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The potential of mild testicular heating as a safe, effective and reversible contraceptive method for men

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Summary

A preliminary assessment of the contraceptive efficacy of a daily mild increase (1–2°C) in testicular temperature during waking hours is reported in nine couples using two techniques of non-surgical fixation of the testes close to the inguinal canal. With technique 1, immobilization was achieved by passing the penis and the empty scrotum through a hole made in close-fitting underwear; there was one pregnancy, from a man who stopped the heating after 7 weeks, for 42 cycles of exposure in three couples. With technique 2, immobilization was achieved by adding a ring of soft material surrounding the hole in the underwear; there was no pregnancy for 117 cycles of exposure in six couples. Reversibility and safety were assessed. These preliminary results suggest that a daily mild increase in testicular temperature could be a potential contraceptive method for men.

Keywords: male contraception, testicular heating, contraceptive, efficacy, severe oligozoospermia

Introduction

In normal fertile men, induced elevation of body temperature (MacLeod & Hotchkiss, 1941; Procope, 1965; Brown-Woodman *et al.*, 1984) or scrotal temperature (Watanabe, 1959; Robinson & Rock, 1967; Robinson *et al.*, 1968; French *et al.*, 1973) has been reported to decrease sperm output. In most of these studies the temperature elevation was large (higher than deep body temperature) lasted a short time (less than 1h per day), and required an impractical heat source. However, from the results obtained with daily scrotal insulation during waking hours, Robinson & Rock (1967) suggested that a rise of 1°C in scrotal temperature could be used as a male contraceptive method.

From all these data and this information we devised a new method of inducing an elevation in testicular and epididymal temperature by using the body as a heat source. The testes were lifted close to the inguinal canal and maintained in this position during waking hours by means of two different techniques. In this location, elevation in testicular temperature was assumed to be 1–2°C, as the temperature of testes located in the inguinal canal is reported to be 1.5–2°C higher than for intrascrotal testes in men (Kitayama, 1965). Repeated every day for 6–24 months, this local hyperthermia induced a decrease in sperm output, a reduction in the percentage of motile spermatozoa (Mieusset *et al.*, 1985) and an increase in the percentage of abnormally shaped spermatozoa (Mieusset *et al.*, 1987a). By achieving better immobilization of the testes close to the inguinal canal, the second technique resulted in > 97% inhibition of the total motile sperm count within 3 months (Mieusset *et al.*, 1987b).

Because of this mild increase in testiculo-epididymal temperature was thus proved to induce a strong inhibition of spermatogenesis, in a second step the potential contraceptive effect of this mild heating was evaluated in volunteer couples through an experimental study. The present paper reports the preliminary results of this experimental study.

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Materials and methods

Subjects

Nine healthy male volunteers (mean age 29.9 years, range 23–34 years) were involved in the present study, three using technique 1 and six using technique 2. The female partners had a mean age of 29.7 years (range 22–34 years). The previous fertility history of these couples was as follows: five with a voluntary interruption of pregnancy; three with at least one child; one with no fertility history but with normal ovulatory cycles and no history of genital disorders in the female partner. Testicular history including cryptorchidism or varicocele, abnormal clinical examination or altered spermatogenesis were the only criteria of exclusion.

Heating techniques

Each testis was pushed up close to its corresponding inguinal canal. (Fig. 1a). Men were taught carefully, and easily succeeded in doing this through a recommended 'training' period of 5 days to adjust progressively (with a 3h/day increase) to this new location of the testis. Maintaining the testis close to the inguinal canal was performed with two successive techniques.

Technique 1 (n=3): Immobilization of the testis was achieved by the use of close-fitting underwear in which a hole was made, through which the penis and the empty scrotum were passed (Fig. 1b). As this technique did not ensure the permanent localization of the testis close to the inguinal canal, a second technique was used (Mieusset *et al.*, 1987b).

Technique 2 (n=6): A ring of soft material made of smooth rubber was either added to the underwear surrounding the hole (Fig. 1c) or was worn without underwear but maintained with thin straps (Fig. 1d).

Semen analysis and clinical examination

Semen analyses were performed every month before, during and after the heating period. Every 3 months a clinical examination was performed, including palpation of the testes and epididymides for any abnormalities, and of the spermatic cord for clinical varicocele. Testicular volumes were not measured but were evaluated subjectively (Bujan *et.*, 1989). Semen analyses were performed in the laboratory after a 3-day abstinence period, as reported elsewhere (Mieusset *et al.*, 1985). The results are expressed as the motile sperm count per ml (sperm count/ml × percentage of motile spermatozoa).

Contraceptive use

This experimental study was undertaken with the agreement of the Biomedical Ethics Committee of the Région Midi-Pyrénées (Toulouse France). All participants were informed that both their sperm output and the percentage of motile spermatozoa would be reduced progressively. As azoospermia was rarely obtained with these techniques (Mieusset *et al.*, 1987b), all men and women involved were informed of the possible occurrence of a pregnancy during the use of heating as a contraceptive. It was hypothesized that this mild testicular heating could be used as an efficient contraceptive means if the motile sperm concentration was $\leq 1 \times 10^6$/ml. Thus, the couples were asked to use other contraceptive means until the motile sperm count was $\leq 1 \times 10^6$/ml in two semen samples collected at an interval of 3 weeks; then all other means of contraception were stopped. The menstrual cycle was considered an exposure cycle. For each couple, all the exposure cycles were consecutive, except for subject 1 (see Results).

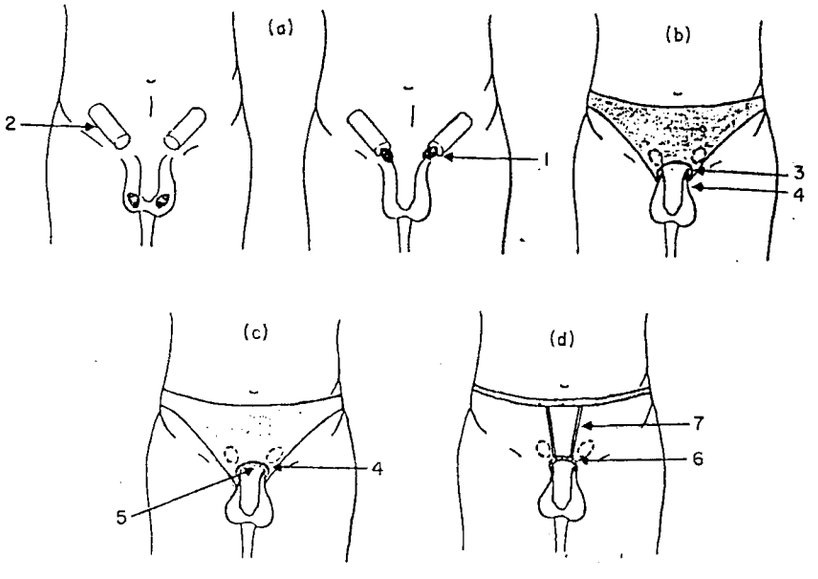

Figure 1. Techniques of heating the testes. (a) Testes are lifted up (1) close to the inguinal canal (2). (b) With technique 1, testes are maintained in the previous location by means of underwear in which a hole (3) was made at the level of the root of the penis. The penis and the scrotal skin are passed through this hole (4). (c) With technique 2, either a ring of soft rubber (5) was added to the hole in the underwear (4) or (d) this ring was worn alone (6), but maintained with thin straps (7).

Statistical analysis

Intra-group comparisons were made using the Wilcoxon *T* test for semen parameters. Contraceptive efficacy was calculated from the Pearl Index, i.e. the number of pregnancies divided by the number of exposure cycles multiplied by 1200 to give the pregnancy rate per 100 years.

Results

Spermatogenesis before and during the heating period

Baseline semen parameters were all within the normal range, as defined by WHO (1992), with mean values (± SEM) as follows: volume: 4.1 ± 0.4 ml; sperm concentration: 70.0 ± 5.1 × 10^6/ml; percentage of motile spermatozoa: 63.9 ± 1.9%; percentage of morphologically normal spermatozoa: 58.4 ± 2.1%.

Contraceptive efficacy

Technique 1: The mean length of the heating period was 28.7 months for the three men using technique 1. There were 42 cycles of exposure. The mean length of heat exposure when using it as a contraceptive was 13.3 months. During this heat contraceptive period, the mean (± SEM) motile sperm concentration was 1.86 ± 0.27 × 10^6/ml, with extreme individual values reported in Table 1. A motile sperm count ≤ 1 × 10^6/ml was observed in 41% of all semen analyses performed during the 42 cycles of exposure; there was no azoospermia.

One pregnancy occurred with subject 1. During the period of heat exposure, but before its use as a contraceptive, he had stopped the heating for 7 weeks (from weeks 42 to 48) and he had then started the heat exposure again. The first cycle of contraceptive use was during weeks 61–63 of heat exposure when the motile sperm concentration was 0.04 (week 61) and 0.7 (week 63) × 10^6/ml, respectively. The pregnancy occurred during the second cycle of contraceptive use (weeks 65–66), with the motile sperm concentration reaching 19.3 and 10.4 × 10^6/ml at weeks 68 and 71, respectively. Contraceptive use was then started again from week 76. It is obvious from this case that any interruption in heat exposure results in a partial recovery of spermatogenesis. For technique 1, one pregnancy in 42 cycles equals 1/42 × 1200 = a Pearl rate of 28.6 per 100 years with 95% confidence intervals of 0.7–159.2 per 100 years.

Technique 2: The mean length of the heating period was 22.3 months for the six men using technique 2. There were 117 cycles of exposure. The mean length of heat exposure when using it as a contraceptive was 19.3 months. During this period, the mean (± SEM) value for the motile sperm concentration was 0.12 ± 0.03 × 10^6/ml, with extreme individual values reported in Table 1. Azoospermia was observed in 11.3% of samples and a motile sperm concentration ≤ 1 × 10^6/ml was found in 86.4% of all the semen examinations performed. As reported earlier (Mieusset *et al.*, 1987b), the inhibitory effect of heat on spermatogenesis appeared sooner, and was stronger for technique 2 than for technique 1. This explains why contraceptive use was started sooner (Table 1) with technique 2 (mean = 3.5 months; range: month 2–9) than with technique 1 (mean = 11.0 months; range: month 7–15). There were no pregnancies

Table 1. Duration of exposure to heat by the two techniques and semen characteristics during the contraceptive phase

Heating technique	Subject No.	Duration of exposure to heat (months)	Time to beginning use as contraception (months)	Duration of use as contraception (months)	Motile sperm count (10^6/ml) during the contraceptive phase			Number of cycles of exposure
					Minimum	Mean	Maximum	
1	1	24	15	8	0.04	2.59	7.40	8
	2	24	7	5	1.20	3.13	5.53	6
	3	38	11	27	0.00	1.42	5.85	28
2	4	8*	2	6	0.06	0.34	0.90	6
	5	36	9	28	0.00	0.02	0.10	30
	6	7†	3	5	0.00	0.02	0.06	4
	7	49	2	47	0.00	0.13	0.52	46
	8	15	3	13	0.00	0.38	1.60	13
	9	19	2	17	0.00	0.14	1.00	18

* End of the experiment: semen survey no longer possible because of subject moving location.

† Experiment was stopped because of azoospermia.

with technique 2. Thus, for technique 2, no pregnancies in 117 cycles equals a Pearl rate of 0.0 per 100 years, with 95% confidence intervals of 0.0–37.8 per 100 years.

Clinical survey

No modifications appeared in the clinical examinations. With regard to libido and sexual rhythm no changes were reported by any of the men.

Spermatogenesis after cessation of heat exposure

After the heating was stopped, recovery of sperm number and of the percentage of motile spermatozoa occurred within 12–18 months, regardless of the heating technique used. Of the six men using technique 2, we lost touch with one because he moved to an area where no semen survey was possible, and a second one is still in the contraceptive process (Table 2).

Table 2. Recovery of the motile sperm count after heating was stopped. Values are means ± SEM. There were no significant differences between values after heating and the preheating values (Wilcoxon *T* test).

	Motile sperm count (10^6/ml)		
		After heating	
Heating technique	Before heating	0–6 months	7–18 months
1	50.2 ±10 (n = 3)	51.2 ±39.5 (n = 3)	98.7 ±39.7 (n = 3)
2	40.2 ±11.8 (n = 4)	26.5 ±19 (n = 4)	36.3 ±19.4 (n = 4)

Fertility after the heating period

Technique 1: For subject 3 a pregnancy occurred 2 months after heating was stopped. For subjects 1 and 2 a pregnancy occurred when desired, 2 and 3 years (respectively) after the heating was stopped.

Technique 2: None of the men who used this technique has yet attempted to father a child after the end of the heat contraception period.

Discussion

Regardless of the technique used, a contraceptive method is required to fulfil four characteristics: (1) safety for the user and his partner, (2) reversibility of the contraceptive effect, (3) high efficacy as a means of birth control, and (4) acceptability for the user.

(1) *Safety.* No complaint or pain of any kind was reported by any of the men in our study, and none of the men involved in the present study dropped out because of discomfort or any compliance problem. Libido was never depressed and sexual rhythm was unmodified. No modification was observed in the clinical examinations performed during and after the heating period. However, as testicular volumes were not measured but evaluated subjectively, small modifications cannot be excluded completely.

(2) *Reversibility.* After heating was stopped, sperm counts in all of the men involved in the present study recovered to their pre-heating values, as was reported in part in previous studies (Mieusset *et al.*, 1985, 1987a). Fertility was also restored as indicated by the occurrence of pregnancies for the three men who used technique 1. Moreover, three other men using the same heating technique in a preliminary study (Mieusset *et al.*, 1991) have fathered a child without any problem within 2–4 years after the end of a 6–36-month period of exposure to heat. There were no miscarriages and no pathologies in the five babies, who are now 3–6 years of age.

(3) *Efficacy.* Pearl rates were 28.6 and 0.0 per 100 years for heating techniques 1 and 2 respectively. The greater suppression of sperm output achieved by technique 2, in which the maximum motile sperm concentration never rose above 1.6×10^6/ml (Table 1), appeared to assure better contraceptive efficacy than did technique 1.

(4) *Acceptability.* The present study was designed as an experimental protocol to evaluate the potential contraceptive efficacy of mild testicular heating. Thus, mild testicular heating was never really suggested to be used as a contraceptive method for men asking for a male contraception, since before the results of the study the real contraceptive efficacy of such a method was unknown. As regards the volunteers involved in the present study, which was supposed to last for between 6 and 12 months, the mean heating time was 17 months (range 6–49 months), which could indicate a good compliance and that the techniques were reasonably comfortable. Acceptability of mild testicular heating as a potential contraceptive method for men must be evaluated in the general population.

As our experimental study was running, one author published successful results of the contraceptive efficacy of scrotal insulation in 14 men for 12 months (Shafik, 1992), using a suspensory sling as advocated previously (Robinson & Rock, 1967). Such scrotal insulation for day and night induced an increase of about 2°C in intratesticular temperature (Shafik, 1992). However, azoospermia resulting from this insulation was somewhat difficult to analyse, as the suspensory sling was made of polyester fabric which induced 'electrostatic field effects' which might itself have induced alterations in spermatogenesis (Shafik, 1992). However, in a previous study the same author has reported successful contraceptive results of mild testicular heating in 28 men for 12 months (Shafik, 1991). The heating process did not differ from that which we have devised and validated previously (Mieusset *et al.*, 1985) and that used in the present study, as the testes were 'elevated to the superficial inguinal pouch

close to the scrotal neck' (Shafik, 1991), and lifted close to the inguinal canal (present study). The difference was in the means chosen for maintaining the testes in such a position, with immobilization obtained in Shafik's study either by surgical fixation of the testes (which seems ethically contestable) or by use of a special suspensory sling made of non-stretchable fabric with a ball fixed in its bottom. This testicular location 'close to the scrotal neck' resulted in an increase of about 2°C of the intratesticular temperature, and was maintained day and night (Shafik, 1991), unlike the present study (daytime only). Severe oligozoospermia was observed; there were no pregnancies in the 28 couples using testicular heating as the only contraceptive method from month 4 to 12 of heating; after testicular immobilization was released, fertility recovered with no developmental anomalies in the fetuses or in the infants (Shafik, 1991).

The heating method is one of several techniques which have been explored as potential male contraceptives. The efficacy of gossypol was proven, but with 10–40% irreversibility after only 1 year of treatment (Meng *et al.*, 1988; Wooley, 1991). Immunization against either various hormones or spermatozoa is still in the laboratory stage (Isojima, 1990; Gupta & Koothan, 1990). Finally, different studies are in progress involving various methods for hormonal inhibition of spermatogenesis (Soufir *et al.*, 1983; Guérin & Rollet, 1988; Waites, 1993). Heating was suggested as a potential contraceptive method for men as early as 1959 (Watanabe, 1959); the preliminary results of the present study, especially using technique 2, confirm this possibility, with moreover a steady effect during the longest heat exposure ever used, and a constant recovery after its cessation.

However, as retention of the testes 'inside' the body could interfere with the image a man has of his body, other techniques of mild heating of the testis could be used, such as scrotal insulation. However, whatever the technique used, mild heating of the testes is an inexpensive method, and easy to perform by the man himself.

Besides its contraceptive use, the results of the present study and of the study by Shafik (1991), involving together a total of 37 couples, indicate clearly that heat, when repeated daily even in a small amount, induces deleterious alterations in spermatogenesis and fertility of men. Moreover, when this physical insult is withdrawn, spermatogenesis and fertility recover. The implications of these findings with regard to testicular physiology are undoubtedly also of interest with respect to the aetiology (Mieusset *et al.*, 1987c, Zorgniotti & Sealfon, 1988) and treatment (Zorgniotti *et al.*, 1986) of male infertility.

From these preliminary results it is suggested that mild daily heating of the testes with a monthly semen survey could be used as a male contraceptive strategy. Further multicentre studies are required, involving a greater number of couples, to establish acceptability and compliance.

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