Stretch Tolerance in a Controlled Neural Tissue Tension Test.

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Abstract – *The aim of this study was to test the hypothesis, that stretch tolerance in a passive knee extension alters when shifting position of the upper body into a nerve tissue tension position. 10 healthy individuals were tested. The extension was stopped by the subject at "onset of pain", and range of motion and torque were recorded. Comparison of these parameters were made between 2 settings: sitting in erect position and sitting in slump position. Only the positioning of the upper body was changed in between the settings.*
Results showed that range of motion and torque was accepted at lower levels when sitting in slump position.
These findings indicate that tolerance for knee extension seems to be influenced by non-local structures.
It is suggested, that influence caused by an extension of the nerve tissue complex could be considered when explaining the alteration of stretch tolerance by stretch exercises. Further studies are needed if this hypothesis is to be supported.

Keywords: Stretching, tolerance, nerve tissue, slump, range of motion.

1. Introduction

Studies have shown, that lasting increase in joint range of motion (ROM) after stretch exercises, is not caused by change in mechanical stiffness. It has therefore been suggested that the improvement in ROM might be caused by altered stretch tolerance [1,2]; but the mechanism behind this change in tolerance remains unclear.

From clinical empiric experience it is known, that neurogenic sensations occur when stressing the nerve tissue [3,4,5]. These experiences could suggest, that a stress on the neural tissue could increase afferent input or sensitize stretch tolerance and thereby decrease ROM.

It is also known, from cadaver studies, that the neural tissue is mobilized and stressed by movements of the limbs and columna [6].

To combine these findings and experiences, this study was designed to quantitatively asses whether ROM is affected by stretching of the nerve tissue-complex in a controlled neural tissue tension test (slump test).

The object for the study was to observe any altering of ROM for knee extension, when position was shifted in the upper body in a way, that did not affect structures relating mechanically to the knee.

2. Material and Methods

Subjects

10 students and teachers from a Physiotherapy-school volunteered to participate in the study. An informed consent, approved by the local ethic committee, was signed before the experiment. The subjects were free from any lower extremity or back pathology at the time of the study.

Protocol

Measurements of joint angle and passive knee flexion torque were done with the upper body in two positions:

1) erect position, - with columna in normal upright position
2) slump position, - sitting with flexion of thoracal and cervical columna.

It was controlled that pelvis did not alter position, when shifting position of upper body.

The sequence of erect position respectively slump position was randomised.

The subject was holding a stop button and was instructed to stop the knee extension himself, at "onset of pain" in the back of the thigh or knee.

Before the tests emg-baseline and goniometer reference was recorded, and 10 extensions were performed in erect position, to let the subject get accustomed to the setting and to minimize a viscoelastic relaxation component in the tissue.

The tests consisted of:

10 extensions in each upper body position with the ankle in neutral position, and

10 extensions in each upper body position with the ankle in dorsal flexion.

Measurement technique

The subject was seated on a firm bench with the right thigh elevated 20 – 30 degrees resting on a firm pad. It was intended, that the subject could not reach full knee extension, so that extension was limited by hamstring muscles alone. The thigh was firmly strapped to the thigh-pad. The positioning was aimed to be like the one described by P Magnusson 1998 [1].

The pelvis was kept from anterior/posterior tilt by a low back-support and fixation by straps, and sitting posture was instructed to be with support on tuber ischii.
When testing with ankle dorsal flexion, the dorsal flexion was fixed with straps.

The passive extension of the knee was performed by a custom made high pressure hydraulic isokinetic dynamometer, described by M Voigt et al 1999 [7]. The dynamometer and the knee joint axis were aligned and crus was fixed to the dynamometer-arm.

Knee joint angle was measured by an electric goniometer (Penny and Giles M180) and was controlled by measurement of the dynamometer arm position.
Torque was calculated from recording of force by a piezoelectric sensor in the crus support and the distance of this sensor from axis of rotation of the actuator.
To control whether movement was performed passively, muscle activity was recorded by emg´s for hamstring and quadriceps, and for some subjects for gastrocnemii as well.

3. Results

For the 10 test persons, age varied from 21 to 47 with a mean of 30; finger-ground distance (FGD) varied from –20cm to +16cm with a mean of –3cm and body mass index (BMI) varied from 18,8 to 26,3 with a mean of 23,5.

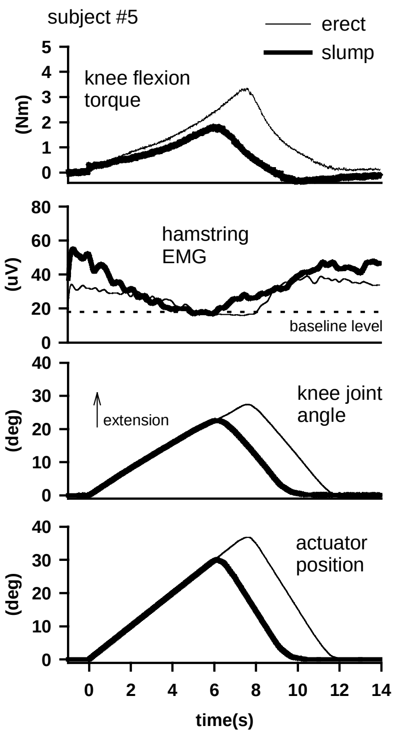

Figure 1. A typical example of the outcome of the slump test with the ankle joint in neutral position. Each signal is the average of ten trials. The position, knee, joint angle and torque signals are drawn as changes from the initial level.

Results from the tests showed significant decrease in ROM and torque when shifting from erect to slump position (fig.1).

Results averaged for 10 subjects:

Change in range of motion
Ankle neutral: 2,9°, CI(95%): 1,2° - 4,6°
Ankle dorsal flexion: 4,1°, CI(95%): 2,7° - 5,4°

Change in torque
Ankle neutral: 1,4Nm, CI(95%): 0,2Nm – 2,5Nm
Ankle dorsal flexion: 2,6Nm, CI(95%): 1,4Nm – 3,8Nm

4. Discussion

In general there were individual variations in the reactions of the different settings. But all subjects, flexible or not, showed the same tendency to stop the extension at an earlier stage (smaller range of motion) and at a smaller torque, when sitting in slump position compared to erect position. The only exception was one subject showing an increase in torque with ankle in neutral position.
This tendency to an earlier stop seemed more eligible with ankle dorsal flexion, and with less flexible individuals.
One subject experienced onset of pain in the back (Th9) when stretched in slump position. This individual had marked difference in stop-parameters

Several subjects were unable to relax completely during the passive stretch maneuver. This could influence on the results, since it would be expected, that a pre-tension in the muscle would lead to an earlier stop according to the subjects sensations. But no fixed correlation was found between emg´s and ROM / torque.

It has been of concern, whether pelvis could be fixed properly, so that there would be no movement of hamstring insertion. The forward bending in slump sitting could cause a forward tilt of pelvis and a passive pre-tension of the hamstrings giving a smaller ROM. But the results showed, that the stop in slump position also occured at lesser torque values. So, whith torque tolerance changing accordingly to range of motion, this concern could be relieved.

It has been the aim to avoid any change in position of local structures connected to the knee extension, when shifting between the erect and slump position of the upper body. We seem to have accomplished that, so that changes in ROM and torque should be related to influence from non-local structures only.
We were operating with a cognitive stop depending on sensoric input. The change in stop point must therefore relate to either a) an increased sensoric input or b) a lower stretch tolerance level or both.

ad. a) According to cadaver studies and clinical empiric works it could be suggested, that the change in upper body position could cause a pre-tension in the nerve tissue in slump position. It could be hypothesized, that the afferent input from this stress on the nerve tissue, would lead to an earlier stop point, when increasing the stress on the nerve tissue complex by extending the knee. It is also possible, that increased stress on the nerve tissue, would increase the "background input" and thereby sensitize the person for stressing of other structures. In this way a lesser torque would be accepted, giving a lesser ROM, when sitting in slump position.

It is not necessarily only afferent input from nerve tissue that gives a lesser ROM. Also additional afferent input from other structures, which are stressed in the slump position, must be considered. The fascia complex is an all-over-body tissue structure and an increased tension in dorsal thoraco-lumbal fascia will occur in slump position. A flexion in the neck means excitation of the large number af proprioceptors located to this area.

ad. b) A lower stretch tolerance level in slump position could be considered. Here a psychological factor could be of influence, since the slump position tends to isolate the person to some degree. The slump position also gives less possibility for free respiration, which could influence on the pain sensation of the subject.

But also an excitation by a stress of the nerve tissue in the slump position could lower the stretch tolerance level.

We find a decrease in ROM caused by the slump position. Considering the cited studies and clinical experiences we find, that the most likely explanation for this finding is, that the nerve tissue complex is pre-stressed in slump position and thereby leads to an earlier knee extension stop. This consequence can be based on increased sensoric input or a combination of sensoric input and lower stretch tolerance.

Seeing nerve tissue as a possible limiting factor in ROM might lead to a new view of the findings of P Magnusson and JP Halbertsma [1,2]. One could suggest that the increase in ROM (with no corresponding change in torque) by stretch exercises, could result from a mobilization of the nerve tissue. Clinical experiences suggest that mobilization of symptom-provoking nerve tissue often can lead to a relief of the symptoms [4]. If this is true, a lesser sensoric contribution from the nerve tissue, might be an explanation of one of the mechanisms of stress tolerance. The backgroud for this change in contribution can only be guessed. It could be based on an altering in the mechanical properties of the nerve tissue, or in a de-sensibilization on a more central level.

If mobilization of the nerve tissue can be one factor in stretching, this leads to some interesting aspects regarding the performance of stretch exercises. Should one focus on positioning of the body so that nerves are stretched, when training for increased movement in the clinical field or in sports?

The often postulated well-being and better performance after stretching might be linked to aspects of this hypothesis.

Evidently more studies are required to justify this hypothesis, and, if supported, eventually investigate the impact of these thoughts.

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