Effect of Fluori-Methane® Spray on Passive Hip Flexion

L. ROBERT HALKOVICH, MS,
WALTER J. PERSONIUS, MA,
H. PETER CLAMANN, PhD,
and ROBERTA A. NEWTON, PhD

The purpose of the study was to evaluate the influence of Fluori-Methane® spray as a method of affecting passive range of motion measured at the right hip joint. Subjects were 30 normal volunteers randomly divided into an experimental group and a control group. A special table was constructed to position and stabilize each subject for monitoring the right lower extremity's resistance to side-lying straight leg raising. Specific right hip flexion goniometric measurements were compared and analyzed before and after application of Fluori-Methane® spray to the soft tissues overlying the posterior part of the right thigh. The results of the study showed that the experimental group, which received application of Fluori-Methane® spray and static passive stretch, did significantly (p < .02) increase the range of passive hip flexion over that of the control group, which received only static passive stretch.

Key Words: Cold, Contracture, Physical therapy, Hip joint.

Vapocoolant application can be defined as intense spot cooling produced by rapid evaporation of a bottled hydrocarbon compound on selected areas of the skin. Although vapocoolants such as Ethyl Chloride®* spray and Fluori-Methane® spray have been used clinically with reported success, their effects have been described qualitatively and not quantitatively. Historically, vapocoolant application has been reported to increase active joint range of motion; assist in the reduction of muscle spasm; diminish local, referred, and chronic pain perceived by the patient; act as a counterirritant; and serve as an effective local anesthetic.

The purpose of this study was to evaluate Fluori-Methane® spray as a method of increasing passive range of motion measured at the right hip joint. Fluori-Methane® spray is a vapocoolant used in the management of restricted joint range of motion due to a shortening of the soft tissues surrounding that joint structure. The spray has been thought to alter passive range of motion by way of neuromusculoskeletal pathways and has been used in the clinic for a number of years. However, no objective evidence has been documented concerning the spray's effectiveness. Using experimental design and a quantitative joint measurement technique, a controlled trial was designed to test the validity of clinical observations associated with vapocoolant application.

METHOD

Subjects were 30 normal volunteers, 13 men and 17 women, randomly divided into an experimental and a control group. They ranged in age from 19 to 39 years, with a mean of 24.5 years.

A specially designed table was constructed to position and stabilize each subject for monitoring the force of the right lower extremity's resistance to side-lying straight leg raising (Fig. 1). Each subject assumed left side lying on the force table with the right lower extremity resting on the secondary level of the force table.
The right lower extremity was positioned and secured on a skateboard apparatus. Ball bearings were attached to the skateboard undersurface to minimize friction between the subject’s lower extremity and the secondary level of the force table. A radial arm, composed of galvanized pipe, was attached to the undersurface of the primary level of the force table at its center. This center point corresponded to the center of rotation of the hip joint of each subject. The radial arm extended from the center of the primary level of the force table out to the periphery and was able to rotate in an arc of 180 degrees around the circumference of the primary level of the force table. The top surface of the secondary level of the force table was marked in one-degree increments from 50 degrees to 155 degrees to produce a surface goniometer. This device was used to measure the pelvifemoral angle in degrees of motion as the skateboard apparatus passed over these goniometric markings on the secondary level of the force table.

The tip of the right greater trochanter was identified and marked on each subject. This point was positioned directly beneath a suspended plumb bob, thereby aligning the centers of rotation for both the right hip joint and the radial arm.

The right lower extremity was positioned and secured to the skateboard apparatus and positioned at the neutral angle as measured by the surface goniometer. Stabilization was applied to the anterior superior iliac spines bilaterally, to the sacrum, and to the left thigh by means of fitted pads and belts. An ankle cuff was applied just superior to the tip of the right lateral malleolus. A cable from the ankle cuff was aligned at a 90-degree angle to the long axis of the right lower extremity and affixed to a Gould-Statham model UC3 universal transducing and 200-lb load cell accessory† incorporated within the radial arm (Fig. 2). Force data from the load cell were amplified through a Gould-Statham model SC1105 bridge amplifier† and displayed on a Data Precision model 248 digital voltmeter‡.

After the subject had been positioned and stabilized as described, a threshold force was ascertained for passive hip flexion. The threshold force was defined as that force needed to evoke a “pulling” sensation in the right popliteal fossa with the knee in 180 degrees of extension, when the radial arm was moved around the circumference of the force table at about 5 degrees a second. At the point the subject acknowledged a “pulling” in the popliteal fossa, the radial arm was stopped, the prepelvifemoral angle was measured, and the voltmeter reading was recorded. Measurement of the pretest pelvifemoral angle was obtained by the surface goniometer, which was drawn on the secondary level of the force table (Fig. 2). Pelvifemoral angle was defined as the angle opening postero-inferior to the hip joint constructed by two lines, one between the tip of the anterior superior iliac spine and the tip of the ischial tuberosity, and a second line depicting the long axis of the lower extremity and used to ascertain the degree of hip flexion in relation to the stabilized pelvis. The identification of a threshold force ensured that the hip would be passively flexed with the same amount of force following treatment procedures. The mean threshold force for the experimental and control groups was 3.08 kg and 3.17 kg, respectively.

Experimental-group subjects were given application of Fluori-Methane® for over approximately a 45-second period. Six applications, each lasting about

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Fig. 1. Force table. A. Radial arm. B. Skateboard apparatus.

Fig. 2. C. Transducing cell and 200-lb load cell accessory. D. Bridge amplifier. E. Digital voltmeter. F. Surface goniometer.

† Gould-Statham Products, 2230 Statham Blvd, Oxnard, CA 93030.
‡ Data Precision Corp, Audubon Rd, Wakefield, MA 02115.
Comparison of Pelvifemoral Angle Measurements Before and After Fluori-Methane® Treatment

<table>
<thead>
<tr>
<th>Source</th>
<th>s</th>
<th>Pelvifemoral Angle (mean degrees)</th>
<th>Maximum Range of Pelvifemoral Measurements (degrees)</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental Group (n = 15)</td>
<td>± 1.70</td>
<td>119.60 (Pretest) 122.50 (Posttest)</td>
<td>5.50</td>
<td>1.21*</td>
</tr>
<tr>
<td>Control Group (n = 15)</td>
<td>± 0.57</td>
<td>118.30 (Pretest) 118.60 (Posttest)</td>
<td>2.00</td>
<td>0.21</td>
</tr>
</tbody>
</table>

*a Statistically significant (p < .02).

The difference in prepelvifemoral and postpelvifemoral angle measurements among the 30 experimental and control group subjects was calculated. The mean difference in pelvifemoral angle measurement for the experimental and control groups was 1.21 degrees and 0.21 degrees, respectively, as seen in the Table.

Among the experimental-group subjects, 10 subjects displayed an increase in passive hip flexion, 3 subjects showed a decrease in passive hip flexion, and 2 showed no change. The total increase of all experimental-group subjects combined was 23 degrees.

Among the control-group subjects, five subjects displayed an increase in passive hip flexion, two subjects showed a decrease in passive hip flexion, and eight subjects showed no change. The total increase of all control-group subjects combined was 3.25 degrees.

The mean differences and maximal range of pelvifemoral angle measurements between the pretest and posttest experimental and control groups were statistically significant (p < .02) as determined by an unpaired t test and summarized in the Table. Interpretation of this data analysis indicated that the experimental group, which received application of Fluori-Methane® spray, significantly increased the range of passive hip flexion over that of the control group.

DISCUSSION

Factors that caused an increase in passive hip flexion of experimental-group subjects may have been neurophysiological or mechanical, or a combination of both. Neurophysiological effects may have been caused by cold, tactile, and static-stretch stimuli; mechanical effects would have been caused by static passive stretch.

Application of Fluori-Methane® spray does not appear to affect muscle spindle afferent firing directly. Lippold and associates reported a decrease in afferent discharges from muscle spindles after cooling 5°C below body temperature. However, Travell has reported that the application of Fluori-Methane® spray to the skin of one subject did not decrease intramuscular temperature but did cause substantial cutaneous cooling. Therefore, inasmuch as temperature effects caused by Fluori-Methane® spray may be limited to the skin, application of the spray would not directly alter the afferent discharges from muscle. An indirect effect on muscle afferents may possibly be caused by stimulation of cutaneous afferents that could influence gamma motoneurons and subsequently the muscle afferents. I believe this study was not affected by cutaneous input that was facilitatory to the motor system because the dependent variable was passive range of motion. Only the hip joint was free to move through its range of motion. No active hip range of motion was noted in the subjects by the experimenter during test procedures.

Because the Fluori-Methane® spray is pressurized and emitted from a fine nozzle, the vapocoolant strikes the skin as a jet stream, which may act as a
tactile stimulant analogous to light touch or brushing. Cutaneous receptors that have been shown to respond to tactile stimuli are free nerve endings, touch receptors, and endings surrounding hair follicles. These skin receptors may have been influenced by the innocuous stimulation of the skin, thereby causing a flexor-reflex response with contraction of the hip flexors and relaxation of the hip extensors. A true flexion response would facilitate the knee flexors as well, but because the knee joint was maintained in 180 degrees of extension by means of the skateboard apparatus, only the hip joint was free to move through its range of motion. The relaxation of the hip extensors may have been responsible for the decrease in tension noted with 55 percent of the experimental-group subjects. 

Hunt has shown that gamma motoneurons respond more readily to touch of the skin than do alpha motoneurons. He showed that with initial light touching of the skin, the gamma activity increases, but after about two seconds of continuous light touching of the skin, the gamma activity decreases to a level below that of its initial resting rate. This occurred without muscle contraction that would unload the muscle spindle. The decrease in gamma activity appears to be a form of adaptation. This may have happened in my study because the Fluori-Methane® spray was applied continuously for about five seconds each sweep. The sequence of events may be that the vapocoolant stimulates cutaneous afferents that decrease gamma motoneuron discharge, which in turn bias the intrafusal muscle fibers. This spindle bias would then decrease spindle afferent activity and ultimately decrease the activity of the alpha motoneurons and extrafusal muscle fibers of the hamstring muscles. This would allow more passive stretch to be applied to the soft tissues of the posterior thigh, thus increasing passive range of motion measured at the hip joint.

Mechanical adaptation of muscle and connective tissues to passive stretch may have been responsible for the decreased tension as monitored by the strain gauge. Static stretch was applied to the soft tissues of the posterior part of the thigh during test procedures. Statistical analysis indicated that application of Fluori-Methane® spray increased passive hip flexion in the experimental-group subjects over that of the control-group subjects (p < .02). Results of the statistical analysis indicated that application of Fluori-Methane® spray increased passive hip flexion in the experimental-group subjects over that of the control-group subjects (p < .02).

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REFERENCES