have recently described a new technique of vaginal hydrolaparoscopy (Gordts et al., 1998). This technique is based on vaginal access using a needle puncture technique and saline for distension. Access from the caudal pole allows the tubo-ovarian structures to be inspected in their normal position in the fossa ovarica without manipulation. It is performed as an outpatient procedure under local anaesthesia at the posterior fornix allowing the fully conscious patient to watch the exploration.

We report for the first time in the human the endoscopic visualization of the retrieval by the fimbriae of the cumulus oophorus.

Case report

As part of a fertility work-up, a 25 year old patient with a 2 year history of primary subfertility was asked to monitor her cycle with daily urinary luteinizing hormone (LH) assays. Since the patient had regular cycles of 28 days, monitoring was started on day 11 of the cycle. The LH assay was positive on the morning of the 13th day of the cycle, and an appointment was made for 1830 h on the same day for further exploration. A vaginal ultrasound examination showed the presence of a 20 mm follicle in the left ovary with subtle irregularity of the follicular wall. At vaginal hydrolaparoscopy the ovulation stigma was identified on the caudal pole of the left ovary. The fimbriae were distended and embracing the caudal pole of the ovary. The fimbrial vessels were engorged and the edges of the erect fimbriae were in close contact with the ovary and...
Figure 1. Congested fimbriae on the ovulatory side. Note the congested circumferential fimbrial vessel.

Figure 2. Cumulus oophorus stretched between the erect tip of the fimbriae and the ostium of the ruptured follicle.

gently sweeping the surface of the ovulation ostium in a pulsatile way (Figure 1). The fimbrial pulsations were synchronous with the patient’s heartbeat. On close inspection a mucinous structure was seen protruding from the ovulation ostium which was firmly adherent to the tips of the erect fimbriae. The mucinous structure was identified as the matrix of the cumulus–oocyte complex (Figure 2). The pulsatile movements of the fimbriae slowly pulled the cumulus–oocyte complex free from the ostium of the ruptured follicle. During the observation follicular fluid leaked slowly from the ovulatory ostium. The total duration of the observation was 15 min. Erect fimbriae and pulsatile movements were not seen on the contralateral side.

Discussion
To the best of our knowledge this is the first time that the process of ovum retrieval by the fimbriae has been visualized
in the human and recorded in vivo. Our observation shows that the release of the cumulus oophorus is a slow process, and confirms the view that the cumulus oophorus is not ejected by hydrostatic pressure from within the follicle or by obvious contractions of ovarian smooth muscle cells. In our case the rupture of the follicle had already started at the time of observation and the release of the cumulus mass was apparently assisted by fimbrial activity. We observed the disappearance of the matrix of the cumulus oophorus between the fimbriae during a period of 15 min and therefore conclude that the duration of ovum release and retrieval lasted for more than 15 min. The fimbriae on both sides were distended in the fossa ovarica and positioned underneath the caudal pole of the ovaries. On the ovulating side the fimbriae were rigid and erect due to the presence of engorged vessels and showed pulsatile beatings which were synchronous with the maternal pulse. The edges of the erect fimbriae were seen to sweep gently over the ruptured follicle while the matrix of the cumulus oophorus sticking to the fimbriae was slowly released from the ovulatory ovary. Apart from the pulsating sweepings there were no obvious contractions of the tube or ovary to assist in the retrieval process. Together with the data of Kunz et al. (1996) on rapid sperm transport our observation suggests that the Fallopian tube on the side adjacent to the corpus luteum is 'dominant' for gamete transport.

Scanning electron microscopy studies (Vasquez et al., 1980) have shown that the fimbrial folds have a uniform density of ciliated cells on the ridge and lateral walls, covering more than 60% of the fimbrial surface. The fimbrial folds are in continuity with 5–6 complexes of major ampullary folds forming a similar number of channels lined by large folds in the ampulla. In contrast to the fimbriae the folds in the ampulla are surrounded by a circular muscle, the ridges of the folds are scarcely ciliated, the lateral walls have a surface which is 40–60% ciliated and few cilia are present at the bottom between the folds. Apparently the cumulus mass firmly adheres to the fimbriae and is actively transported by ciliary activity of the mucosal fold system. It seems likely that the cumulus mass is transported between the opposing sides of two folds (Vasquez et al., 1983). At the fimbriae the opposition of folds is apparently not achieved by muscular contractions but by vascular congestion. The forces generated by the ciliated cells on the two opposing mucosal folds may be responsible for the passage of the ovum down the Fallopian tube as there is now good evidence that tubal muscular activity does not play a primary role in promoting egg transport in the distal tubal segment (Halbert et al., 1976). Whether the ampullary folds show similar congestion and erection to form channels of closely opposed folds after ovulation remains speculative.

The congestion and pulsatile movements of the fimbriae on the side of ovulation indicate that the changes are under ovarian control. After ovulation high concentrations of follicular 17β oestradiol are released. 17β oestradiol causes an enhanced vasodilatation by stimulating endothelial nitric oxide and prostacyclin activity (White et al., 1995) and by decrease of protein kinase C activity (Mazgness et al., 1991). This can explain the vascular changes of the fimbriae seen on the side of ovulation. Admittedly, the peritoneal instillation of saline during the procedure, which amounted to 300 ml, had a diluting effect on the concentration of 17β oestradiol in the peritoneal fluid. Therefore under physiological conditions, when peritoneal 17β oestradiol rises to more than 1500 pg/ml (Koninckx et al., 1980) a similar, but delayed vascular effect on the contralateral fimbriae cannot be excluded.

There is clinical evidence that a second modality of retrieval from the cul-de-sac or intervisceral spaces exists in the human. The secondary uptake is more likely to result in delayed retrieval and also in peritoneal transmigration of the oocyte to the contralateral Fallopian tube. Women with one ovary and only a contralateral Fallopian tube have been reported to conceive. Judging from the finding of the oocyte in the tube contralateral to the corpus luteum the frequency of this phenomenon is less than 5% in normal fertile women (Crozatto and Ortiz, 1989). However, its frequency may be significantly increased in conception cycles in which tubal implantation occurs. The frequent association with chronic salpingitis, however, makes it difficult to establish the relative importance of transmigration and underlying tubal damage in the pathogenesis of tubal pregnancy (Kleiner and Roberts, 1967; Vasquez et al., 1983).

In conclusion, the endoscopic observation of ovum retrieval in the human showed a close relationship between the fimbrial mucosa and the ovarian surface with slow release of the cumulus oophorus. Vascular congestion causing erection of fimbrial folds and pulsatile beating apparently assists the ciliary activity in picking up the cumulus mass from the site of follicle rupture. The technique of vaginal hydrolaparoscopy offers new possibilities for in-vivo investigation of the tubo-ovarian function in normal and abnormal conditions.

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References


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