Effects of the Use Knee-Ankle-Foot Orthosis on Proprioception Function Change in Healthy Adult Male

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Abstract

Background: Proprioception includes joint position and motion. Sensory information, central processes, and neuromuscular control are important in improving joint stability. The effective use of knee joint orthosis on knee joint performance, balance and coordination is still highly controversial and has slight information on the effect of the orthotic use on proprioceptive function.

Objective: To analyze the effect of knee orthosis on proprioception function in adult male health's subjects.

Method: This study used an experimental research with pre-post study design. The sample of this study was the male patient of Physical and Rehabilitation treatment that met inclusion criteria. The data was taken by consecutive sampling in February 2017. The subjects were 11 healthy male adults who aged of 21-40 years old that meeting the inclusion criteria. All the subjects were measured proprioception function before and at 30 minutes using knee orthosis. Joint position sense (JPS) and time to detect passive movement (TTDPM), were measured by the cybex isokinetic dynamometer tool to measure the function of proprioception.

Result: All the mean values of JPS before and at 30 minutes by using orthosis on both sides did not statistically show a significant difference ($p > 0.05$), except at the corner of the JPS 60° on the right-sided knee ($p < 0.05$). It meant TTDPM before and during 30 minutes using orthosis on both sides of the knee also did not show a significant difference ($p > 0.05$).

Conclusion: The use of ambulatory knee-ankle-foot orthosis caused the change in proprioception (JPS) at the right side 60º knee angle on the subject before and at 30 minutes using knee orthosis.

***Keywords**: Healthy Adult Male, Knee Orthosis, Proprioception.*

Introduction

Knee joint is the largest joint in the human body and ginglymus-type joint (hinge joint modifications) [1]. Knee motion and stabilization is performed by the origo muscles above the hip joint, the entire shaft of the femur is also above the knee joint of the lower limb muscles. Proprioceptive comes from the position of the body, refers to the sense of knowing the position of a person's body that is classically composed of static and dynamic components [2,3]. The design of orthosis is used based on the desired function. Knee orthosis is either a sleeve or has a rigid bars design on one side or both sides, nonelastic hinges and straps [4]. Knee orthosis types which are often used including prophylactics, rehabilitative, functional, unloader/Offloader [5].

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The integrated set of various mechanoreceptor, nociceptors and afferent muscles is known as proprioception. This information allows for feedback for motor movement control through position sensation and motion sensation (kinesthesia) and provides dynamic stability of joint. The motor movement control achieved through the feedback mechanism is realized during movement, well monitored, as well as to the appropriate response to the feedback given. The wide variability of joint position sensation has been observed in some subjects. The presence of deficits in proprioception

is associated with the increased frequency of injuries and recurrent injuries to the knee joint. Proprioception includes joint position and joint motion. Sensory information, central process, and neuromuscular control are important in improving joint stability [6].

The successful use of knee orthosis has been discussed over the years. Although there is evidence to suggest that orthosis can decrease the frequency of knee injury, some researchers have reported that in the use of knee orthosis there is no difference in the injury pattern. This problem is related to multifactorial epidemiological studies that are considered to be the cause of conflicting findings. These factors include the material components of the orthosis used, the different surface contact areas of each individual against the orthoses used. Researchers who tested kinematic joint and muscle activity have compared the condition without orthosis by using orthosis and observed differences in electromyographic and kinematic joint activity while performing the functional activity. Based on these findings, proprioception may be affected by the use of orthosis. Although there is still minimal information about proprioceptive testing and athletic orthoses, as well as groups of subjects with knee joint arthritis, there is an increase in proprioception function in the use of orthosis drytex economy hinged knee brace and hinge buttress orthosis. Similarly, in studies conducted, it was found that the use of orthosis can improve the function of healthy individual proprioception [7,8].

The effectiveness of the use of knee joint orthosis on knee joint performance, balance and coordination is still highly controversial and has the slight information on the effect of the orthotic use on proprioception function. At present, the proprioceptive function gets a great attention on the literature of sports medicine [7]. In the study, the use of orthosis can improve the proprioception function, thereby increasing the mechanical stability of knee joint and the use of knee orthosis in athletes based on the factors which have implication for the proprioception function [8]. Until now, there has been several researchs on the effects of knee joint orthosis on proprioception function. This study was conducted to determine the effect of knee joint orthosis on proprioception function in healthy adult male.

Method

The sample of this study was a male patient of Physical and Rehabilitation treatment that meets inclusion criteria. The data were taken by consecutive sampling in February 2017. The inclusion criteria were healthy men, aged 21-40 years, the range of knee joint movement 0-135o in extension-flexion, no deformity and willing to sign informed consent [9]. The subjects exclusion criteria were with lower extremities, pelvic and spinal injuries, underwent spinal, pelvic, knee and ankle joint surgery, with neurologic and systemic disease affecting the lower extremities, hyperlaxity, and unstable joints. The subject had informed consent and underwent a proprioception with Cybex Isokinetic Dynamometer, before and after 30 minutes using knee orthosis on both knees. This research was a pre-experimental research and posttest study design.

Joint position sense (JPS) and time to detect passive movement (TTDPM) were measured for proprioception using Cybex Isokinetic Dynamometer. The behavior examination in a sitting position with eyes closed and ears, flex knee at 90 degrees. JPS was measured at 30 °, 45 °, and 60 °. JPS and TTDPM for both knees were measured before and after 30 min using knee orthosis. Then, an examination of JPS and TTDPM on both knees without and when using knee orthosis was collected and analyzed data by using t-pair test (Paired t-test). In this study used statistical tests SPSS V.20.0 (SPSS, Inc., Chicago, IL.) with a significance level of $p < 0.05$.

Results

The total sample of characteristics subjects was 11 male. The mean age of the study subjects was 32.82 ± 2.99 years, with the lowest age of 28 years and the highest 36 years. The average height of subjects was 165.81 ± 6.03 cm and average weight were 66.18 ± 7.80 kg. The mean body mass index (BMI) was 24.25±3.11 kg/cm^2 (Table 1). In table 2 the JPS was explained at an angle of 30°, 45o, 60°

The mean difference of right-sided knee TTDPM without orthosis and at 30 min using orthosis was not statistically significant, as did the mean difference of TTDPM on the left side of the knee. The mean TTDPM without the use of orthosis on the right side knee and on the left side of the knee and also at 30 min using orthosis on the left side knee and right-sided knee also did not show statistically significant differences as seen in table3.

Table 1.Characteristics of the Subjects

	N	Minimum	Maximum	Mean	SD
Age(y/o)	11	28.00	36.00	32.8182	2.99393
Weight(kg)	11	58.00	84.00	66.1818	7.80792
Height(cm)	11	156.00	177.00	165.8182	6.03023
BMI (kg/cm2)	11	21.81	32.30	24.2500	3.11068

Tabel 2. JPS on the corner30^o, 45°, 60°

	Right	p-price*	Left	p-price*
2 JPS at an angle 30°				
Δ without ortosis (o)	2.33±1.47	0.978	2.42±1.32	0.909
Δ 30 minutes with orthosis (o)	1.39±1.26	0.434	1.21±0.85	0.736
p-price * without orthosis and at 30 minutes using orthosis	0.163		0.078	
JPS at an angle 45o				
Δ withoutorthosis (o)	2.18±2.46	0.242	2.42±2.86	0.088
Δ 30 minutes with orthosis (o)	1.81±2.03	0.141	1.45±1.57	0.156
p-price * without orthosis and at 30 minutes using orthosis	0.215		0.250	
JPS at an angle 60°				
Δ withoutorthosis (o)	2.87±2.91	0.712	2.02±2.27	0.625
Δ 30 minutes with orthosis (o)	1.54±1.93	0.221	1.84±1.73	0.622
p-price * without orthosis and at 30 minutes using orthosis	0.018		0.631	

Note: Δ is the difference between the reproduced angle of the subject with the angle of 30°, 45°, 60° knee flexion. * p significance level tested by paired t-test ($p < 0.05$).

Table 3. The average value of TTDPM

	Right	p-price*	Left	p-price*
TTDPM withourorthosis (dt)	2.59±1.14	0.971	2.61±1.03	0.941
TTDPM 30 minutes with orthosis (dt)	2.22±0.93	0.415	2.33±1.26	0.364
p-price * without orthosis and at 30 minutes using orthosis	0.092		0.284	

Note: the average value is the average time when the subject feels the knee passive movement. Significance level tested by paired t test ($p < 0.05$).

Discussion

The assessed parameters were the JPS for a sense of joint position and TTDPM to assess the ability to detect passive movement of the joints. This examination was performed in one visit. Prior to the examination of JPS and TTDPM, firstly evaluated vital signs (blood pressure, pulse, and breathing) and measuring height, the weight of clinical examination of knee joint stability and knee extensor muscle strength with manual muscle test. Measurements of JPS and TTDPM were performed before the use of knee orthosis and at 30 minutes using knee orthosis. During the wait, research subjects can perform activities in the polyclinic. JPS measurements were performed at angles 30º, 45º, and 60º. TTDPM checks were done at 10/sec. The average measurement of each subject was taken from 3 times the measurement. The average JPS was calculated from the average value of the difference between the reproduction angle at a predetermined angle. The examination was performed on both knees on both the left and right sides.

Based from the results of this study, there were no significant statistically on proprioceptive differences in JPS and TTDPM in the right and left sides of the knee before using knee orthosis and at 30 minutes using knee orthosis except for right-sided knee at treatment angle 60°. On the right side of the knee at an angle of 60°, there was a statistically significant JPS. The study in this study is similar to the study of prophylactic knee orthosis conducted in the study used the prosthetic-type prosthesis knee of Mc David Knee Guard. The study was conducted on 36 healthy male subjects who performed the measurement of proprioception function before and when using knee orthosis, the result did not get a significant difference to the JPS. In the study, it was concluded that prophylactic knee orthosis had minimal influence on the proprioceptive feedback mechanism [10].

In the study was obtained on 24 healthy subjects (14 male and 10 female) to determine the effects of prophylactic knee orthosis on balance, proprioceptive, coordination and the strength of muscle [7]. They use 5 different types of knee orthosis that will be used entirely by the subject. From this research, it was obtained that Drytex economy hinged knee brace has the best result for improvement of proprioceptive function compared to the other four orthosis. This type of orthosis was what we use in this study. In the study also reported that proprioceptive knee joints increased when using elastic neoprene in healthy subjects [11]. It was believed that the use of elastic neoprene as found in prophylactic knee orthosis may stimulate the skin during joint motion and put pressure on joint muscles and capsules. Afferent feeds from a number of receptors present on the skin, muscles, ligaments and joint capsules contribute to the proprioceptive mechanism in the knee joint overall. Most cutaneous receptors will respond to changes in movement and quickly adapt. The difference in the results of this study with the findings in this study may be due to neoprene wrapping in knee orthosis is not completely appropriate around the knee joints thus reducing the increase in skin stimulation. In addition, in this study, we used healthy subjects without a history of problems in the knee joints to allow for statistically significant results [12].

On JPS examination of the knee joint, the target magnitude of the reliable flexion angle for the increase of the JPS in the vertical position was between the 60º-90º flexion angle.Target this knee joint position to get maximum JPS knee joint [13]. It was also obtained in our study that between JPS angle 60º on right leg side knee without using orthosis and with 30 minutes using orthosis there was a statistically significant difference. It was said that in this position it was possible to obtain a balance of both agonist and antagonist muscles and

the required minimal complex neurological processes thereby that will causing a minimal error rate.

In this study we found a statistically significant JPS difference in the right-hand side 60º knee angle, this may be because the right knee was the dominant knee of the study subjects, but we can't confirm it. So far we have not obtained data on the difference in the function of proprioception on the dominant and non-dominant side in healthy subjects and also still lack research on the use of knee orthosis which assessed the proprioceptive function of the knee joint.

For athletes and non-athletes who have previously suffered an ACL injury will show a worse knee joint JPS than a healthy subject. Joint Position Sense (JPS) and TTDPM without using orthoses compared to the time 30 minutes using orthosis in our study did not show the statistically significant difference, except at the right side 60º angle of the knee. The 30 minute time may be less to get a meaningful change and this still needs further research.

The TTDPM examination in this study uses Cybex isoquant dynamometer which in its use must be moved first in the direction of flexion before the machine moves toward the extension so that the subject was able to recognize when the machine starts to move and it can also be biased in the examination.

Study Limitation

In this research, we were using healhy adult male subject without any problem at the knee joint so the result was not significant statistically and the study effect when subject underwent 3 times measurement before using orthosis so the subject have experience.

Conclusion

The use of knee orthosis for 30 minutes may improve the healthy knee joint proprioception function at the right side corner of the JPS 60°. The use of knee joint orthosis cannot improve the knee proprioception function in TTDPM at 30 minutes of application.

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Ethical Clearance: This study was approved by Ethical Commission of Health Research Faculty of Medicine University of Airlangga (298/Panke.KKE/IV/2017) in dr. Soetomo General Hospital Surabaya, Indonesia.

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