Scrotal Cooling Increases Rectal Temperature in Man

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The aim of this study was to evaluate the effect of scrotal cooling on rectal temperature in man. Pilot studies suggested that immersing the scrotum in a 30°C water bath increased rectal temperature, but immersing the scrotum in a 0°C water bath did not. Six healthy young men immersed their scrotums in a 35°C water bath for 11 min followed by 21 min at 30°C. Rectal temperature rose by 0.38 ± 0.04°C ($P < 0.01$) in response to the 30°C water bath. Repetition of the study by immersing the hands instead of the scrotum in the water bath had no effect on rectal temperature. The scrotum appears to play a role in human temperature regulation. [Exp Biol Med Vol. 227(2):105–107, 2002]

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Testicular temperature in man is maintained approximately 2°C lower than abdominal temperature (1). One important mechanism maintaining this temperature gradient is thermal exchange between the testicular artery and vein, which are coiled in close contact with each other (2). Scrotal heating in the ram triggers rapid respiration and scrotal sweating with a drop in deep body temperature (3). Whether scrotal cooling does the opposite and the extremes that will trigger the mechanism are unknown. This study evaluates the effect of cooling the scrotum on rectal temperature in man.

Materials and Methods

Pilot Studies Two healthy males between 40 and 50 years of age had a rectal thermometer placed and the temperature was recorded for 10 min. Scrota were then immersed in a 0°C water bath for 20 min with continued rectal temperature recording. The entire scrotum was immersed in an insulated beaker. Surrounding areas including the anus and penis were not affected. The room temperature was 20°C and the subjects were dressed above the waist only.

Two healthy males between the ages of 18 and 25 years had a rectal thermometer placed and had their scrota placed in a 35°C water bath. The method of scrotal immersion was the same as the first pilot study: the room temperature was 20°C and the subjects were dressed above the waist. Their temperatures were recorded for 10 min. The water bath was then reduced to 30°C for 20 min with continued rectal temperature recording

Study 1. Six healthy, nonsmoking males between the ages of 18 and 25 years of age participated in this study, which was approved by the Institutional Review Board of the Century City Hospital. Subjects ranged from normal weight to mildly overweight with body mass index (BMI) values ranging from 22 to 28 kg/m^2. Subjects had no sunburn, were on no medications, had not exercised for 24 hr, and were fasted for 3 hr at the time of the study. The scrota of the subjects were immersed in a 35°C water bath at time 0 and a Diatek rectal temperature probe with a digital readout was inserted. The entire scrotum was immersed in the insulated beaker, but the surrounding areas, including the anus and penis, were not affected. Room temperature was 20°C, and the subjects were dressed above the waist. After 10 min, the water bath was lowered to 30°C and the rectal temperature was recorded for 21 min.

Study 2. This study was conducted in an identical manner to Study 1 with the hands of the subjects substituted for their scrota.

Results

Pilot Studies Rectal temperature did not change when the scrotum was placed in the 0°C water bath. There was an average increase of 0.5°C in the rectal temperature when the water bath surrounding the scrotum was decreased from 35°C to 30°C.

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Study 1. Rectal temperature remained at baseline, 36.85°C ± 0.02°C, for the first 11 min with the scrota in 35°C water baths. Rectal temperature began to rise 3 min after the water baths in which the scrota were immersed were lowered to 30°C. The rectal temperatures reached a new plateau after 11 min of 37.23°C ± 0.05°C and they remained there for the last 10 min of rectal temperature recording. The rise in rectal temperature was 0.38°C ± 0.04° C ($P < 0.01$ by paired t test; Fig. 1). There was no shivering or other symptoms to suggest increased sympathetic activity.

Study 2. Rectal temperature remained at baseline, 36.30°C ± 0.02°C, for the first 11 min with the hands in 35°C water baths. There was no change in rectal temperature, which was 36.30°C ± 0.01°C, when the water bath was reduced to 30°C (Fig. 1).

Discussion

Maintaining testicular temperature approximately 2°C below deep abdominal temperature is necessary to maintain sperm quality (4). Sweating and tachypnea in rams in response to testicular heating can be envisioned as a mechanism for maintaining fertility. The drop of body temperature in rams to scrotal heating suggested the possibility of a body temperature rise in response to scrotal cooling (3). Zero degrees Centigrade and 5°C below baseline appeared to represent the extremes of a water bath to cool the scrotum that might be expected to result in a rise of rectal temperature. Because we found that a water bath 5°C below baseline was effective in the pilot studies, this water bath temperature was selected for the subsequent experiments.

A rise in rectal temperature to testicular cooling, however, is an unexpected finding (5) and it suggests that the scrotum is involved in body temperature regulation. The time course of the rectal temperature rise over 11 min with a lag time of 3 min is consistent with a mechanism mediated through vasoconstriction by way of a neural reflex involving the central nervous system. If this mechanism is designed to maintain the testicular temperature at 35°C, the optimal level for sperm production, it is not surprising that it operates at temperatures commonly experienced by scrotum. The scrotum is rarely exposed to temperatures near 0°C and when this happens, survival is threatened. Reproduction mechanisms are typically overridden by those associated with survival.

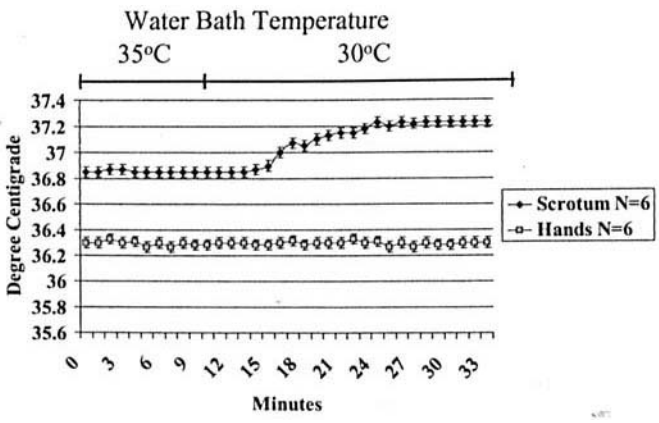

Figure 1. Rectal temperature measured by rectal thermistor during scrotal cooling and cooling of the hands.

Li and Thornhill (6, 7) have described warm and cold receptors in the scrotum that activate ventromedial hypothalamic neurons, and they have demonstrated that the medial preoptic nucleus is necessary for this activation to occur. The cold receptors in the rat scrotum are activated between 10°C and 20°C. Acute activation of the scrotal cold receptors in the rat does not trigger shivering or brown fat thermogenesis, suggesting that the rise in body temperature is through a mechanism different from metabolic stimulation (6, 8). This is consistent with the findings of Swiergiel (9) who observed no change in food intake with scrotal cooling, but an increase in food intake after 4 hr of total body cold exposure, which is known to stimulate thermogenesis.

Although mechanistically the rectal temperature rise in response to scrotal cooling is not understood, changes in humoral factors or an increase in metabolic rate seem less likely mechanisms than a neural reflex causing vasoconstriction and limiting heat dissipation. The mechanism mediating the rectal temperature rise in response to scrotal cooling appears to involve the central nervous system, which appears to differ from the mechanism maintaining the baseline scrotal-rectal temperature gradient. The mechanism mediating baseline scrotal-rectal temperature gradient appears to be a local or peripheral one because men with spinal cord injuries have a normal scrotal-rectal temperature gradient (10).

In conclusion, mild cooling of the human scrotum, but not the hands, increases rectal temperature. This suggests that the scrotum plays a role in human temperature regulation. The reason this mechanism evolved, the mechanism by which it functions, the temperature range over which it operates, and whether there is a temperature at which the effect is optimal all need further clarification and suggest the need for further research into the role of the scrotum in regulating body temperature.

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