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COMMENTARY

Different roles of cilia in different segmentations of reproductive tract

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Many studies have showed that cilia in reproductive tract play a key role in germ cell transport and sperm-egg meeting. Raidt J et al. showed that fallopian tube cilia lead to directional fluid flow into the uterine cavity through coordinated beating [1]. In addition, interestingly, in the study of mare oviduct, Desantis S et al. found that ciliated cells were not evenly distributed in the oviduct, but with the percentage increasing from fimbriae to ampulla and significantly decreasing in isthmus [2]. The result indicates that the cilia may play different roles in different segmentations of reproductive tract.

In the traditional concept, it was believed that cilia in oviduct were indispensable in egg pick up and embryo transportation [3]. Recently, Yuan et al. demonstrated that the oviduct cilia were essential for egg pick up but unnecessary for the transportation of sperm and embryos, therefore fimbriae plays a key role in egg transport [4]. By experimenting on mice lacking miR-34B/C and miR-449 (oviduct lacking cilia), Yuan' study showed that the ovulated COCs are trapped within the ovarian bursa cavity in miR-dKO mice, unlike WT mice with ovulated cumulus-oocyte complex (COC) located in the ampulla of the oviducts. However, WT sperm still manage to reach the ampulla region of oviducts in the miR-dKO mice despite reduced efficiency. Meanwhile, about half of the early embryos transferred to the ampulla region of oviducts also successfully migrate to the uterus for implantation in the miR-dKO mice. The study also supported that smooth muscle contraction, not motile cilia beating, is the major force driving embryo transport in the other regions of oviduct, such as isthmus and ampulla [5, 6]. This article is very interesting and gives a unique perspective to understand the transport mechanism, which reveals that genital cilia have different functions in different segments of the organ. This manuscript also provides the similar tip for the role of cilia in male reproductive organs.

Corresponding to oviduct, epididymis also has the function of transporting sperm in the male reproductive system. Epididymis is a tube several meters long (up to 60 m in domestic mammals) and is divided into the four regions (initial segment, caput, corpus and cauda) in rodent species [7], which is similar to the four regions of oviduct (fimbriae, ampulla, isthmus and intramural portion). It is worth noting that initial segment is found in rodent species, whereas in humans, the proximal region is formed by efferent ducts, which are the only region of the male tract that have motile cilia [8]. Although efferent ducts have a different morphology and function compared to the epididymal segments, we consider they could be regarded as a part of the epididymis, like ampulla of oviduct.

After generated in the testis, sperm is collected to the initial segment of epididymis through efferent duct and then is transported to the cauda. The transport time of sperm in epididymis will affect its maturation [9]. However, the mechanism of sperm transport in epididymis is not clear. In view of this, some studies have been carried out on the cilia of epididymis. Cilia in the efferent ducts of the testis are a kind of water-propelling cilia and the ultrastructure of the central machinery of the flagellum and that of the cilium are very similar [10]. Aprea I et al. found that mice have immotile efferent duct cilia when lack outer dynein arm (ODA) and show accumulation of sperm in the efferent duct with unaffected sperm motility [11]. It is also reported immotile cilia can cause male infertility [10] and the cilia of the efferent tubules play a key role in sperm transport [12]. Yuan et al. declared that efferent ductal cilia in the male display continual changes in direction, generating turbulence, which maintains immotile spermatozoa in suspension within the lumen. The result showed cilia is critical for the germ cell transport both in efferent ductules of the male and ampulla of oviduct, but the mechanism may be different.

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Since the role of the different segments of epididymis is similar to oviduct, muscle contraction may also be the main factor for sperm transport in the other segment of epididymis [13, 14]. Therefore, after reading this article, we sincerely hope the author can conduct research in this aspect.

In conclusion, this study provides valuable hint for sperm transport in male reproductive tract.

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Declarations

Conflict of interest The authors declare no competing interests.

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