The Functional Anatomy of The Male Gonadal Vessels: A Re-Appraisal

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ABSTRACT

The male gonad, testes best function within limits of a regulated ambient temperature range. Physiologists and andrologists credit multi-factorial mechanisms that thermo-regulate testicular health. Among the most accepted ones is the operation of a counter-current temperature balance produced by the pampiniform plexus of veins that sheathes the testicular artery.

This brief paper discusses a few other less discussed mechanisms that could play additional roles in temperature maintenance of the testes.

Key words: Scrotum, testes, pampiniform plexus, testicular artery, chaotic cooling systems

INTRODUCTION

One of the major causes for male sub-fertility or infertility (oligozoopermia or azoospermia) is the compromise in the functional efficiency of spermatogenesis. While many factors have been described which in one way or other influence the numbers and health of spermatozoa, one factors physiological factors is thermoregulation. Inbuilt temperature regulatory and maintenance mechanisms operate in most mammalian reproductive systems. Derangement or interference with thermo-control is one of the primary causes for male infertility.

Maintenance of an ambient testicular temperature of 2-7°C below body temperature is essential for spermatogenesis. The principal factors that regulate temperature of the gonads are:

- Thin and hairless scrotal skin
- Presence of a large number of sweat glands
- Absence of fat
DISCUSSION

Anatomically, one or the other half of the scrotal sac hangs at a lower level than the other. The testes with their sac, are situated in an asymmetrically suspended position, one slightly lower than its other counterpart. While many theories on why and how of the testicular levels have been proposed, including those engendered by vascular, functional, embryological or evolutionary influences, none of the proposed scientific reasons is totally convincing.

It is certain that any or all the above listed factors do contribute their mite to thermoregulation of the male gonad, physiologists credit the pampiniform plexus of veins (proximal segment of the testicular vein) that drain the testes as one of the more significant factors. These tortuous venous channels sheathe the testicular artery as it descends into the sac, in effect cooling the arterial blood before it reaches the testes. A countercurrent heat exchange mechanism operates transferring heat between vessels descending down into vessels moving upwards. The question raised by this conclusion is, if countercurrent heat exchange is the principal thermoregulatory factor in the male, why do the female gonads, the intra-abdominally located ovaries also possess a similar pampiniform plexus of veins?

Another novel hypothesis credits the operation of a complex ‘chaotic cooling system’ in the male which aids in maintenance of lower temperature in the testes\(^2\). The free suspension of the testicles in a loosely wrapped and hyper mobile sac, contributes to a random swing of the organs. The involuntary up, down, anterior, posterior, right or left, circular and elliptical motions that the hung scrotum exhibits, continuously, induces a chaotic cooling system to operate. The non-volitional erratic excursions of the freely suspended sac, allows for better exposure and fanning of its contents to ambient environmental temperature, more effectively. In our opinion, the scrotum is a classic example of natural chaotic cooling system, and that this may well be the primary contributor to thermoregulatory mechanisms in the metabolically active gonad.

That the testicles are pulled up, involuntarily, if and when temperatures go below optimal levels, through a reflex muscular contraction the retracted scrotum becomes less mobile and more fixed or, far less chaotic in movement. The control of erratic excursions and the subsequent inhibition of the chaotic cooling system, arrests continued cooling – evidenced by continued use of restrictive and binding clothing, believed to be one of the triggering factors for development of testicular malignancies.

One additional, yet overlooked cause for the naturally displaced level could be simply, to expose more surface area of the active organ to cooler environs\(^2, 3, 4\). While it is an accepted fact that suspension of the scrotum outside the abdominal cavity is paramount to the functional efficiency of testes in a preferred lower temperature – it still does not address the question – why hang at different levels?
Assuming the scrotum to be symmetrical, the two medial surfaces of the two testes would face each other, juxtaposed – the total surface area of testes exposed to lower environmental temperature would be that provided by the two lateral surfaces only. By modulating, differential rates of descent of the testes in the prenatal development stage, the final position of the testis allow for more surface area exposure to environment –in addition to being a part of the lower medial surface of the lower testis and a part of the upper medial surface of the higher testis.

In effect, just by suspension at two levels, nearly one entire extra surface is available for cooling. That is, the surface area available now becomes two lateral, plus two halves of the two medial. This extra area available to the testes probably is yet another significant, but overlooked anatomical factor that dictates differential rates of descent and displacement of anatomical levels of twin reproductive male gonads.

![Diagram of vein and artery arrangements](image)

Figure shows linear veins could kink on shortening lengths (A). The modified pampiniform arrangement could eliminate any kinking during reduction in length (B). The tortuous testicular artery is more elastic than the vein allows shortening or lengthening freely (C)

The pampiniform anatomical arrangement of veins sheathes the highly convoluted and tortuous testicular artery as it descends into the scrotum. This arrangement of vessels, venous and arterial, is crucial to the delivery of ‘cooled’ arterial blood flow into the gonad. Physiologists credit this counter-current flow pattern to be the principal cause for the sustained maintenance of a below-body ambient temperature is essential for gonadal health and normal sperm count. Even minor fluctuations in the thermoregulatory systems result in male sub-fertility or infertility. Other theories on thermoregulatory mechanisms, based on chaotic cooling systems’ have been proposed. (1)
There could be yet another, less obvious cause for the plexiform (pampiniform) arrangement of the testicular veins: The continuous upward and downward excursions of the scrotal sacs could stretch the thin-walled vein (as it is, veins have less elastic fiber). The artery, much like other ‘stretchable’ arteries in the human anatomy (maxillary, facial) is not only tortuous but also have denser elastic coat. The testes ascend or descent along with their coverings and sac involuntarily, depending on the thermoregulatory systems that operate from time to time. (2, 3, 4) The up-down swing of the gonad may extend two centimeters or more. The testicular artery being convoluted and tortuous, adjust to the ascent and decent of the scrotal sac by closing-up its convolutions and tortuousness. Were the testicular vein not be in its pampiniform arrangement, it would be unable to shorten its length without a possible kinking during the latter exercise. The possibilities of development of such kinks are more common in veins. (figure)

Yet another factor worth a second look is that, by stretching during the lowered phase of gonads, there is a perceptible increase in the surface area of contact and exposure between the testicular artery (carrying warmer blood) exposed to the counter-current pampiniform testicular vein (with cooler blood). The addition to the lengths of vessels, thanks to the tortuousness of the artery and the pampiniform arrangement of the vein allows a more efficient counter-current cooling mechanism. The surface area, in situ is partly also augmented by the wrinkled (crenated) surface of the scrotal skin.

While there is disputing the fact that the pampiniform pattern aids in a counter-current thermal exchange between artery and vein, the functional anatomy of the plexiform (pampiniform) veins could well be also to help in reduction in length (during ascent) without kinking and obstruction there-from to venous flow and to engender a more functionally efficient method to enhance ‘cooling’ through extension in lengths of target vessels of the gonads.

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