THE INFLUENCE OF COLD IN PROPRIOCEPTION OF THE NORMAL KNEE JOINT

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The objective of this study was to determine whether the therapeutic use of cold, affects proprioception when applied to the knee joint. Cryotherapy decreases sensory and motor nerve conduction velocities, which are necessary for a normal proprioceptive acuity. Normal proprioceptive acuity is necessary in order to avoid injuries of the musculoskelectal system. Sixty-four healthy volunteers, aged 18-25, moderately active men and women were recruited from a large sample of University students. Subjects were randomly assigned to either the control or the experimental group. The subjects of the experimental group were subjected to 20 min of temperature at constant (5˚C), with an ice application to the knee joint. The results showed that cold does not affect the joint position sense in a normal knee.

KEY WORDS: proprioception, position sense, cold, criotherapy

INTRODUCTION: Proprioception depends on the integrity of receptors of the ligaments, of the articular capsulae, of the intra-articular receptors and of muscular receptors (Barrak, 1983; Barrack, 1984a; Barrack 1984b; Clark, 1985; Assimakopoulos, 1992; Nyland, 1994). These factors all play a role in the performance of the musculoskelectal system, especially in sports and activities that demand coordination and equilibrium.
Proprioception performs a prophylactic role in injuries, by avoiding excessive movements or non-physiological movements (Nyland, 1994).
Proprioception can be described as a static process, which usually relates to the sense of position. It also means conscious orientation and perception of different parts of the body with respect to each other. Dynamic proprioception is frequently defined as kinesthesia and sense of rates of movement (Jerosch, 1996).
The therapeutic use of cold is indicated when musculoskelectal damage occurs, because it decreases pain, decreases limb swelling, and decreases the inflammatory process, but it also decreases sensory and motor nerve conduction velocities, necessary for the integrity of receptors (Hocutt, 1981; Kenneth, 1995).
The knee joint was chosen because it is frequently injured, especially during sports.
There are some clinicians who believe that the use of cold can decrease proprioception, exposing the patient to new injury. However, there are have been only a few studies concerned with this issue, and those could be considered controversial. Cross et al. (1996) observed that the muscular function and the equilibrium decreases after 20 min of ice immersion of the leg. Conversely,Thieme et al. (1996) did not observe any decrease in proprioception after 20 min of ice pack application.
The present study was undertaken to determine if cryotherapy plays a role in modifying proprioception. The proprioception evaluation protocol of Karkouti and Marks (1999) was followed where both control and experimental group were exposed to four different sensory conditions.

METHODS: Subjects. The present study was carried out on 64 healthy, moderately active subjects, 30 male and 34 female and between the ages of 18-25 years who were recruited from a large sample of University students. Exclusion criteria included those subjects with any pre-existent leg injury or who were hypersensitive to cold. The subjects were randomly assigned to either the control or the experimental group.
The control group was tested without the application of cold and the experimental group was submitted to cryotherapy. Within both groups, there were four different sub groups, each tested under a different sensory condition: One, with intact vision and firm support surface: Two, with vision occluded and a firm support surface: Three, with intact vision and a compliant support surface: Four, with vision occluded and the same compliant support

surface. The leg to be tested (dominant or non dominant) was also randomly assigned. 50% of the subjects in each group had their dominant leg tested and 50% had their non dominant leg tested.

Procedures. The camera was mounted on a tripod 88 cm from the floor at a perpendicular distance of 272 cm from the test limb. All subjects wore shorts, which were marked by the first investigator, with a dermatographic pencil, at the great trochanter, the lateral femoral epicondyle and the lateral malleolus of the test leg. The experimental group were submitted to a 20 min application of PolarCare, placed about 10 cm above the patella and on the knee joint, at a constant temperature 5°C. A brief explanation of the test was given to the subjects before starting the test by one of the investigators. Subjects were asked to keep the arm of the same side of the test leg on the chest.

Subjects then stood in bare feet, on one leg and flexed their test leg a short distance (30°-criterion knee angle), in response to a verbal command from the second investigator. A photograph of the angle attained, was taken by the first investigator. The subjects then held this position for 10 seconds to permit memorization. The subject then returned at their own speed to the upright position and within 10s after returning upright, they tried to reproduce the criterion angle in response to a verbal command of the investigator 3. A second photograph was taken by the first investigator. The same procedure was repeated twice in exactly the same manner with a one-minute rest period between each trial.

In the experimental group, the test explanation was given in the last minutes of the application of cold. After finishing the application, the subjects were immediately subjected to the test. During the tests, subjects were permitted to stabilize themselves using the wall on the non-test side as required. To evaluate the photograph, two lines were drawn using a ballpoint pen and a ruler connecting the marker centroids. One connected the greater trochanter to the lateral epicondyle, and the other connected the lateral epicondyle to the lateral malleolus. A protractor was placed along lines drawn on the photograph and an angle was determined. This was applied with each picture of each subject (Karkouti & Marks, 1999).

Cards were placed behind the subject and the second investigator changed the cards during the procedure in order to identify the photograph sequence. When on the compliant support surface, the subjects were placed 5 cm from the edge of the mattress. In the case of occluded vision, the blindfold was secured once the subject was upright.

The results were then analyzed using Student´s t-test ($p \leq 0.05$) to determine whether differences existed between control and experimental groups.

RESULTS: No significant difference was found between the experimental and control groups. The comparison between each similar subgroup of experimental and control groups also showed no significant difference as shown in Tables 1 to 4.

Table 1 Value of $\overline{X}$ ± SD of Angles in Degree of Control and Experimental Groups under the Sensory Condition of Vision Occluded and Firm Support Surface

	Control	Experimental
Picture 1	25 ± 5.02	26.38 ± 4.37
Picture 2	26.06 ± 7.38	25.88 ± 7.79
Picture 3	27.13 ± 9.89	26 ± 7.56
Picture 4	26. 75 ± 8.72	29.88 ± 8.22

$p \leq 0.05$

Table 2 **Value of $\overline{X}$ ± SD of Angles in Degree of Control and Experimental Groups, Subgroup Intact Vision and Compliant Support Surface**

	Control	Experimental
Picture 1	26 ± 6.20	25. 75 ± 7.61
Picture 2	32.25 ± 8.1	27.06 ± 9.11
Picture 3	29. 94 ± 8.40	28.88 ± 8.99
Picture 4	32.25 ± 9.84	29.06 ± 9.28

$p \leq 0.05$

Table 3 **Value of $\overline{X}$ ± SD of Angles in Degree of Control and Experimental Groups, Subgroup Vision Occluded and Compliant Support Surface**

	Control	Experimental
Picture 1	27.13 ± 2.79	26 ± 3.99
Picture 2	28.25 ± 4.89	27.75 ± 5.17
Picture 3	29.69 ± 5.18	29 ± 4.80
Picture 4	30.19 ± 7.74	28.56 ± 4.92

$p \leq 0.05$

Table 4 **Value of $\overline{X}$ ± SD of Angles in Degree of Control and Experimental Groups, Subgroup Intact Vision and Firm Support Surface**

	Control	Experimental
Picture 1	29.31 ± 4.76	29.38 ± 7.08
Picture 2	31.19 ± 6.90	30 ± 7.11
Picture 3	30.38 ± 10.57	32 ± 7.31
Picture 4	31.88 ± 8.54	32.06 ± 8.38

$p \leq 0.05$

The comparison between the means of the control group and the experimental group using the Student´s *t*-test showed no differences between each different sensory condition. Situation 1, p=0.454, situation 2, p=0.117, situation 3, p=0.805 and situation 4, p=0.787.
The mean angle of the four pictures of all subjects in each subgroup, both control and experimental and a general mean angle of all subjects of both experimental and control groups is showed on Table 5.

Table 5 **Value of $\overline{X}$ ± SD of Angles in Degree of Control and Experimental Groups under the Sensory condition: Vision Occluded and Firm Support Surface (S1); Intact Vision and Compliant Support Surface (S2); Vision Occluded and Compliant Support Surface (S3); Intact Vision and Firm Support Surface (S4) and Total Group (S5)**

	Control	Experimental
S1	26.24 ± 0.93	27.04 ± 1.91
S2	30.11 ± 2.95	27.69 ± 1.58
S3	28.07 ± 1.56	27.83 ± 1.32
S4	30.69 ± 1.11	30.86 ± 1.37
S5	28.78 ± 2.03	28.35 ± 1.71

DISCUSSION: These data confirm those in the study presented by Thieme et al. (1996), emphasizing the fact that the use of cold on the knee joint does not decrease proprioception, and also suggests that receptors of the muscles are more important to proprioception than those in the joint.

The study by Cross et al. (1996) reported a decrease in functional performance following an ice immersion of the lower extremities, also suggesting that the application of cold in the muscles can decrease proprioception.

The influence of each sensory condition in the proprioception will be the subject of further studies.

The cold did not decrease the ability to judge the active placement and replacement of the knee joint. A 20 minute cold treatment had no effect on joint angle reproduction. This data is in agreement with the study by Thieme et al. (1996) which also found that cooling improved proprioceptive ability. In that study, an ice pack was used as the cooling agent, so temperatures were not stable. The ice pack increased in temperature as it melted, so it was not sufficiently cool enough to effect the knee joint. The present study used a Polar Care with temperature constant at 5°C and found the same response of proprioception to cold. These findings provide relevant confirmation that the use of cold does not affect proprioception when applied to joints.

CONCLUSION: Based on the data obtained in this study, it can be concluded that the use of cold, when applied to the knee joint, does not affect proprioception.

Althought this study did not analyze the effect of cold in functional performance, or its influence when applied to the muscle, cryotherapy may be applied to the affected joints without fear of predisposition to new injuries. This information supports the implementation of optimal knee rehabilitation strategies, such as the application of cold and exercise for injuries to the knee joint.

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