Duration of Stretching Effect on Range of Motion in Lower Extremities

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The duration of the effect of contract-relax stretching on range of motion (ROM) in the lower extremities was measured on eight male volunteers. The stretching procedure was performed as one isometric contraction, followed by relaxation and then a passive extension of the muscle being stretched. The treated muscle groups were the adductors, hamstrings, rectus femoris, iliopsoas, gastrocnemius, and soleus. The total stretching time was 15min. Six ROMs were tested 0, 30, 60, and 90min after the stretching procedure. There was a significant increase in hip abduction (+17% ±3), knee flexion (+4% ±1), hip flexion (+4% ±2), ankle dorsiflexion with knee flexed (+18% ±7), and ankle dorsiflexion with knee straight (+16% ±5). The increase remained for 90min for all ROMs except for ankle dorsiflexion with the knee straight.

KEY WORDS: Extremities; Motion; Muscle contraction; Sports medicine

It has been suggested that muscle tightness which restricts the range of motion (ROM) predisposes to lesions such as muscle rupture and tendinitis2,7,9,12-16, and impairs performance in sports where flexibility is important.2,14,15 Different forms of stretching are used increasingly as a means to increase flexibility. We have shown previously that the effect of contract-relax stretching is superior to the effect of massage and general warming up.11 Several authors8,13 have described the contract-relax stretching as one of the most effective forms of stretching. If stretching is to be used in sports as a warm-up procedure it is important to know whether its effect will persist throughout a competition match or training session. The stretching method also should be simple and easy to teach. We therefore selected contract-relax stretching in this study of the duration of the effect of one stretching session for the lower extremities as it would be performed before, for example, a soccer game. The results were to serve as a basis for recommendations about the design of a warm-up program that could use full benefit of the stretching procedure.

SUBJECTS AND METHODS

Eight healthy male volunteers with no history of musculoskeletal or neurologic disorder were examined. All participated in moderate physical fitness programs, but were not active sportsmen.

The stretching program consisted of a general warm-up on a bicycle ergometer with a load of 50W for 15min, followed by the stretching procedure. Stretching consisted of the following: (a) an isometric contraction, followed by (b) relaxation, and (c) passive extension of the muscle being stretched. Starting from a maximal, passive extension of the muscle or muscle group, the subject makes a maximal isometric contraction lasting 4 to 6sec. This is followed by full relaxation (b) lasting at least 2sec.10 Passive extension (c) involves a second passive joint movement as far as possible without causing pain, and maintained for 8sec at the maximally extended position. The cycle A-C is repeated five times for each muscle or muscle group. The whole stretching program for all six muscle groups took 15min.

The muscle groups treated were the following muscles: the adductors except for gracilis, hamstrings, iliopsoas, gastrocnemius, soleus, and rectus femoris. When stretching the adductor group, the subject was sitting on the floor (fig 1) with the knees bent and the feet together. The subject pressed the knees with the elbows downwards to the floor. In an isometric contraction the knees were pressed against the elbows.

The hamstring group was stretched with the subject standing...
Range of Motion Initially, and at 0, 30, 60, and 90 Min After One Session of Stretching for Each ROM in Eight Volunteers

<table>
<thead>
<tr>
<th>Position*</th>
<th>Initial</th>
<th>0</th>
<th>30min</th>
<th>60min</th>
<th>90min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ankle dorsiflexion with knee flexed</td>
<td>34 ± 2.5</td>
<td>35 ± 2.4</td>
<td>33 ± 2.3</td>
<td>32 ± 2.1</td>
<td></td>
</tr>
<tr>
<td>Ankle dorsiflexion with knee straight</td>
<td>27 ± 1.8</td>
<td>31 ± 1.9</td>
<td>31 ± 2.1</td>
<td>31 ± 2.4</td>
<td>29 ± 1.7</td>
</tr>
<tr>
<td>Hip abduction</td>
<td>32 ± 1.9</td>
<td>37 ± 1.5</td>
<td>38 ± 1.4</td>
<td>38 ± 2.1</td>
<td>36 ± 2.0</td>
</tr>
<tr>
<td>Hip extension</td>
<td>81 ± 1.6</td>
<td>85 ± 1.4</td>
<td>83 ± 2.0</td>
<td>85 ± 2.2</td>
<td>87 ± 1.9</td>
</tr>
<tr>
<td>Hip flexion</td>
<td>72 ± 2.1</td>
<td>78 ± 1.5</td>
<td>77 ± 1.6</td>
<td>78 ± 1.9</td>
<td>77 ± 1.7</td>
</tr>
<tr>
<td>Knee flexion</td>
<td>138 ± 3.0</td>
<td>143 ± 3.4</td>
<td>145 ± 2.9</td>
<td>143 ± 2.2</td>
<td>144 ± 2.9</td>
</tr>
</tbody>
</table>

*Significance levels are given for comparison with the initial value. Mean values in degrees ± SEM.

up and the foot on a bench. The bench served as resistance for the isometric contraction of the muscle group. Then the leg was moved forward gradually on the bench with the trunk leaning forward.

Stretching the iliopsoas muscle, the subject was standing with one knee on the floor (fig 2, top) as far back as possible and one foot on the floor in front of the body. The iliopsoas muscle was activated when the subject pressed the back knee simultaneously downwards and forward. The muscle was then stretched when the subject pushed the pelvis forward.

Stretching of the gastrocnemius muscle was done standing with the hands against a wall and the leg being stretched and positioned as far back as possible. The knee was kept straight with the heel on the ground. The isometric contraction was done by pressing the foot against the ground. The passive extension was achieved by pushing the pelvis forward with the knee straight and the heel on the ground.

The rectus femoris muscle was stretched in a standing position (fig 2, right). The leg to be stretched was held at the ankle by the hand of the same side, bending the knee maximally and simultaneously pulling the thigh backwards. The isometric contraction was performed by pressing the lower leg against the hand.

When stretching the soleus, the foot was positioned on a stool with the knee maximally flexed, and the heel in contact with the stool. The isometric contraction was performed by pressing the foot against the stool.

Hip flexion, extension, and abduction, knee flexion, ankle dorsiflexion with the knee straight and flexed were measured by a standardized method published previously. The experiment was made in the afternoon, at a room temperature of 18°C. No food was taken for at least 4h before tests. ROM was measured initially, and at 0, 30, 60, and 90min after stretching. Between the measurements of ROM the subjects were allowed to walk around in the laboratory. Values are given as the mean ± standard error of the mean (X ± SEM). Differences in ROM at different times after stretching were tested for significance by Student’s paired t-test. Differences between
means were tested by Student’s two sample t-test. The statistical results were checked by analysis of variance.¹

RESULTS

The results of goniometry are shown in the table and figures 3 and 4. No differences could be found between the left and right sides. For each movement the average of left and right was used to represent the ROM.

Directly after the stretching procedure all ROMs except hip extension had increased significantly by 4% – 18%. Ankle dorsiflexion with knee flexed showed the greatest increase (18%) and knee flexion the least.(4%).

Ninety minutes after the stretching procedure ROM was still increased for all motions except for ankle dorsiflexion with the knee straight. Hip abduction showed the greatest increase with 13% and hip extension and knee flexion the smallest with 4%.

DISCUSSION

Ekstrand and associates³ reported that 67% of soccer players had one or several tight muscles in the lower extremity. Hamstring strains were more common in teams not using special flexibility exercises for these muscles.⁴ A soccer training session or match lasts about 90min, and the same applies to ice hockey, squash, running, skiing, and track-finding.

It is therefore important to know whether the effect of a single session of contract-relax stretching persists over this period. During the warm-up for a soccer game one session of stretching could be included in order to increase flexibility during the game.

It is clear from the results that the increase in ROM could last for the time period expected for a normal game. Hip abduction showed the greatest increase which might be of benefit as muscle ruptures and tendinitis in soccer often occur in the hip adductors.³ In fact, Ekstrand, Gillquist, and Liljedahl⁶ also found that a new warm-up routine with greater emphasis on flexibility, and the addition of a cool-down, reduced muscle injuries.

Before recommending stretching as part of a warm-up program it is necessary to know if the response is modified or abolished by physical activity. If this is so, the usefulness of stretching in sports training may be limited.

REFERENCES