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Experimental Research on the Influence of Vibration on Knee Mobility

Besides hand - arm system, the vibration can enter in the human body through the feet, too. In these case - when the subject was in a standing position and the vibrations have a vertical component - longer exposures may cause disease of joints, lower extremity and serious disorders of the cerebral blood vessels, internal organs and circulatory system. This paper focused on the influence of vibration on knee mobility. We used a MediTouch system which consists of a motion capture device (an ergonomic leg brace) and a dedicated software.

***Keywords**: MediTouch, ergonomic leg brace, knee, joints, mobility*

1. Introduction

Studies show that vibration - when there are several components (and the vibrations are transmitted through the arm of the operator), and in cases where one vertical component (subject was in a standing or sitting position) – can cause the following effects: [1] [2]

- Vascular, vestibular and movement disorders (3...5 Hz);
- Disorders at the head level and stomach, internal organs, intestines disorders (3...11 Hz);
- Urogenital system disorders, visual disturbances, nausea (11...45 Hz);
- Serious disorders of the cerebral blood vessels and circulatory system (unidirectional vertical vibration with a frequency greater than 45 Hz).

Another important observation would be that, if the operator is positioned on additional support, the impedance amplitudes decrease over the entire range, and if the operator is in an inclined position, impedance changes (body impedance is influenced by the position of the subject found in standing position). [1] [2]

This article focused on the influence of vibration on knee mobility.

2. Method

Location: Innovation Research Institute Labs of the University "Transilvania" of Brasov.

Equipment: MediTouch system consists of a motion capture device (an ergonomic leg brace) and a dedicated software (Figure 1).

Figure 1. MediTouch system

Subjects: Subject A - female, 39 years old, no medical problems at legs, Subject B - male, 43 years old, no medical problems at legs (Figure 2).

Figure 2. Subjects

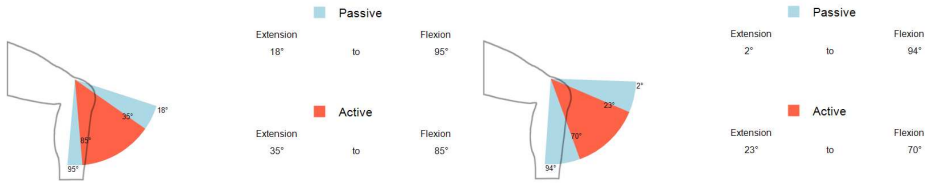
Procedure: I. Three sets of measurements on each knee joint of each subject (reference test - subjects rested);

II. Another three sets of measurements after the subjects were exposed to vibration through the legs on the laboratory vibrant platform (Figure 3).

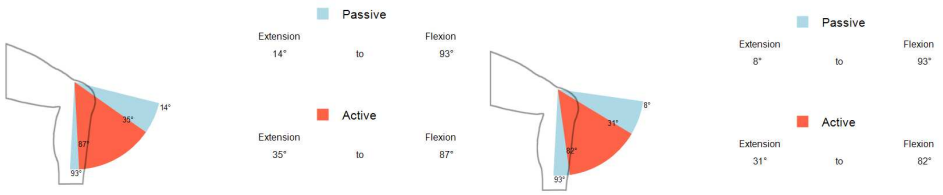
Figure 3. Subject in test and vibrant platform

3. Analysis

Figures 4, 5, 6, 7 have revealed angular displacement flexion and extension of the foot for the two cases (active and passive motion).



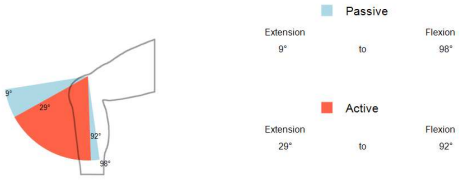
a) Reference – test 1 b) After-vibration – test 1



c) Reference – test 2 d) After-vibration – test 2

e) Reference – test 3 f) After-vibration – test 3

Figure 4. Subject A – right-leg



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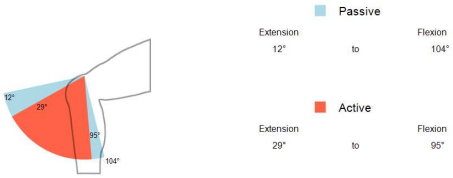

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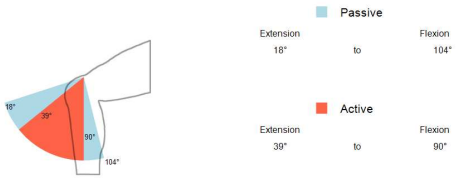

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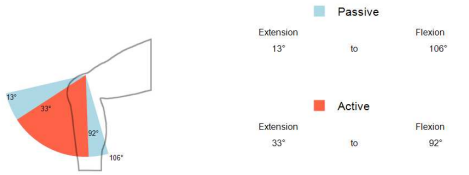

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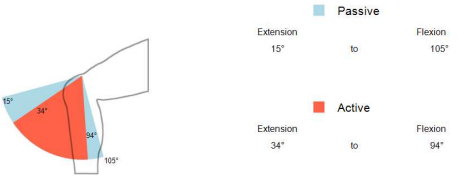
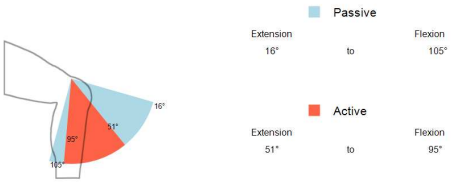


f) After-vibration – test 3

Figure 5. Subject A – left-leg



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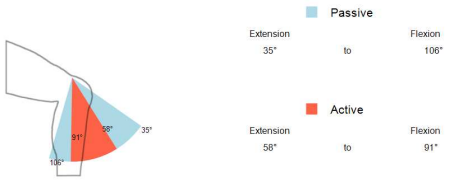

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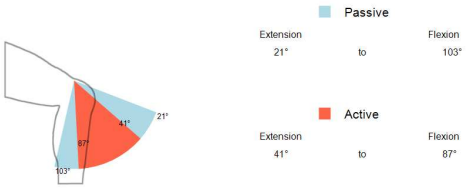

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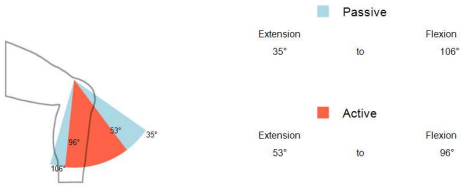

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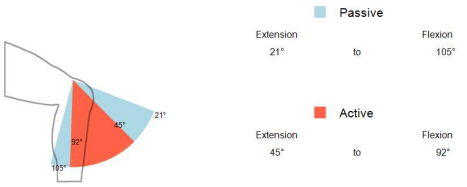

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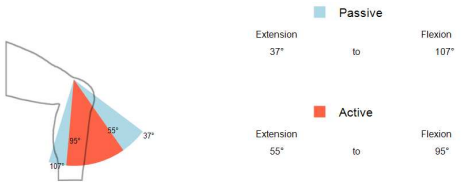
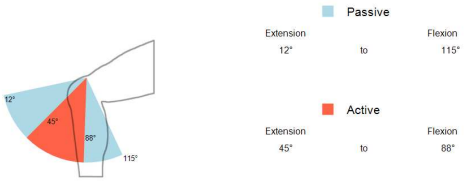


f) After-vibration – test 3

Figure 6. Subject B – right-leg



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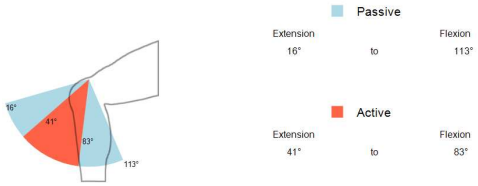

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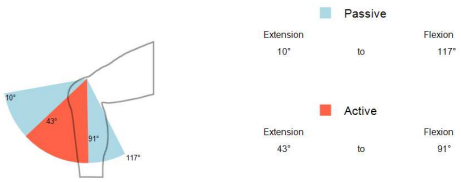

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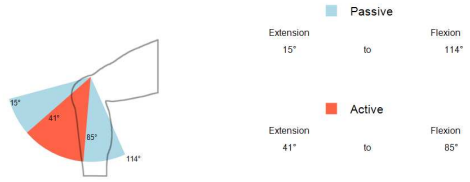
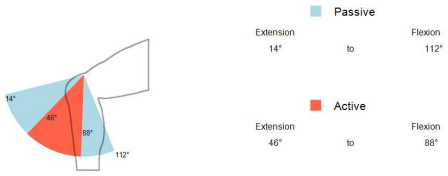


d) After-vibration – test 2

e) Reference – test 3



f) After-vibration – test 3

Figure 7. Subject B – left-leg

4. Conclusion

Subject A

There was a greater mobility of the left knee joint (max: 9^o in extension and 106^o in flexion) compared to the right (max: 14^o in extension and 97^o in flexion). This is apparently contrary to the fact that the Subject A uses in games (like soccer), for kicking the ball, the right foot. The subject has a tendency to rely more on the left leg, as confirmed by the wear out of the left foot shoe sole.

After exposure to vibration, an improvement of the joint mobility in both legs was found, but only in extension (max: 2^o at right knee joint and 5^o at left knee joint). In flexion, the knee mobility decreases (max: 94^o at right knee joint and 105^o at left knee joint).

From the active movement analysis a better left leg motion control was found.

Subject B

There was a greater mobility of the left knee joint (max: 10^o in extension and 117^o in flexion) compared to the right (max: 16^o in extension and 105^o in flexion). The subject B (as well as subject A) uses in games, for kicking the ball the right foot.

This subject has a tendency to rely more on the left leg too, as confirmed also by the wear out of the left foot shoe sole.

After exposure to vibration, a decrease was found of the right joint mobility in extension (max: 35^o) and an improvement of the left joint mobility in flexion (max: 107^o). For the left leg, extension has improved too (max: 16^o) as opposed to an insignificant decrease in extension (max: 114^o)

From the active movement analysis a better left leg motion control was found, as well.

Better control of mobility to the left leg can be attributed to the fact that the subjects are right-footed, use their right leg vigorously and do not give it - during movement - enough attention. By contrast, pays great attention to the left leg movement, that they consider unsafe.

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