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ARE BOXER SHORTS REALLY BETTER? A CRITICAL ANALYSIS OF THE ROLE OF UNDERWEAR TYPE IN MALE SUBFERTILITY

ROBERT MUNKELWITZ AND BRUCE R. GILBERT*

From the Department of Urology, Health Sciences Center, State University of New York at Stony Brook, Stony Brook, New York

ABSTRACT

Purpose: Elevation of testicular temperature may result in arrest of spermatogenesis, abnormal semen parameters and sterility. It has been proposed that brief style underwear may produce scrotal hyperthermia and lead to clinical subfertility. Although this idea is regarded as dogma by many in the lay community and the changing of underwear type is a therapy frequently recommended by medical practitioners, there is a paucity of data measuring scrotal temperature as a function of underwear type.

Materials and Methods: Scrotal, core and skin temperatures were measured in 97 consecutive men presenting for evaluation of primary clinical subfertility. These cases were categorized by underwear type to boxer or brief group. Semen analyses were obtained in all patients. Individuals from each group were compared to ascertain differences in temperature when wearing and not wearing underwear. Baseline semen parameters also were compared. In 14 subjects (crossover group) underwear type was changed to the alternative type and scrotal temperature measurements were repeated. Literature regarding underwear type, testicular temperature and/or fertility was reviewed and critically analyzed.

Results: Mean scrotal temperature plus or minus standard deviation was 33.8 ± 0.8C and 33.6 ± 1.1C in the boxer and brief group, respectively. There were no significant temperature differences between the groups. Differential temperatures comparing core to scrotal temperature and semen parameters also were not significantly different. These observations remained constant in the crossover group.

Conclusions: The hyperthermic effect of brief style underwear has been exaggerated. In our study there was no difference in scrotal temperature depending on underwear type. It is unlikely that underwear type has a significant effect on male fertility. Routinely advising infertility patients to wear boxer shorts cannot be supported by available scientific evidence.

KEY WORDS: testis, scrotum, temperature, fertility, men

The idea that the scrotum may regulate temperature was first proposed by Crew in 1922.[1] The concept that elevated testicular temperature may impair spermatogenesis developed in response to experiments by Moore.[2] In a series of experiments on a rat, rabbit and guinea pig, and later on sheep it was demonstrated clearly that elevation in testicular temperature results in atrophy of germinal epithelium and arrest of spermatogenesis.[3] Similar experiments have shown abnormalities in semen parameters in response to elevated testicular temperature. Methods to produce elevation of testicular temperature have included surgical cryptorchidism, induced febrile illness, scrotal insulation, elevation of ambient temperature, experimental varicocele, and application of dry or wet heat from a variety of sources as well as exposure of the testis to infrared, microwave and ultrasound energy.[4–6]

Many various conditions associated with infertility, such as cryptorchidism and varicoceles, are thought to exert deleterious effects at least in part as a result of abnormal thermoregulation.[7–9] That abnormally elevated scrotal temperature may be responsible for idiopathic infertility follows from these findings. Davidson first recognized the potential for underwear type to impact testicular temperature and fertility. He stated that "Many men repeat upon themselves Phillips and McKenzie's[4] experiment by wearing suspensory bandages or a supporting type of underwear. These fulfill both the conditions of abolishing movement of the testes, keeping them close to the body and of preventing heat loss by insulation."[10]

This hypothesis was adopted by others[11] and further tested by Rock et al.[12–14] Avoidance of testicular hyperthermia by abandoning brief style underwear in favor of boxer shorts has been touted as a means to improve fertility.[15] This sentiment has been espoused by the media as dogma but it is based on limited scientific evidence. We evaluate the hyperthermic effect of brief style underwear compared to boxer shorts in men presenting for infertility evaluation. An attempt was made to control for ambient and core temperature by calculating differential temperatures.

METHODS

A total of 100 consecutive men 25 to 52 years old presented for evaluation of primary subfertility. Excluded from study were 2 men who had undergone orchiectomy, and 1 who had recently completed chemotherapy for lymphoma and had only remnant testicular tissue. Thus, 97 men were enrolled in our study. Histories and physical examinations were obtained. All subjects had 2 descended testes and no concomitant illness. Underwear type was noted by the examiner and patients were assigned to group 1 (boxer shorts, 51 patients) or group 2 (brief style underwear, 46). It was confirmed by questioning the patient that the underwear worn at presentation was the normal style of dress. Testicular size was

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* Requests for reprints: 900 Northern Blvd., Suite 230, Great Neck, New York 11021.

measured on ultrasound (7.5 MHz. linear array probe). Using these measurements testicular volume was calculated by approximation to a prolate ellipse as 0.54 × length × width × height. Color flow Doppler ultrasound was used to determine varicocele size. A varicocele was defined as veins greater than 3.0 mm. in diameter posterior to the testis, midway on an axial projection with a reversal of flow noted on color flow ultrasound.

All temperature measurements were obtained after patients were acclimated at rest in a room temperature of 24.4 to 27.8C (76 to 82F) to ensure a relatively constant temperature for measurement and to minimize physiological thermoregulatory mechanisms. Core body temperature was recorded as the mean of temperatures measured from the right and left ears using an instant thermometer. Skin temperatures were measured on the upper extremity and midline anterior portion of the scrotum using an electronic digital thermometer, and surface skin and scrotal probes, which have an accuracy of ±0.2%. Measurements were taken with the patient supine while wearing and not wearing underwear as well as standing while not wearing underwear. Differential temperatures were measured simultaneously and calculated electronically. They were determined by subtracting scrotal from core temperature (delta T1) and skin from scrotal temperature (delta T2, see figure). Delta T1 allowed comparison between groups irrespective of ambient temperature while delta T2 allowed comparison irrespective of body habitus, for example obesity or hypoplastic scrotum, or probe positioning.

Semen samples were collected shortly after initial evaluation and 2 to 3 days abstinence from sex. Sperm concentration, total count, percent motility, forward progression and normal forms were noted for an average of 2 specimens using standard techniques. There were 14 patients (crossover group) who were asked to switch to the alternative underwear type, after which repeat temperature measurements were obtained. Five patients switched from boxers to briefs while 9 switched from briefs to boxers. No attempt was made to compare semen parameters after crossover since our study design included men with and without obstructive etiologies. Statistical analysis of the data was done using computer software. In addition, articles in English pertaining to underwear type, testicular temperature and/or fertility were critically reviewed.

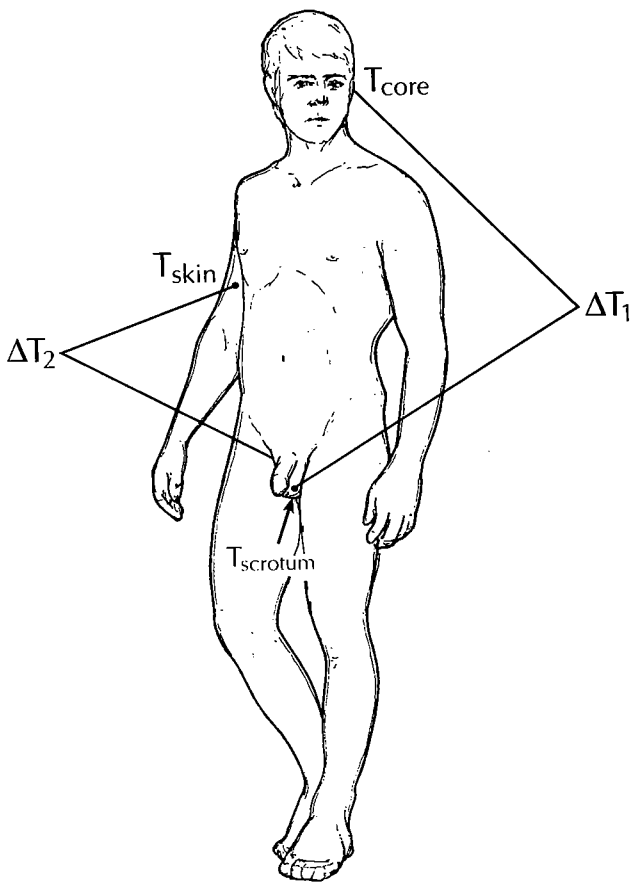

Diagram of temperature (*T*) probe placement and calculation of differential temperatures. Δ*T1* is scrotal minus core temperature and Δ*T2* is skin minus scrotal temperature.

RESULTS

No significant demographic differences were noted between the 2 groups (table 1). Average patient age was 35.3 ± 5.4 years in group 1 and 36.0 ± 5.5 in group 2. The number of patients with varicoceles (25 in group 1, 24 in group 2) was also similar for both groups. These similarities were maintained in the crossover group. Average duration of clinical subfertility assessed by history was 19.9 ± 17.4 and 24.6 ± 26.3 months in the boxer and brief groups, respectively. Testicular volumes were not significantly different between the groups.

Temperature data for each group are shown in table 2. Core temperature was 36.6 ± 0.4C (97.9 ± 0.8F) in group 1 and 36.5 ± 0.5C (97.7 ± 0.8F) in group 2 ($p > 0.5$). Surface skin temperatures were 30.8 ± 1.2C (87.4 ± 2.3F) in group 1 and 30.9 ± 1.3C (87.6 ± 2.3F) in group 2. Scrotal skin temperature was 33.8 ± 0.8C (92.8 ± 1.5F) compared to 33.6 ± 1.1C (92.5 ± 1.9F) in groups 1 and 2, respectively ($p = 0.4$). Core temperature was consistently higher than scrotal, which was higher than skin. Differences among these measurements were statistically significant ($p < 0.01$).

When measurements were repeated in all subjects not wearing underwear while supine again there were no significant differences in skin or scrotal temperature ($p > 0.5$). Temperature measurements in patients not wearing underwear while standing likewise were similar in the 2 groups. Differential temperature delta T1, defined as core minus scrotal temperature, was similar for both groups. In men wearing underwear while supine this value was 2.8 ± 1.0C and 2.9 ± 1.2C in the boxer and brief groups, respectively. Delta T1 was consistent for temperature measurements in men while supine and standing, and not wearing underwear. There were no statistically significant differences in these measurements between the 2 groups ($p > 0.5$). Furthermore, the differential temperature delta T2, defined as scrotal minus skin temperature, was also similar in both groups. In men wearing underwear while supine the temperature difference was 2.9 ± 1.1C and 2.8 ± 1.5C in the boxer and brief groups, respectively. Again, these findings were consistent in each group not wearing underwear while supine and standing, and slight variation between the groups did not approach statistical significance ($p > 0.5$).

Data on semen analysis are shown in table 3. Total sperm count was 110.1 ± 118.1 and 132.3 ± 159.5 million in the boxer and brief groups, respectively ($p > 0.5$). Similarities were noted in sperm concentrations as well. The broad range of values is also reflected in the wide standard deviation in these measurements. Additionally, qualitative parameters of percent motility, forward progression, normal forms and tapered forms were not statistically different between the groups.

In the crossover group mean core temperature was 36.3 ± 0.8C in men switching from boxers to briefs and 36.4 ± 0.8C in those switching from briefs to boxers. Skin temperature was 30.8 ± 1.0C and 31.0 ± 1.3C, and scrotal temperature was 34.0 ± 0.7C and 34.3 ± 0.5C in the boxers to briefs and briefs to boxers groups, respectively (table 4). No signif-

TABLE 1. *Clinical characteristics*

	Group 1	Group 2
Total No. pts.	51	46
Mean age ± SD (range)	35.3 ± 5.4 (25.0–51.9)	36.0 ± 5.5 (26.3–49.8)
Mean mos. subfertility ± SD (range)	19.9 ± 17.4 (0–96)	24.6 ± 26.3 (3–132)
No. pts. with varicocele*	25	24
Mean cc testicular vol. ± SD (range):†		
Rt.	12.5 ± 4.2 (2.5–25.7)	12.1 ± 3.6 (1.6–21.1)
Lt.	10.8 ± 3.5 (2.5–19.4)	10.9 ± 4.9 (1.4–28.5)

* Varicoceles measured on ultrasound and defined as veins with greater than 3.0 mm. dilation on mid transverse scrotal cross section images.
† Testicular volume calculated from ultrasound measurements as 0.54 × length × width × thickness.

TABLE 2. *Temperature measurements*

	Mean ± SD	
	Group 1	Group 2
Wearing underwear, supine:		
Core	36.6 ± 0.4	36.5 ± 0.5
Skin	30.8 ± 1.2	30.9 ± 1.3
Scrotal	33.8 ± 0.8	33.6 ± 1.1
DeltaT1	2.8 ± 1.0	2.9 ± 1.2
DeltaT2	2.9 ± 1.1	2.8 ± 1.5
Not wearing underwear, supine:		
Skin	31.4 ± 1.2	31.2 ± 1.5
Scrotal	33.7 ± 0.9	33.8 ± 0.8
DeltaT1	2.8 ± 0.9	2.7 ± 0.9
DeltaT2	2.3 ± 1.2	2.5 ± 1.2
Not wearing underwear, standing:		
Scrotal	33.7 ± 1.1	33.6 ± 1.5
DeltaT1	2.8 ± 1.2	2.9 ± 1.5
DeltaT2	2.3 ± 1.1	2.4 ± 1.0

icant difference in core, skin, scrotal or differential temperature was noted between the crossover group and the entire study group ($p > 0.5$).

DISCUSSION

Scrotal core temperature difference is maintained by a thermoregulatory apparatus that consists of the cremasteric muscle and blood vessels of the spermatic cord, as well as the dartos muscle and scrotal blood vessels. These components work collectively in reaction to changes in environmental temperature. The muscles of the spermatic cord and scrotum might serve as a sphincter, thereby regulating blood flow within the scrotal vessels.[16] Additionally, by varying exposed surface area of the scrotal skin and spermatic cord these structures control radiant heat loss. Thus, exposure to heat promotes spermatic cord and dartos relaxation, which increases blood flow and exposed surface area, favoring heat loss and maintaining the scrotal-rectal temperature differential. The converse is true when the testicle is exposed to cold temperatures.[16] Experimental evidence suggests that increased arterial blood flow secondary to scrotal warming may bypass the testis through arteriovenous anastomoses in the spermatic cord,[17] again favoring maintenance of a cooler testicular temperature. The efficiency of this system has been shown experimentally. When compared to skin of the chest or abdomen, scrotal skin exhibits the largest inertia and limitation of heat storage.[18]

A number of authors have suggested that behavioral adaptations in humans, resulting in elevated testicular temperature, may directly lead to infertility. The list of offending agents has included warm baths, tight clothing and suspensory type underwear. Indeed, some have advocated these methods as potential forms of contraception for men.[12,19] Conversely, various ways to promote scrotal cooling have been offered as methods to improve fertility.[20,21] The belief that brief style underwear may elevate scrotal temperature and impair fertility is based largely on theory and anecdotal data. To our knowledge our study represents the best attempt to determine if the scrotal temperature differential is truly impaired.

In 2 initial studies conscious attempts were made to elevate scrotal temperature using an insulated jock strap or application of heat from an electric light bulb.[12,14] While impaired differential scrotal temperatures and semen parameters were obtained in 6 and 14 experimental subjects, respectively, these conditions hardly mimic those produced by wearing briefs. In addition, the change in spermatogenesis requires months to occur under these conditions, not days as implied in this study. Hendry et al reported pregnancy or normal semen analysis in 25 of 166 individuals treated with general measures, including wearing loose underwear.[22] However, no scrotal temperature measurements were obtained and other variables, such as timing of intercourse and cessation of tobacco or alcohol use, were not controlled.[22] Brindley demonstrated a 0.5C lower temperature in 1 patient who wore boxer shorts rather than briefs but no semen or fertility data were presented.[23] Lynch et al found improvement of statistical significance or approaching significance in approximately 50% of 128 infertile men treated with conservative therapy, including tepid baths and loose cotton boxer shorts.[15] Again, no scrotal temperature measurements were obtained and study design did not allow for exclusion of other variables. Furthermore, these findings were not consistent as roughly half of these men with normal semen parameters showed a decrease in sperm count and concentration when they changed from briefs to boxers. In addition, the best results were obtained in men with normal semen parameters. Based on these limited experimental data and uncontrolled clinical trials boxers have been proclaimed better.

Our study is an initial attempt to quantify temperature differences as a factor of underwear type. The data do not support the contention that briefs result in higher scrotal temperatures. This finding implies that testicular temperature is also unchanged as it has been shown that scrotal closely approximates testicular temperature.[24] Furthermore, no difference in semen characteristics was noted in the 2 groups, implying similar potential fertility. That the thermometers used were capable of demonstrating differences in temperature is supported by data comparison of the core, skin and scrotal temperatures in the entire population ($p < 0.01$). Moreover, the presence of a crossover group validates the finding of no significant temperature difference for each underwear type and lessens the possibility of experimental biases in this nonrandomized study.

As first observed by Newman and Wilhelm, average testicular temperature is a function of environmental temperature and must be considered when comparing scrotal temperatures.[25] This factor has been neglected in other investigations. Although all temperature measurements were obtained under similar conditions, individuals may react to environmental temperatures differently. The calculation and inclusion of differential scrotal temperatures in our study allow for exclusion of ambient temperature as a confounding variable.

The potential importance of type of underwear as a cause of disordered testicular thermoregulation should be considered. It is unlikely that, even if slightly lower scrotal temperature could be achieved with boxer shorts, this difference could be maintained with additional layers of clothing. Like-

TABLE 3. *Semen parameters*

	Group 1	Group 2
Mean cc vol. ± SD (range)	2.8 ± 1.6 (0.8–9.3)	2.7 ± 1.5 (0.5–6.2)
Mean million total sperm count ± SD (range)	110.1 ± 118.1 (0.0–474.0)	132.3 ± 159.5 (0.0–683.4)
Mean million sperm concentration ± SD (range)	38.6 ± 45.0 (0.0–238.0)	48.8 ± 51.1 (0.0–214.0)
Mean % motility (range)	44.1 ± 20.7 (0.0–68.0)	47.1 ± 16.5 (0.0–75.0)
Mean % normal World Health Organization forms (range)	9.9 ± 5.6 (0.0–24.0)	9.7 ± 6.5 (0.0–30.0)
Mean % tapered forms (range)	21.5 ± 8.8 (8.0 ± 44.0)	21.9 ± 9.6 (0.0–52.0)

TABLE 4. *Mean age and temperature measurements in 14 crossover subjects*

	Brief to Boxers (9 pts.)	Boxers to Briefs (5 pts.)
Mean age ± SD (range)	32.7 ± 3.2 (29.2–36.7)	
Mean core temperature ± SD (range)	36.4 ± 0.8 (35.0–37.7)	36.3 ± 0.8 (35.4–36.9)
Mean skin temperature ± SD (range)	31.0 ± 1.3 (29.1–32.7)	30.8 ± 1.0 (29.1–32.1)
Mean scrotal temperature ± SD (range)	34.3 ± 0.5 (33.3–35.1)	34.0 ± 0.7 (32.7–34.8)
Mean DeltaT1 ± SD (range)	2.1 ± 1.1 (0.9–3.4)	2.3 ± 1.2 (0.2–4.1)
Mean DeltaT2 ± SD (range)	3.3 ± 1.3 (2.0–5.4)	3.2 ± 1.2 (2.1–4.9)

wise the supportive effect of brief type underwear of pulling the testes close to the body and lack of this effect with boxers is minimized by wearing pants. Therefore, unless one advocates wearing underwear alone or the abandonment of clothing altogether, advising infertility patients to wear a particular type of underwear appears to have little impact.

It is clear that factors other than underwear type must be responsible for impaired fertility. Anatomical factors, such as varicoceles, can elevate scrotal temperature and produce temperature related variations in semen quality. This finding is supported by our observation of an increase in tapered forms in patients with compared to those without varicoceles (21.3 ± 2.1% with and 18.3 ± 2.3% without varicocele, $p \leq 0.05$), and an increase in scrotal temperature in patients when standing (33.7 ± 0.2C with and 32.3 ± 0.3C without varicocele, $p \leq 0.05$). Shafik et al demonstrated impaired spermatogenesis and infertility in dogs, and in men wearing polyester underwear.[26,27] It is possible that type of fabric has more importance than type of underwear. Mieusset et al reported that infertile men have higher scrotal temperatures on average than fertile controls.[28] Varicoceles alone could not explain this difference, suggesting a role for metabolic factors in subfertile men. In addition, a recent study by Wang et al revealed no suppression of spermatogenesis in men wearing a polyester lined scrotal support for 1 year.[29]

Recent experiments by Pera et al suggest that the deleterious effects of temperature on fertility may take place at the level of gene transcription.[30] They demonstrated that cultured dog epididymal cells maintained at 33C express abundant messenger ribonucleic acid (mRNA) for CE5, the canine counterpart of the human CD52/HE5 mRNA that encodes for a glycosylphosphatidylinositol anchored sperm membrane glycopeptide. When these same cells were maintained at 37C expression of the CE5 mRNA was blocked. These results demonstrate a potential for narrow changes in temperature to influence spermatogenesis, sperm maturation and fertility. Although the evidence presented in our study should not distract from the potential harm of scrotal hyperthermia on spermatogenesis, it should rationalize the appropriate assignment of blame for this effect. Our data clearly demonstrate that scrotal temperature (and presumably testicular temperature) is equal in men wearing boxers or briefs.

CONCLUSIONS

Scrotal and differential scrotal temperatures were determined in men presenting for evaluation of primary infertility and wearing boxers or briefs. No difference in temperature or semen parameters was identified. From our data it is difficult to conclude that type of underwear has a significant impact on testicular temperature or fertility. Disordered scrotal thermoregulation still may be an important determinant of spermatogenesis in subfertile men but it must occur in response to other anatomical or physiological factors. Our data suggest that routinely advising infertility patients to wear boxer shorts cannot be supported by available scientific evidence.

REFERENCES

1. Crew, F. A. E.: A suggestion as to the cause of the aspermatic condition of the imperfectly descended testis. J. Anat., **56:** 98, 1921.
2. Moore, C. R.: Cryptorchidism experimentally produced. Anat. Rec., **24:** 383, 1923.
3. Moore, C. R. and Oslund, R.: Experiments on the sheep testis—cryptorchidism, vasectomy and scrotal insulation. Amer. J. Physiol., **67:** 595, 1924.
4. Phillips, R. W. and McKenzie, F. F.: The thermo-regulatory function and mechanism of the scrotum. Res. Bull. (Missouri Agricultural Experimental Station), **217:** 1, 1934.
5. Kandeel, F. R. and Swerdloff, R. S.: Role of temperature in regulation of spermatogenesis and the use of heating as a method for contraception. Fertil. Steril., suppl., **49:** 1, 1988.
6. Bedford, J. M.: Effects of elevated temperature on the epididymus and testis: experimental studies. In: Advances in Experimental Medicine and Biology: Temperature and Environmental Effects on the Testis. Edited by A. W. Zorgniotti. New York: Plenum Press, p. 19–32, 1991.
7. Frankenhuis, M. T. and Wensing, C. J. G.: Induction of spermatogenesis in the naturally cryptorchid pig. Fertil. Steril., **31:** 428, 1979.
8. Saypol, D. C., Howards, S. S., Turner, T. T. and Miller, E. D., Jr.: Influence of surgically induced varicocele on testicular blood flow, temperature, and histology in adult rats and dogs. J. Clin. Invest., **68:** 39, 1981.
9. Zorgniotti, A. W.: Elevated intrascrotal temperature. I: a hypothesis for poor semen in infertile men. Bull. N.Y. Acad. Med., **58:** 535, 1982.
10. Davidson, H. A.: Treatment of male subfertility testicular temperature and varicoceles. Practitioner, **173:** 703, 1954.
11. Kapadia, R. M. and Phadke, A. M.: Scrotal suspenders and subfertility. J. Fam. Welfare, **2:** 27, 1955.
12. Rock, J. and Robinson, D.: Effect of induced intrascrotal hyperthermia on testicular function in man. Amer. J. Obst. Gynec., **93:** 793, 1965.
13. Robinson, D. and Rock, J.: Intrascrotal hyperthermia induced by scrotal insulation: effect on spermatogenesis. Obst. Gynec., **29:** 217, 1967.
14. Robinson, D., Rock, J. and Menkin, M. F.: Control of human spermatogenesis by induced changes of intrascrotal temperature. J.A.M.A., **204:** 290, 1968.
15. Lynch, R., Lewis-Jones, D. I., Machin, D. G. and Desmond, A. D.: Improved seminal characteristics in infertile men after a conservative treatment regimen based on the avoidance of testicular hyperthermia. Fertil. Steril., **46:** 476, 1986.
16. Shafik, A.: The cremasteric muscle. In: The Testis. Edited by A. D. Johnson and W. R. Gomes. Vol. IV, pp. 481–489, 1977.

17. Mieussett, R., Sowerbutts, S. F., Zupp, J. L. and Setchell, B. P.: Increased flow of testicular blood plasma during local heating of the testes of rams. J. Reprod. Fert., **94:** 345, 1992.
18. Candas, V., Becmeur, F., Bothorel, B. and Hoeft, A.: Qualitative assessment of thermal and evaporative adjustments of human scrotal skin in response to heat stress. Int. J. Andrology, **16:** 137, 1993.
19. Shafik, A.: Contraceptive efficacy of polyester-induced azoospermia in normal men. Contraception, **45:** 439, 1992.
20. Zorgniotti, A. W., Sealfon, A. I. and Toth, A.: Chronic scrotal hypothermia as a treatment for poor semen quality. Lancet, **1:** 904, 1980.
21. Zorgniotti, A. W., Sealfon, A. I. and Toth, A.: Further clinical experience with testis hypothermia for infertility due to poor semen. Urology, **19:** 636, 1982.
22. Hendry, W. F., Somerville, I. F., Hall, R. R. and Pugh, R. C.: Investigation and treatment of the subfertile male. Brit. J. Urol., **45:** 684, 1973.
23. Brindley, G. S.: Deep scrotal temperature and the effect on it of clothing, air temperature, activity, posture and paraplegia. Brit. J. Urol., **54:** 49, 1982.
24. Kurz, K. R. and Goldstein, M.: Scrotal temperature reflects intratesticular temperature and is lowered by shaving. J. Urol., **135:** 290, 1986.
25. Newman, H. F. and Wilhelm, S. F.: Testicular temperature in man. J. Urol., **63:** 349, 1950.
26. Shafik, A., Ibrahim, I. H. and el-Sayed, E. M.: Effect of different types of textile fabric on spermatogenesis: electrostatic potentials generated on the surface of the human scrotum by wearing different types of fabric. Arch. Androl., **29:** 147, 1992.
27. Shafik, A.: Effect of different types of textile fabric on spermatogenesis: an experimental study. Urol. Res., **21:** 367, 1993.
28. Mieusset, R., Bujan, L., Mondinat, T. C., Mansat, A., Pontonnier, F. and Grandjean, H.: Association of scrotal hyperthermia with impaired spermatogenesis in infertile men. Fertil. Steril., **48:** 1006, 1987.
29. Wang, C., McDonald, V., Leung, A., Superlano, L., Berman, N., Hull, L. and Swerdloff, R. S.: Effect of increased scrotal temperature on sperm production in normal men. Fertil. Steril., **68:** 334, 1997.
30. Pera, I., Ivell, R. and Kirschhoff, C.: Body temperature (37C) specifically down regulates the messenger ribonucleic acid for the major sperm surface antigen CD52 in epididymal cell culture. Endocrinology, **137:** 4451, 1996.