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Test-Retest and Inter-Rater Reliability of Isokinetic Ankle Dorsiflexor and Plantar Flexor Strength Measurement in Healthy Adults

Sağlıklı Erişkinlerde Ayak Bileği Dorsifleksör ve Plantar Fleksör İzokinetik Kas Kuvvet Ölçümlerinin Gözlemci İçi ve Gözlemciler Arası Güvenilirliği

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Summary

Objective: To determine the test-retest and inter-rater reliability of isokinetic strength measurements of ankle dorsiflexor and plantar flexors.
Materials and Methods: Thirteen healthy subjects (mean age: 34.3±9.2 years; female/male: 11/2) were participated in the study. Isokinetic measurements of ankle dorsiflexion and plantar flexion were performed by the isokinetic dynamometer. The participants were tested at 30^0 and 120^0/sec angular velocities while lying in prone position. Each subject was tested three times by two examiners. All the tests were performed at the same time period of the day.
Results: Intraclass correlation coefficients for test-retest reliability ranged between 0.86 and 0.92 for isokinetic measurements of ankle plantar flexion and dorsiflexion at 30^0/sec and between 0.81 and 0.93 at 120^0/sec angular velocity. The ICC values for inter-rater reliability ranged between 0.81 and 0.93.
Conclusion: Peak torque measurements of ankle dorsiflexors and plantar flexors at 30^0 and 120^0sec angular velocities had a high intrarater and inter-rater reliability using the isokinetic dynamometer. *Turk J Phys Med Rehab 2013;59:32-5.*

Key Words: Isokinetic measurement, reliability, ankle, dorsiflexion, plantar flexion, peak torque

Özet

Amaç: Ayak bileği dorsifleksiyon ve plantar fleksiyon kuvvetlerinin izokinetik ölçümlerinin gözlemci içi ve gözlemci arası güvenilirliğini değerlendirmek.
Gereç ve Yöntem: On üç sağlıklı birey (ortalama yaş: 34,3±9,2 yıl; Kadın/Erkek: 11/2) çalışmaya alındı. Ayak bileği dorsifleksiyon ve plantar fleksiyon kuvvetlerinin izokinetik ölçümleri izokinetik dinamometre ile yapıldı. Testler, katılımcılar yüzüstü pozisyonda yatarken 30^0 ve 120^0/saniye açısal hızlarda uygulandı. Testler iki farklı uygulayıcı tarafından bütün katılımcılara günün aynı saatinde toplam üçer kez olmak üzere gerçekleştirildi.
Bulgular: Ayak bileği plantar fleksiyon ve dorsifleksiyon kuvvetlerinin izokinetik ölçümlerinin test-tekrar test güvenilirliği için sınıf içi korelasyon katsayıları 30^0/saniye açısal hız için 0,86-0,92 aralığında ve 120^0/saniye açısal hız için 0,81-0,93 aralığında idi. Uygulayıcılar arası güvenilirlik için sınıf içi korelasyon katsayısı 0,81 ile 0,93 arasında idi.
Sonuç: Sağlıklı genç bireylerde izokinetik dinamometre ile 30^0/saniye açısal ve 120^0/saniye açısal hızlarda uygulanan ayak bileği dorsifleksiyon ve plantar fleksiyon kuvvetlerinin izokinetik ölçümleri yüksek uygulayıcı içi ve uygulayıcılar arası güvenilirliğe sahiptir. *Türk Fiz Tıp Rehab Derg 2013;59:32-5*.

Anahtar Kelimeler: İzokinetik değerlendirme, güvenilirlik, ayak bileği, dorsifleksiyon, plantar fleksiyon, döndürme moment tepe değer

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Introduction

Proper functioning of ankle joint is essential for daily living, recreation and sports activities. Ankle strategy is an important component of maintaining postural control. Small adjustments to changes in balance are accomplished by actions of the muscles about the ankle joint. Body moving around the ankle like an inverted pendulum corrects the position of the center of gravity (1). Hip strategy is activated when the ankle strategy is insufficient to control the deviations in balance.

In many sports and dancing activities, perfect postural control is required. The role of ankle strategy becomes prominent especially during unipedal stance to achieve the principal desired motion, such as kicking a ball in soccer or attack in judo or karate (2).

Strength of muscles around the ankle is also of concern in amputee rehabilitation (3) and prevention of falls, especially in elderly and neurologically impaired patients (4-6) as well as sports injuries (7). Precise measurement of strength becomes valuable in studies identifying patients at risk and determining the progress of the therapeutic approach. Isokinetic measurement is preferred in strength assessment because it provides objective and quantitative results. It is important that the difference obtained in two consecutive measurements is attributable to the progression observed in the treatment and not to measurement errors arising from the examiner, the subject tested or the device.

In the present study, we aimed to determine the test-retest and inter-rater reliability of isokinetic strength measurements of ankle dorsiflexor and plantar flexors.

Materials and Methods

Subjects

Thirteen subjects (mean age: 34.3±9.2 years; female/male: 11/2) were recruited from hospital attendants who volunteered for this study. The subjects were healthy with no systemic diseases and were not taking any medications. None of the subjects were engaged in regular sports activities. Exclusion criteria included history of trauma or surgery to the lower extremity and any contraindication for isokinetic testing. None of the subjects had been tested previously for ankle isokinetic strength. All participants provided informed consent. The study protocol was approved by the local ethics committee.

Procedure

All measurements were performed in the isokinetic laboratory of our Physical Medicine and Rehabilitation Department. Cybex 770 Norm (Lumex Inc. Ronkomkoma, NY, USA) was used for isokinetic strength testing. The dynamometer was calibrated according to the manufacturers' guide before each test sessions. The tests were performed when the subjects were lying in a prone position on the dynamometer with hip and knee in full extension. Patient's position was secured by pelvic and thigh stabilizer belts. Only the dominant extremity was tested. Location of footplate was adjusted according to the patient's height. Patient's foot was strapped on the footplate and axis of rotation passed through the tip of the fibula laterally and the trochlea of the talus medially. After testing the range of motion (ROM) of the ankle and adjustment of the set-up accordingly, test session was started in full dorsiflexion. The position of the subject in full knee extension put forward the gastrocnemius action in plantar flexion. Isokinetic testing speeds of 30^0 and 120^0/sec were used and four submaximal warm-up repetitions were performed before testing at each speed. At 30^0/sec angular velocity, the subject was asked to perform 5 maximal contractions as forcefully as possible. After a rest period of 10 minutes, the subject was instructed to complete 20 concentric contractions as fast as possible. Each subject was tested by two examiners three times in 4 days. All the tests were performed at the same time period of the day. The first examiner repeated tests three times on days 1, 2 and 3; the second examiner performed three tests on days 2, 3 and 4. On the 2nd and 3rd days, there was a rest period of 10 minutes between the tests performed by the two examiners.

Data Analysis

The highest peak torque of the contractions at each velocity which was obtained from the records of the dynamometer was put into the analysis. Statistical analysis was undertaken by using SPSS for Windows, version 11.5. Means and standard deviations for peak torque values of the ankle dorsiflexor and plantar flexor muscle groups were calculated at both angular velocities. Intraclass correlation coefficients (ICC) were used for intrarater and inter-rater reliability. ICC values equal or greater than 0.80 were regarded as meaningful.

Results

The mean age of the subjects was 34.3±9.2 years. Means and standard deviations of the peak torque values for both examiners are presented in Table 1 and box plots are also shown in Figure 1 and 2.

Test-retest Reliability

Intraclass correlation coefficients were 0.88-0.92 and 0.81-0.91 for isokinetic measurements of ankle plantar flexion and dorsiflexion at 30^0/sec angular velocity, respectively. The ICC values were 0.89-0.86 and 0.93-0.85 for ankle plantar flexion and dorsiflexion peak torque values at 120º/sec angular velocity, respectively (Table 1).

Inter-Rater Reliability

The ICC values for inter-rater reliability were 0.90 and 0.93 for ankle plantar flexion peak torque values at 30^o/sec and 120^o/sec angular velocities, respectively. They were 0.86 and 0.81 for ankle dorsiflexion peak torque values at 30^o/sec and 120^o/sec angular velocities, respectively. Graphic illustrations of the relationships between peak torque values of each subject on day 1 for 30^o/sec and 120^o/sec angular velocities are shown on Figure 3 and 4.

Discussion

In the present study, isokinetic measurements of ankle plantar flexion and dorsiflexion for 30^0/sec and 120^0/sec angular velocities were highly consistent and reproducible in healthy adults.

The number of studies assessing reliability of ankle isokinetic strength is relatively limited when compared with studies investigating knee isokinetic strength reliability (8-11). The results of these studies showed that isokinetic measurement of ankle strength were highly reliable (8,11), whereas the results of some other studies indicated lower reliability (9,12).

Reliability of the measurements can be affected by many factors: equipment, test protocol, examiner, and patient-related factors. The dynamometer used in the present study was demonstrated to be reliable in the previous studies (13,14). However, to our knowledge, the reliability of the isokinetic measurement using the ankle apparatus of Cybex Norm device has not been investigated.

Test protocol was set on the basis of the recommendations of the manufacturer's manual. Hence, the position of the subject and the axis of rotation were determined according to the same rules preceding each test session. The reliability of isokinetic ankle measurement in prone position was not studied before. In case of small positioning errors, the subject can compensate using mechanical play in the ankle joint and can reach same peak torque values. Therefore, precise positioning of the subject on the dynamometer is crucial. The reproducibility of the measurements was found to be lower when testing was started with higher angular velocities (15), and we also started the test protocol with 30°/sec. Angular velocities of 30°/sec and 120°/sec preferred in the present study were in accordance with other studies (9,11). Higher velocities are more important predictors for daily functional activities, such as normal gait, hence 120°/sec was chosen. For low angular velocity that is expected to result in higher peak torque values, 30°/sec was used because it is the most commonly preferred velocity in other studies (8,9,11).

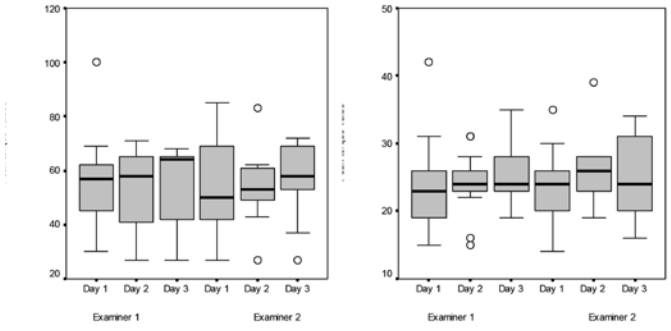

Figure 1. Box plot representation of isokinetic measurements of ankle plantar flexion (a) and dorsiflexion (b) at 30°/sec angular velocity.

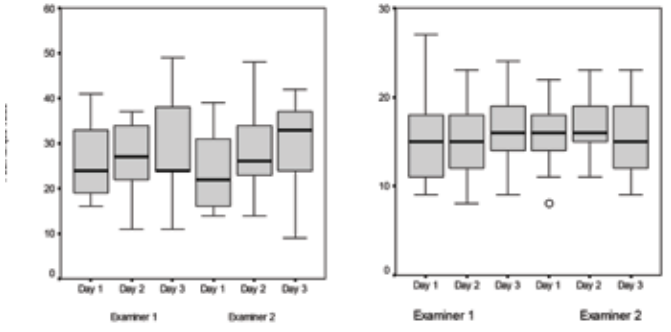

Figure 2. Box plot representation of isokinetic measurements of ankle plantar flexion (a) and dorsiflexion (b) at 120°/sec angular velocity.

To minimize examiner-related factors, verbal encouragement other than an effort to give information about the test protocol was not used. Visual feedback was also not applicable due to the prone position of the subjects limiting the visual access to the monitor.

Subject-related factors include willingness and acceptance of the procedure. As our study population consisted of the hospital attendants that were volunteers, this may contribute to the favorable reliability degrees. Age, educational level and health status that might play a role were also homogenous among the subjects.

In studies testing the isokinetic strengths in different knee flexion degrees, the action of the soleus muscle also engaged in different proportions (9,11). Möller et al. (9) tested and compared the reliability of ankle dorsiflexion and plantar flexion strength measurements in seated and supine positions. Supine or prone positions provide higher torque values than seated positions (9). The ICC values were lower than those of our study. In supine position, the results were not reliable for ankle dorsiflexion at both low and high angular velocities. They made a suggestion that ROM in ankle dorsiflexion was limited in full knee extension in supine position that caused difficulty in dorsiflexion. However, our results were reliable for dorsiflexion and plantar flexion in both angular velocities.

Limitations

The study sample was small and participants consisted of relatively homogenous sample, younger adults with

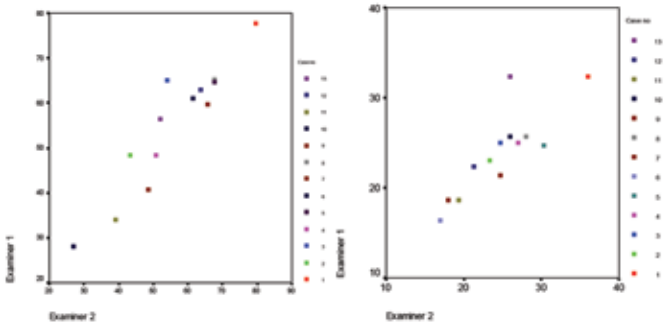

Figure 3. a-b. Peak torque values of each participants' plantar flexion (a) and dorsiflexion (b) at 30°/sec between tests performed by two examiners on Day 1.

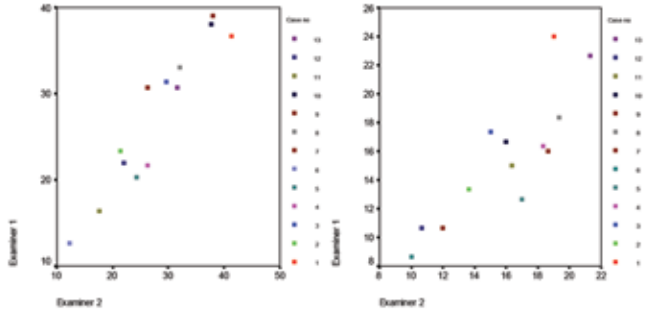

Figure 4. a-b. Peak torque values of each participants' plantar flexion (a) and dorsiflexion (b) at 120°/sec between tests performed by two examiners on Day 1 performed by two examiners on Day 1.

Table 1. Mean and standard deviations of peak torque values at 30°/sec and 120°/sec angular velocities for both examiners.

	Peak Torque (Nm), mean±SD Examiner 1				Peak Torque (Nm), mean±SD Examiner 2			
	Day 1	Day 2	Day 3	ICC	Day 1	Day 2	Day 3	ICC
30°/sec PF	55.6±18.1	54.2±1V4.4	54.4±14.3	0.88	55.4±17.9	54.3±12.9	56.3±14.4	0.92
30°/sec DF	23.7±7.1	23.1±4.3	24.8±4.3	0.81	23.4±5.5	25.6±5.1	25.0±6.1	0.91
120°/sec PF	25.9±8.5	26.8±7.9	29.3±11.4	0.89	24.6±9.1	28.3±9.6	30.1±9.8	0.86
120°/sec DF	15.3±5.1	16.0±4.8	16.0±4.8	0.93	15.4±3.7	15.4±3.7	15.8±4.7	0.85

Nm: Newton meter, SD: Standard deviation, ICC: Intraclass correlation coefficient, PF: Plantar flexor, DF: Dorsiflexor

the participants reported that prone positioning on the dynamometer was not comfortable. Adults with systemic diseases limiting prone lying might experience some difficulty in this protocol. It is suggested to compare the reliabilities of prone position with other positions in isokinetic measurements of the ankle.

Conclusion

We demonstrated that peak torque measurements of the ankle dorsiflexor and plantar flexors at 30º and 120º/sec angular velocities had a high intrarater and inter-rater reliability using the Cybex Norm isokinetic dynamometer.

Acknowledgement

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Conflict of Interest

Authors reported no conflicts of interest.

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