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The Effects of Backrest Angle on Lower Extremity Muscle Strength in Adult

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Abstract

Purpose: The purpose of this study was to investigate the effects of backrest angle on lower extremity muscle strength in adult. **Method:** This research results are based on 10 healthy adults. 10 degree difference in pelvic angle does not effect the cross-connection of the Hamstring muscles, and created 3 types of rest with 20 degree differences each at 95, 115, and 135 degree angles. **Result:** significantly difference in contractibility muscle strength in accordance to the 3 rake angle. **Conclusion:** After putting together all these results, since both the expansibility muscle strength and contractibility muscle strength of the knee showed to be effected as the backrest angle changed during isokinetic muscle strength assessment, further research should be conducted if similar research results as this study can be acquired at various angles.

Key words : Strength, Knee joint

Ⅰ. Introduction

Training in order to improve muscle strength consists of resistance exercises such as isotonic exercise, isometric exercise, and isokinetic exercise. Generally, well-used muscle constrictions are climbing up and down stairs, walking, running, jumping, and other activities consisting expansibility, and constriction of contractibility, implying that average day activities starts from the joint, with the constriction of the agonistic muscle, and the antagonist muscle working in opposition against each other to create tension leading to muscle activity. Isotonic exercises making use of such closed chain exercises are getting much spotlight nowadays. However, even though it shows impressive muscle strength improvements, isotonic exercises using expansibility constriction, show side effects such as extreme pain from the muscle, preventing training using these exercises from being used to its full potential. Yet, as instruments using isokinetic exercise that improved on the downfalls of isotonic exercises, allowing for expansibility and contractibility constrictions to be performed, researches on the shapes of muscle constriction using isotonic exercise instruments are being conducted (Kim and Jeon, 2006).

Isokinetic exercises have many benefits compared to

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other exercises. Although isotonic exercises can expense the maximum resistance to the weakest part of the exercise chain, isokinetic exercises can provide the maximum resistance throughout the whole range of motion of the exercise, lower danger of injuries, and due to the difference in speed the isokinetic instrument provides, can be effective toward both the white and the red muscle fibers (Urzica et al., 2007).

Therefore, isokinetic exercise can not only assess muscle strength for the general public and professional athletes, but also, due to benefits such as that it can provide stable and proper exercise throughout the full range of motion during rehabilitation, it is widely used for improving muscle strength during exercise injuries (Bogdanis et al., 2017).

Isokinetic exercise is based on choosing the exercise speed beforehand, then uses the principle that resistance changes as the exercise speed changes, artificially changing the expended resistance as the applied torque changes while trying to maintain the same speed. Unlike isotonic exercise, since it is not affected by inertia, it was designed to extract maximum exertion from any part of its full range of motion. Also, since it induces exercise from multilateral speed levels, it can affect many types of muscle fiber at once. Since in isokinetic exercises, high velocity load lessens the pressure in the joints, which allows muscle improvement with the least amount of edema and pain possible, making it a great exercise option to improve muscle during injuries (Hall et al., 2017).

Also, according to researches done by Bohannon (2009) based on researches done on isokinetic muscular strength since 2009, constriction or exercise form, are effected by assessment conditions.

Especially, among all the variables, there is an assessment position that fulfills isokinetic muscular strength assessment. It was reported that each position has its own length-tension correlation, showing different results of maximum muscular strength, work, and work efficiency at each speed level. Also, it has been reported the difference in assessment position resulted in some statistical and significant difference of the amount of torque in the isokinetic assessment.

Therefore, even with the attention isokinetic exercises are getting, the lack of domestic research on the subject of backrest angle effecting muscular strength, and the lack of results on the backrest angle that exerts maximum muscular strength, has led to this research.

Ⅱ. Methods

1. Subjects

This research results are based on 10 healthy adults in their early-mid-twenties attending G-university physical therapy course, the screening criteria consisted of physically healthy male with no specific illnesses or operation done to their waist or knee joints. Research participants were briefed on the research beforehand and volunteered to help of their own accord. The physical attributes of the participants are as Figure 1 states.

2. Procedure

In order to measure the maximum torque contractibility and expansibility of the Quadriceps and Hamstring muscles generate, the following isokinetic exercise instrument was used.

Researchers such as Paschalis conducted their research between the angles of 90 to 135 degree. Based on these evidences, this study based its work on Currier’s report that 10 degree difference in pelvic angle does not effect the cross-connection of the Hamstring muscles, and created 3 types of rest with 20 degree differences each at 95, 115, and 135 degree angles, with participants positioned so their thigh meets the end of the chair at each angle and the table was adjusted so the knee joint was aligned with the axis of the instrument.

Before the assessment, the instruments were returned to normal position and each participant were strapped in at the torso, pelvic, thigh, and ankles with pads so no compensation would occur during assessment, and gravity correction was done so the weight of the leg would not effect the results. Participants were encouraged to put their maximum effort during assessment, and were instructed to cross their arms in front of their chest so they would not grab anything that might effect the results of the study. Assessment orders were 95 degree, then 115 degree, then lastly 135 degree with the dominant leg at 60 degree/sec. During assessment, 3 flexion and extension were conducted at submaximal then 1 maximal exercise. The range of motion of the knee joint during assessment was 0 degree to 90 degrees.

3. Data Analysis

The data collected through this experiment was processed through PASW Ver.18 for window in order to calculate the average and standard deviation for all data. The deviation in max-torque results at each angle was tested for normality then was processed using the One-way ANOVA system, then was revised using Tukey. All statistical significance level was set to a=.05.

Ⅲ. Result and Discussion

1. The difference in contractibility muscle strength in correlation to backrest angle

In sitting position at 95, 115, and 135 degree angles, the difference between the 3 results for the contractibility muscle strength showed significant difference statistically in Hamstring muscle at 60 degree/sec after post-hoc analysis as figure 2 suggests, with 115degree showing significantly higher results than 95 degree and 95 degree showed significantly higher results than the 135 degree.

2. The difference in expansibility muscle strength in correlation to backrest angle

The difference in expansibility muscle strength in accordance to the 3 backrest angles 95 degree, 115 degree, and 135 degree, in sitting position is as shown in figure 3 with 60 degree/sec showing significant difference between results, 95 degree being significantly higher results than 115 degree, and 115 degree showed significantly higher results than 135 degree.

3. Discussion

The tension exhibited during muscle constriction in the musculoskeletal system shows difference in the range of motion as biomechanical factors factor in. If the maximum strength displayed by the isokinetic instrument is created by the joint’s total range of motion, the resistance of the instrument should be in correlation to the ability of the muscle during isokinetic muscle constriction in accordance to the joint angle, and in dynamic muscle constriction delivers the optimum muscle constriction resistance.

Muscle shows maximum strength in stabilization length and when this length changes, strength decreases. This concept can also be seen in the length-tension relation in the isokinetic assessment test as the joint angle the muscle strength takes place in. During dynamic exercise, muscle length also changes as the joint angle changes which will effect the tension exerted by the muscle. In sitting position, the angles were set up as 95 degree, 115 degree, and 135 degree. Quadriceps femoris muscles showed muscle strength in the order of 95 degree, 115 degree, and 135 degree, and the Hamstrings muscles showed results in the order of 115 degree, 95 degree, and 135 degree from highest to lowest.

Therefore, the optimum joint angle for Quadriceps femoris muscle is 95 degree and the optimal backrest angle for maximum motility of the Hamstring muscle is 115 degrees rather than 95 or 135 degree making it the optimal muscle length.

According to former researches such as Goh et al (2017) who reported that Hamstring muscle strength at 90 degree showed stronger muscle strength than at 135 degree, and Yosmaoglu et al (2017) who reported that Hamstring muscle at 110 degree angle showed significantly higher results in muscle strength at 60 degree/sec, 180 degree/sec, and 240 degree/sec than the results at 170 degree, suggested similar tendencies with this study but compared to former researches such as Peterson-Kendall et al (2005) who reported stronger isometric muscle strength when the backrest angle was smaller showed difference with this study which concluded that the 115 degree angle showed significantly higher muscle strength the 95 degree results. Also the results of this study showed similar results to a study done by professor Shin and Kim (2011) that suggested when the muscle strength of Quadriceps femoris muscle was measured in accordance to the backrest angles, the results came in as 60 degree/sec, 100 degree/sec, 120 degree/sec, and 140 degree/sec from highest to lowest. The contractibility of Hamstring muscle strength showed maximum strength at 115 degree, due to the fact that in the 3 backrest angles selected for this study, larger the backrest angle, shorter the Hamstring muscle length became. The 3 muscles of the Hamstring muscle, semitendinosus muscle, semimembranous muscle, and biceps femoris muscle, all show difference in length starting from the hip joint and intersects at the knee joint as the backrest angle changes (Yosmaoglu et al, 2017) with the optimum intersecting connection for maximum muscle strength would be 115 degree of backrest angle rather than 95 degree or 135 degree angles.

The core muscle strength of the Quadriceps femoris muscle showed maximum strength at 95 degree angle. At sitting position, between the 3 angles of backrest angles, the muscle length of the Quadriceps femoris muscle lengthened as the backrest angle increased. The Quadriceps femoris muscle consists of 4 muscles, the vastus lateralis muscle, the vastus intermedius muscle, the vastus medialis muscle, and the rectus femoris muscle, with only the rectus femoris muscle intersecting at the hip joint and the knee joint which shows difference in muscle length as the backrest angle changes (Goh et al 2017).

Quadriceps femoris muscle shows maximum muscle strength at 95 degree rather than the 115 degree or the 135 degree, with 100 degree shown to be the optimal angle to create the muscle length the best actomyosin cross-connection is formed to generate muscle strength.

When the backrest angle change during isokinetic muscle strength assessment in sitting position, it is shown both expansibility muscle strength and contractibility muscle strength are affected. Therefore, in order to gather accurate assessment results in an exercise physiology research with the current standard assessment instrument, backrest angle must surely be considered.

Ⅳ. Conclusions

After an experiment that assessed 10 participants at a rake angle of 95 degree, 115 degree, and 135 degree angle to research the difference between contractibility muscle strength and expansibility muscle strength of the knee muscle as backrest angle changes, the following results were earned. Contractibility muscle strength of the Hamstring muscle at 60 degree/sec showed optimal muscle strength at the rake angle of 115 degree.

Expansibility muscle strength of the Quadriceps femoris muscle at 60 degree/sec showed optimal muscle strength at the rake angle of 95 degree.

After putting together all these results, since both the expansibility muscle strength and contractibility muscle strength of the knee showed to be effected as the back-rest angle changed during isokinetic muscle strength assessment, further research should be conducted if similar research results as this study can be acquired at various angles.

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Appendix 1. Table

Table 1. General Characteristics of the subjects (n=10)

	M±SD
Age (year)	23.70 ± 1.410
Height (cm)	176.84 ± 6.380
Weight (kg)	72.500 ± 10.10
BMI (kg/m²)	23.340 ± 3.080

Table 2. Difference in contractibility muscle strength in accordance to the 3 rake angle (Nm)

Area	Rake angle	M±SD	F	p	post−hoe
Hamstring muscle	95°	87.720 ± 6.11	124.077	.000	C<A<B
	115°	102.25 ± 4.77			
	135°	64.100 ± 5.43			

A:95° B:115° C:135°

Table 3. Difference in expansibility muscle strength in accordance to the 3 rake angle (Nm)

Area	Rake angle	M±SD	F	p	post−hoe
Quadratus femoris muscle	95°	209.73 ± 16.16	102.102	.000	C<B<A
	115°	169.61 ± 5.180			
	135°	125.48 ± 15.28			

A:95° B:115° C:135°