Journal of Andrology, Vol. 25, No. 2, March/April 2004

Effects of Putative Epididymal Osmolytes on Sperm Volume Regulation of Fertile and Infertile c-*ros* Transgenic Mice

CHING-HEI YEUNG*, MICHAEL ANAPOLSKI*, IWAN SETIAWAN†, FLORIAN LANG† AND TREVOR G. COOPER*

*From the * Institute of Reproductive Medicine of the University, Münster, Germany; and the † Institute of Physiology, University of Tübingen, Tübingen, Germany.*

Correspondence to: Dr C. H. Yeung, Institute of Reproductive Medicine of the University, Domagkstrasse 11, D-48129 Münster, Germany (e-mail: yeung{at}uni-muenster.de).

Volume regulation by spermatozoa has been demonstrated to be crucial in both mice and men for transport in the female tract. In order to determine the nature of osmolytes used by spermatozoa, they were released from the cauda epididymis of fertile c-ros heterozygous mice into incubation medium of uterine osmolality (representing an osmotic challenge), containing increasing concentrations of compounds that are major epididymal fluid components and known osmolytes in somatic cells. This should nullify the concentration gradients for osmolytes that mediate volume regulation, prevent osmolyte efflux, and lead to swelling. Of the osmolytes tested, K^+ caused the most rapid and extensive volume increases; glutamate, taurine, L-carnitine, and myo-inositol also were effective, but glycerophosphocholine was not. Such effects were not observed in cauda sperm from the infertile knockout mice, demonstrating a defect in normal volume regulation. K^+ concentrations in cauda epididymal fluid were 21 mM higher in the knockout than the heterozygous mice, but no differences were found in caudal fluid glutamate, carnitine, or myo-inositol. The carnitine content of cauda sperm from knockout males was not different from that of fertile males, but lower amounts of glutamate and inositol were found that could explain the poor volume regulation. In heterozygous mice, cauda but not caput sperm responded to the K^+ channel blocker quinine by swelling, demonstrating development of volume regulation during epididymal transit, whereas knockout cauda sperm showed no response, as with the osmolytes. Major epididymal secretions could serve as osmolytes in murine spermatozoa for volume regulation in response to physiological osmotic challenge in the normal fertile mice; the reduced sperm content of inositol and glutamate in the c-ros knockout mice might reflect maturational abnormalities in volume regulation.

Key words: Sperm swelling, regulatory volume decrease, quinine, organic osmolytes, infertility

This article has been cited by other articles:

Reproduction HOME

T G Cooper, J P Barfield, and C H Yeung
The tonicity of murine epididymal spermatozoa and their permeability towards common cryoprotectants and epididymal osmolytes
Reproduction, May 1, 2008; 135(5): 625 - 633.
[Abstract] [Full Text] [PDF]

Reproduction HOME

A M Petrunkina, D Waberski, A R Gunzel-Apel, and E Topfer-Petersen
Determinants of sperm quality and fertility in domestic species
Reproduction, July 1, 2007; 134(1): 3 - 17.
[Abstract] [Full Text] [PDF]

Reproduction HOME

A M Petrunkina, R A P Harrison, M Tsolova, E Jebe, and E Topfer-Petersen
Signalling pathways involved in the control of sperm cell volume
Reproduction, January 1, 2007; 133(1): 61 - 73.
[Abstract] [Full Text] [PDF]

Journal of ANDROLOGY HOME

Di Zhang and M. Gopalakrishnan
Sperm Ion Channels: Molecular Targets for the Next Generation of Contraceptive Medicines?
J Androl, November 1, 2005; 26(6): 643 - 653.
[Full Text] [PDF]

BIOLOGY of REPRODUCTION HOME

C.H. Yeung, J.P. Barfield, and T.G. Cooper
Chloride Channels in Physiological Volume Regulation of Human Spermatozoa
Biol Reprod, November 1, 2005; 73(5): 1057 - 1063.
[Abstract] [Full Text] [PDF]

BIOLOGY of REPRODUCTION HOME

J.P. Barfield, C.H. Yeung, and T.G. Cooper
The Effects of Putative K+ Channel Blockers on Volume Regulation of Murine Spermatozoa
Biol Reprod, May 1, 2005; 72(5): 1275 - 1281.
[Abstract] [Full Text] [PDF]