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Reliability between examiners for the GNRB knee arthrometer

RENATA VAUHNIK[1) 2)]，FRANCE SEVŠEK[1)]，DARJA RUGELJ[1)]

Abstract: [Background] The measurement of knee anterior laxity is regarded as an important part of the clinical examination when assessing the integrity of the anterior cruciate ligament. In clinical settings, knee arthrometers are used by different examiners and therefore knowing the reliability of the instrument between examiners is crucial in order for the results from different examiners to be accurately interpreted and the limitations fully understood. [Methods] Knee anterior laxity in both knees was tested with a GNRB arthrometer in a group of 28 subjects (12 males and 16 females) aged between 20 and 40 years old (average 26.3 yrs and standard deviation 6.3 yrs) by two examiners. Knee anterior laxity was measured at five test forces (67N, 89N, 134N, 200N and 250N). The reliability of the GNRB knee arthrometer was analysed with intraclass correlation coefficients. [Results] Intraclass correlation coefficients for the GNRB knee arthrometer were 0.92 and 0.82 for force 67N, 0.93 and 0.82 for force 89N, 0.91 and 0.80 for force 134N, 0.90 and 0.79 for force 200N, and 0.89 and 0.77 for force 250N for right and left knees, respectively. [Conclusions] Reliability between examiners for the GNRB arthrometer is good. The GNRB arthrometer offers some technological as well as clinical advances. It allows pressure control of the patella, control of the load on the calf and control of hamstring muscle activity. Knee anterior laxity is measured by the GNRB knee arthrometer through computer software which is controlled by the examiner.

Key words: knee anterior laxity, anterior cruciate ligament, laxity assessment;

Introduction

The measurement of knee anterior laxity is regarded as an important part of the clinical examination of knee joints when assessing the integrity of the anterior cruciate ligament in injured knees as well as after anterior and posterior cruciate ligament reconstruction (Andersson and Gillquist 1990; Puh et al. 2014; Sernert et al. 2004). Since knee anterior laxity is also one of the significant risk factors for anterior cruciate ligament injuries (Myer et al. 2008; Uhorchak et al. 2003; Woodford-Rogers et al. 2004) and traumatic knee injuries (Vauhnik et al. 2008), measurement of knee anterior laxity is important as a screening tool for identification of those who are at greater risk for anterior cruciate ligament injury. This is particularly important among athletes who are generally at greater risk to sustain anterior cruciate ligament injury as compared to non-athletes. Knee ligament injury is a devastating injury for an athlete with short and long-term consequences.

The GNRB knee arthrometer is a new, recently available knee arthrometer for measuring knee anterior laxity. It offers some technological as well as clinical advances as compared to others arthrometers. It allows pressure control of the patella, control of the load on the calf and control of hamstring muscle activity. The GNRB is the abbreviation of the company name GeNouRoB (GeNouRoB SAS, Montenay, France) which developed this knee ligament arthrometer. The GNRB is a device that measures the anterior translation of the tibia at 20 ° of flexion. The leg rests on a shell which can be adapted to the length of each subject's leg and the foot is held at a rotation of 0 °. An electric pressure pad exerts several levels of pressure on the calf, at the

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1）*Biomechanics Laboratory, Faculty of Health Sciences, University of Ljubljana, Slovenia*
2）*Arthron, Institute for Joint and Sports Injuries, Slovenia*

examiner's discretion between 0 and 300N. Surface electrodes applied to the posterior surface of the thigh ensure that there is no hamstring muscle activity for the knee being tested. A motion sensor records the anterior translation of the tibia in relation to the femur. This arthrometer attempts to offer additional characteristics that may improve testing as compared to other arthrometers such as the KT. In particular, its robotic nature heightens the possibility that known loads will be applied at a consistent speed and direction to the lower leg while the proximal segment is stabilised at known forces with this occurring consistently. Additionally, this test system includes electromyography (EMG) as a method to ensure relaxation of the surrounding musculature.

Results from the developers of the GNRB indicated that GNRB has better reliability than the KT (Robert et al. 2009). Similarly, Collette et al. (2012) concluded that the reliability of the GNRB is superior to the KT. In clinical settings, where arthrometers are mainly used by different examiners, knowing the reliability between different examiners is crucial in order for the results from different examiners to be accurately interpreted and the limitations fully understood. The purpose of the present study was to evaluate reliability between examiners when using the GNRB knee arthrometer.

Methods

Knee anterior laxity in both knees was tested with a GNRB arthrometer in a group of 28 subjects (12 males and 16 females) aged between 20 and 40 years (average 26.3 years and standard deviation 6.3 years). None of the subjects had a knee injury that required medical attention. The study was approved by the Slovenian Medical Ethics Committee (164/07/13). Informed written consent was obtained from all subjects in the study. Subjects attended one test session on one day and both examiners tested them with at least a 30 minute interval between the tests. Their age, body mass, body height, and leg dominance (leg used to kick a ball) were recorded prior to the arthrometer testing. Knee anterior laxity was measured at five test forces (67N, 89N, 134N, 200N and 250N) as suggested by the manufacturer of GNRB in the Reference, Maintenance and User's Guide. The two examiners were third year physiotherapy students. Prior to undertaking the study, the students had a month's training in how to use the GNRB knee arthrometer. The leg to be tested first and the examiner who should test first were determined randomly. The GNRB arthrometer was applied to the leg and it was activated by the examiner through computer software (Fig. 1). The subjects were then removed from the GNRB knee arthrometer and the GNRB arthrometer was then applied to the second leg and testing at 5 forces was repeated as described above. Reliability of the GNRB knee arthrometer was analysed with intraclass correlation coefficients (ICC) (2,1) using SPSS (SPSS for Windows 20).

Figure 1. GNRB knee arthrometer set up with subject positioning.

Results

The descriptive statistics for the subjects (N = 28; 12 males and 16 females) who participated in the study are presented in Table 1. All subjects, except three, were right leg dominant. Means, standard deviations and ranges from knee anterior laxity data from both examiners at all five forces are presented in Table 2. ICCs for knee anterior laxity for all five forces for right and left knees are summarised in Table 3. ICCs ranged from 0.77 to 0.92.

Table 1. Descriptive statistics of the subjects (N=28 (12 males and 16 females)).

	Mean	SD	Range
Age（yrs）	26.3	6.3	20 - 40
Body height（cm）	173.6	8.0	158 - 189
Body mass（kg）	66.3	12.5	50 - 103
BMI（kg/m^2）	21.8	2.5	18.6 - 28.8

Key: SD — standard deviation; BMI — body mass index;

Table 2. Means, standard deviations and ranges from knee anterior laxity data from both examiners at all five forces.

Force	Knee anterior laxity (mm) Examiner 1						Knee anterior laxity (mm) Examiner 2					
	Right knee			Left knee			Right knee			Left knee		
	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range
67N	2.7	0.9	1.1-4.6	2.9	0.9	1.5-5.1	2.6	1.0	1.3-5.3	2.4	0.7	1.1-3.5
89N	3.5	1.0	1.6-5.7	3.7	1.0	2.2-5.9	3.3	1.1	1.8-6.2	3.1	0.8	1.6-4.3
134N	5.0	1.2	2.5-7.5	5.2	1.1	3.4-7.4	4.8	1.2	2.9-7.8	4.5	0.9	2.4-5.9
200N	6.9	1.3	3.9-9.5	7.1	1.2	5.1-9.4	6.7	1.3	4.4-9.7	6.3	1.0	3.7-8.2
250N	8.2	1.3	5.1-10.7	8.4	1.2	6.4-11	8.0	1.3	5.4-10.9	7.6	1.1	4.8-9.7

Key: SD — standard deviation;

Table 3. Intraclass correlation coefficients (ICC) for knee anterior laxity for all five forces for right and left knee.

Force	Right knee		Left knee	
	ICC	95% CI	ICC	95% CI
67N	0.92	0.83-0.96	0.82	0.62-0.92
89N	0.93	0.84-0.97	0.82	0.61-0.91
134N	0.91	0.80-0.96	0.80	0.57-0.91
200N	0.90	0.78-0.95	0.79	0.54-0.90
250N	0.89	0.76-0.95	0.77	0.50-0.89

Key: CI — confidence interval;

Discussion

Measurement reliability can be defined as the degree to which measurement results are free from measurement errors. Possible measurements errors are: the measurement error due to the device, the measurement error due to the examiners and subjects, and the interactions between these errors. In the present study, the measurement error due to the different examiners was studied. ICCs ranged from 0.77 to 0.92, indicating moderate to excellent reliability of the use of the GNRB knee arthrometer between examiners. ICCs for knee anterior laxity were lower for left knees as compared to the right knees. Sernert et al. (2004) compared right and left knee anterior laxity data in a group of anterior cruciate ligament reconstructed subjects and in a group of healthy controls. They found significantly greater knee anterior laxity in the right knees compared with left knees preoperatively and 2 years after anterior cruciate ligament reconstruction as measured with the KT1000, with similar findings in healthy control subjects. They have suggested that the hand dominance of the examiner might have influenced the results of the KT measurements. Their examiner was right handed. However, using anterior cruciate ligament reconstructed subjects may have invalidated some, if not all, of their results. That is, differences in knee laxity between right and left knees in anterior cruciate ligament reconstructed subjects are more likely to be a result of the laxity-altering anterior cruciate ligament injury and surgery rather than the hand dominance of the examiner. However, since similar results were also found in healthy controls, their results indicate that KT arthrometer results might be dependent on the hand dominance of the examiner. In their later study, Sernert et al. (2007) found that left hand dominant physiotherapists measured significantly higher laxity values in the left knee and right hand dominant physiotherapists measured significantly higher laxity values in the right knee ($p < 0.001$). When measuring knee anterior laxity with the KT arthrometer on the right knee, the right hand pulls the force handle while the left hand stabilises the patella pad. On the left knee, the left hand pulls the force handle and the right hand stabilises the patella pad. It is therefore possible that a right-handed examiner would produce greater knee anterior laxity results on the right knee as compared to the left knee because a right-handed examiner is more likely to be stronger and more skilful with the right hand. In the same way, a left hand dominant examiner would produce greater knee anterior laxity results on the left knee as compared to the right knee because the left-handed examiner is more likely to be stronger and more skilful with the left hand. Whether hand dominance is also related to the reliability of right and left knee anterior laxity measurements was not studied. Nevertheless, hand dominance might influence measurements of the KT knee arthrometer, while this is less likely to be true for the GNRB knee arthrometer. The GNRB knee arthrometer is a robotic device where force is not applied manually but using software that is connected to the

GNRB machine. On the other hand, the sensor for measuring knee anterior laxity is fixed: when measuring the knee anterior laxity of the right knee it is applied on the lateral part of the knee joint, while when measuring the knee anterior laxity of the left knee it is applied to the medial part of the knee joint. This might be a reason for differences in reliability of right and left knee anterior laxity measurements.

Previous studies which examined the reliability of the GNRB knee arthrometer between examiners did not use the same statistical analysis as the present study (Robert et al. 2009; Collette et al. 2012; Vauhnik et al. 2014). Robert et al. (2009) reported a good reliability between examiners using variance analysis. Since their analysis and results are not clearly presented, a comparison of their results with the present study cannot be performed. Similarly, the results by Collette et al. (2012) are also not clearly presented. They reported no "examiner effect" when using the GNRB knee arthrometer. However, since they have reported only mean values and standard deviations of the measurements by the examiners, comparison with the present study is not possible. A study by Vauhnik et al. (2014) reported ICC values and the ICC values ranged from 0.220 to 0.424. These ICC values are lower than values reported in the present study (ICCs from 0.77 to 0.92). However, Vauhnik et al. (2014) considered force on the patella during measurements of knee anterior laxity for calculating ICC values, while in the present study this was not the case. Regardless of the lower ICC values, no statistically significant differences in average knee anterior laxity between examiners ($p > 0.3$) were reported (Vauhnik et al. 2014), a finding which agrees with the results of the present study.

Conclusions

Measurements of knee anterior laxity with the GNRB knee arthrometer are reliable when performed by two examiners. The GNRB knee arthrometer is a newly available arthrometer for measuring knee anterior laxity which allows control of the pressure on the patella, control of the load on the calf and control of hamstring muscle activity. It also offers measurements of knee anterior laxity with forces up to 300N and therefore offers more precise information about the integrity of the anterior cruciate ligament.

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