Human spermatozoa with a twist


* Department of Molecular, Cellular and Developmental Biology, University of Colorado, Boulder, CO, USA
**Krefting Research Centre, University of Gothenburg, Gothenburg, Sweden
***Sahlgrenska Academy, University of Gothenburg, Gothenburg, Sweden
**** Department of Chemistry and Molecular Biology, University of Gothenburg, Gothenburg, Sweden

Microtubules are an important part of the cellular cytoskeleton, as they, for example, separate the chromosomes during cell division and aide cellular motility in multiple ways. They are 25 nm wide hollow tubules built of tubulin heterodimers. A large number of microtubule-associated proteins (MAPs) are used by the cell to regulate their dynamics, for example by promoting growth or triggering depolymerisation (catastrophe). While the vast majority of MAPs associate with the outer surface of microtubules, relatively little is known about the microtubule lumen and the proteins inside of it. Microtubule inner proteins (MIPs) are found inside the microtubule lumen of cilia and flagella, and bind at specific locations on the doublet microtubule lattice. Another protein, often called “the carrot” extends from the flagellar tip into the A-tubule of the flagellar axoneme. However, so far, no larger protein complex, or complex structure, has been described inside a microtubule.

We performed cryo-electron tomography on healthy human spermatozoa, frozen intact in their ejaculate. A several micrometer long repetitive structure was apparent inside the microtubule lumen in sperm tails, which was revealed by sub-tomogram averaging to be a helix. The helical structure is positioned off-centre inside of the microtubule lumen, only touching a part of the microtubule lattice.

This is, to our knowledge, the first time a complex structure is seen inside the microtubule lumen, and because of its positioning, we speculate that it might be a microtubule stabilizing structure.