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Perspective

A Novel Method to Determine Testicular Temperature

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Abstract

In most mammals, spermatogenesis requires about 2.0 to 2.5°C lower temperature than core body temperature, and any increase will affect sperm quality. Since temperature is related to heat, the objective was to develop a technique that determines the testicular heat content. Sixteen men provided semen samples and had their Scrotal Testis (ST) Complexes immersed in water at 5°C. The increase in water temperature was then monitored for 10 to 12 minutes. The results revealed that the ST Complex heat content of individuals varied between 55 and 140, and that the sperm motility and morphology were negatively correlated, thus confirming the effectiveness of measuring ST complex heat content. To make it practical, convenient and to avoid exposure to ice water, the method was modified by using a cold metal probe with a temperature sensor connected to firmware -a proprietary device "Testcal Gauge" that calculates the relative cumulative heat generated by the stressed ST complex.

Introduction

The Scrotal Testis (ST) Complex should be about 2.0 to 2.5°C lower than core body temperature for spermatogenesis to occur [8,19,22]. To exploit the ST complex temperature as a potential diagnostic tool, investigators over many years have used different methods and techniques to determine the ST Complex temperature, such as the thermocouple technique [1,16-18] thermometer method [15,22] *invagination thermometry* method [3] infrared thermometry method [5,7,11,12,23] photometric thermometry method [14] radio interrogated implant method [3] 680 Aga medical thermovision method [9] surface probe method [13] contact liquid crystal thermography method [20] and microwave thermography [6].

Although these methods provide reliable determination of the temperature of heat spots or a relative mean temperature at a particular ST Complex region, they do not provide a true representative temperature of the ST Complex, because various regions of the testis are known to be at different temperatures. For example, a temperature difference of 1.9°C between the anterior and posterior regions of the testis has been reported [22]. Therefore, none of these methods or techniques detailed above will provide measurement of the overall ST Complex temperature.

Since temperature is related to heat, the objective of this study was to develop a technique that determines the testicular heat content; such a measurement may yield a valuable assessment of the spermatogenetic conditions. Physiological stress has been known to amplify subtle defects that are not usually visible or detectable under normal situations, for example, the physical stress test used during cardiovascular assessment. The basic concept is therefore to measure the amount of heat generated over a brief period by the ST complex in response to low temperature exposure.

Materials and Method

As a prospective preliminary study, cold-stressed ST complex mapping was conducted with sixteen men who presented them to ascertain their fertility potential. Ejaculates were obtained by masturbation and following semen liquefaction, a routine semen analysis was performed that included semen volume, sperm concentration, sperm motility, and normal sperm morphology as detailed in WHO, sixth edition. These men volunteered to have their ST Complexes immersed in 150 to 180 ml of water at 5°C. The increase in water temperature was then monitored for 10 to 12 minutes.

ST Complex heat generated per unit volume of testicle per unit time was calculated as a fraction of the volume of water to that of the volume of testicles (determined with a Prader orchidometer) multiplied by the specific heat of water multiplied by the difference between ending and starting temperatures of the water. For convenience, this value will be referred to as the ST Complex Heat Index.

Results

The mean and standard deviation of the results of semen quality and the ST Complex Heat Index are detailed in Table 1. The results were subjected to Pearson correlation coefficient analysis to determine the association between the ST Complex Heat Index and various other parameters evaluated (Table 2).

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Table 1: Mean ± SD values of the ST Complex Heat Index and various other parameters from the sixteen men.

Men	Semen Volume	Sperm			Testis Volume (ml)		ST Complex Heat Index
		Concentration X 10^6/ml	Motility (%)	Morphology (%)	Right	Left	
1	7	4.4	0	2	9	9	140
2	7	6	33	8	16	16	91
3	6	50	72	28	22	22	65
4	7	4.8	56	16	15	12	93
5	1.5	439	60	8	24	20	75
6	2.4	5.8	43	25	18	18	67
7	3	12.4	54	16	13	13	117
8	4	44	29	7	16	16	78
9	5	5.6	46	18	11	11	132
10	2.8	93	50	28	17	17	74
11	7	85.2	46	22	20	18	84
12	6	31	46	26	20	20	69
13	4	5.6	31	0	10	12	135
14	3.5	238	52	31	20	20	55
15	5	4.2	29	8	11	12	116
16	3.2	60	46	23	20	20	66
Mean	4.7	68.1	43.3	16.6	16.4	16.0	91.1
SD	1.9	115.6	16.5	10.0	4.6	4.0	28.0

Table 2: Association between ST Complex Heat Index and various parameters analyzed from sixteen men.

Parameters	ST Complex Heat Index	P-Value
Semen Volume	0.273	<.306
Sperm Concentration X 10^6/ml	-0.431	<.096
Sperm Motility (%)	-0.579	<.019
Normal Sperm Morphology (%)	-0.708	<.002
Right Testis Volume	0.902	<.00001
Left Testis Volume	0.918	<.00001

Discussion

From the results presented in Table 1, we were able to demonstrate with only sixteen menthe effectiveness of identifying individuals with varying levels of ST Complex Heat Index which ranged from as low as 55 to as high as 140.

Both left and right testicular volume, were significantly correlated to the ST Complex Heat Index, as expected. But, even with the limited number of subjects who presented themselves to ascertain their fertility potential, the sperm motility and morphology were negatively correlated to ST Complex Heat Index (Table 2). This is not surprising since sperm maturation, namely the ability to attain motility and normal morphology, occur during epididymal transit and sperm function is altered due to elevated body temperature [2,4,10].

Although this method of determining ST Complex Heat Index was non-invasive, men did experience varying degrees of discomfort. The 5°C water was experienced as very cold; one man experienced orthostatic shock, while some others shivered. For routine office use the method needs to be practical, convenient, and comfortable for the patient as well as the physician. The method was therefore modified to avoid exposing the ST complex to ice water. The modified method with an improved procedure --a proprietary device "Testcal Gauge" was developed, a cold metal probe with a temperature sensor connected to firmware that calculates the relative cumulative heat generated by the stressed ST complex.

Conclusion

A new method to determine the ST Complex temperature was developed and found to be very effective to determine the ST Complex heat content. Once it is validated by assessing men with different clinical situations, it will be an asset to diagnose male infertility due to increased ST Complex temperature.

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