

Research article/Raziskovalni članek

# INTRA-RATER RELIABILITY OF USING KT 2000 COMPUKT FOR MEASURING ANTERIOR TIBIAL TRANSLATION

ZANESLJIVOST POSAMEZNIKA PRI UPORABI KT 2000 COMPUKT ZA MERJENJE SPREDNJEGA PREMIKA GOLENICE

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**Key words:** anterior cruciate ligament; arthrometer; intra-class correlation coefficient (ICC); knee joint; laxity

**Abstract** – Background. *To examine intra-rater reliability of the KT 2000 CompuKT use in a clinical setting.*

**Methods.** *Fourteen healthy subjects of mean age  $34.5 \pm 5.68$  years participated in the reliability study. Anterior tibial translation was measured using the KT 2000 CompuKT knee ligament arthrometer at 20 lb, 25 lb and 30 lb forces. Measurements were performed three times on each knee, one day apart and were averaged for statistical analysis. Statistical analysis was performed using SPSS (SPSS for Windows 8).*

**Results.** *Intraclass correlation coefficients were 0.83 and 0.88 for 20 lb, 0.92 and 0.93 for 25 lb and 0.95 and 0.93 for 30 lb for right and left knee, respectively.*

**Conclusions.** *Results demonstrated high intra-rater reliability for use of the KT 2000 CompuKT in clinical settings.*

**Gljučne besede:** artrometer; korelacijski koeficient (ICC); kolenski sklep; ohlapnost; sprednja križna vez

**Izvleček** – Izhodišča. *Meritve sprednjega premika golenice so pomemben del kliničnega pregleda kolenskega sklepa za oceno integritete sprednje križne vezi. Poškodba sprednje križne vezi je ena najpogostejših športnih poškodb s kratkotrajnimi in dolgotrajnimi posledicami in zato je pravilna in natančna ocena integritete sprednje križne vezi izrednega pomena. Ena izmed objektivnih metod za oceno integritete sprednje križne vezi je uporaba kolenskega artrometra. Artrometer meri relativno gibanje med dvema senzornima ploščama, pri čemer je ena stabilizirana na pogačici in druga pa na golenici.*

*Namen raziskave je bil ugotoviti zanesljivost posameznika pri uporabi KT 2000 CompuKT kolenskega artrometra.*

**Metode.** *V raziskavi je sodelovalo 14 zdravih preiskovancev, starih od 26–47 let (povprečje = 34,5; SD = 5,68). Antropometrične meritve preiskovancev so prikazane v razpredelnici 1. Vsak od preiskovancev je pred pričetkom testiranja podpisal pristopno izjavo, v kateri so bili navedeni cilji in postopek testiranja. Raziskava je bila odobrena s strani Medicinske etične komisije Univerze v Ljubljani in etične komisije Univerze v Londonu (King's College London). Meritve sprednjega premika golenice so bile opravljene na vsakem kolenu posebej, pri treh različnih silah, 20 lb, 25 lb in 30 lb. Testiranje je potekalo po standardiziranem protokolu, kot je zapisano v navodilih proizvajalca KT artrometra. Meritve so bile ponovljene trikrat na vsakem kolenu. Med prvim in drugim testiranjem je bil en dan. Za statistično analizo so bila uporabljena povprečja treh meritev. Zanesljivost posameznika pri uporabi KT 2000 CompuKT je bila analizirana s pomočjo korelacijskega koeficienta v programu SPSS (SPSS for Windows 8).*

**Rezultati.** *Korelacijski koeficient (ICC) za sprednji premik golenice je bil 0,83 in 0,88 pri sili 20 lb, 0,92 in 0,93 pri sili 25 lb ter 0,95 in 0,93 pri sili 30 lb za desno in levo koleno posebej. Rezultati povprečnih vrednosti in rezultati korelacijskih koeficientov so prikazani v razpredelnicah 2, 3 in 4.*

**Zaključki.** *Rezultati zanesljivostne študije so pokazali visoko zanesljivost posameznika pri uporabi KT 2000 CompuKT. KT*

*artrometer je pogost kliničen instrument za oceno integritete sprednje križne vezi in tako je izrednega pomena zanesljivost rezultatov, pridobljenih s pomočjo KT artrometra. KT 2000 je računalniška nadgradnja artrometra KT 1000. Računalniški program omogoča takojšen grafičen prikaz krivulje odmikov golenice in takojšnjo računalniško obravnavo le-teh podatkov.*

## Introduction

The measurement of anterior tibial translation is regarded as an important part of the clinical examination in anterior cruciate ligament intact and deficient knees as well as after anterior cruciate ligament reconstruction (1, 2). The anterior cruciate ligament injury is one of the most traumatic sport injuries with short and long-term disability (3). Therefore, it is of crucial importance to accurately assess the integrity of the anterior cruciate ligament not only to reduce the incidence of an acute injury, but also to prevent commonly occurring secondary knee disorders, such as osteoarthritis, which can reduce independence and affect quality of life. The integrity of the anterior cruciate ligament in the unloaded knee can be assessed and examined with a knee arthrometer. One commonly used knee arthrometer, the KT, detects the relative motion (displacement) between two sensor pads, one on the patella and the other on the tibial tuberosity and measures the amount of anterior and posterior tibial translation. The knee should be flexed sufficiently between 20 and 30 degrees for the patella to engage with the femoral trochlea, and tibial rotation should not be constrained. If this is the case, then anterior tibial translation will be significantly diminished. Fiebert et al. (4) showed that statistically significant differences in tibial translation exist based upon the position of the tibia in neutral, internal (IR) and external rotation (ER) using the KT knee arthrometer. With IR of the tibia, anterior translation was limited and gave lower readings when compared with neutral and ER of the tibia. Thus the position of the leg is important when using the KT 1000 to assess ACL integrity. It was also concluded that the intra-rater reliability was good only for the neutral position, and was poor for the IR and ER positions.

Accurate KT arthrometry depends on adequate stabilisation of the patella in the femoral trochlea. Varying the pressure on the patellar sensor pad, with the alteration of patellar and pre-patellar soft tissue compression, can affect the amount of tibial translation. A knee effusion makes the stabilisation of the patella difficult as the joint fluid allows the patella to float and thus it does not adequately engage the femoral trochlea, despite the examiner's effort to stabilise the patella. A mid-patellar circumference difference between the injured and uninjured knees of 1cm or more should be aspirated before KT measurements, as measurements with 1 cm or more of oedema will not be accurate (5).

The tibial translation resulting from an external force depends on the level of the force and on the point of application and direction of that force (6). An application of increased force produces increased anterior tibial translation. Highgenboten et al. (7) reported the statistical interaction between the pounds of force and injury status of the knee. As force increased the difference in anterior tibial translation between the normal and ACL disrupted knees increased. In addition, as force increased, anterior tibial translation increased at a greater rate in the ACL disrupted knees than in the normal knees. Most of these factors are tester dependent and their effect can be minimised with testing experience and by strictly following a sound test protocol.

In the present study intra-rater reliability of the KT 2000 CompuKT use was assessed with Intraclass Correlation

Coefficients (ICC) model 3 (8) as this model is appropriate for testing intra-rater reliability with multiple scores from the same rater. The Intraclass Correlation Coefficients is currently the recommended convention for quantifying measurement reliability (8), as it reflects both correlation and agreement. The ICC ranges from 0.00 to 1.00 and it is calculated using variances estimates obtained through an analysis of variance. It reflects both degree of correspondence and agreement among ratings.

## Methods

Intra-rater reliability of the KT 2000 CompuKT Knee Ligament Arthrometer (Figure 1) was tested on 14 healthy women by 1 examiner. 14 subjects were considered sufficient conditions with adequate power (90% at  $p < 0.05$ ) (9). None of the subjects had a recent (last six months) history of lower leg injury that required medical attention or they had an ACL reconstruction surgery. Physical characteristics of the subjects are reported in Table 1. All subjects were required to give informed written consent for participating in the study. Committee for Medical Ethics at University of Ljubljana and Ethics Committee at King's College London approved the proposed study. Anterior tibial translation measurements were performed as advised by the manufacturer in the Reference, Maintenance and User's Guide for Knee Ligament Arthrometer (MedMetric, San Diego, CA, October, 1996).



Figure 1. KT 2000 CompuKT.

Sl. 1. Artrometer KT 2000 CompuKT.

Subjects lay in a supine position with their hands at their side on the examination table. A thigh support platform was placed under both legs at a level proximal to the popliteal space. Then knee flexion angle was measured with a goniometer. Foot support platform was placed under both feet of the subject at a level distal to the lateral malleolus. A velcro thigh strap was placed around the thighs to prevent excessive hip external rotation. A Knee Ligament Arthrometer was placed on the anterior aspect of the tibia in a way that the joint-line arrow aligned with

Table 1. *Physical characteristics of the subjects (N = 14).*

Razpr. 1. *Splošni podatki o testirancih (N = 14).*

Characteristics Podatki	Mean Povprečje	SD	Range Rang
Age (yrs) Starost (leta)	34.5	5.68	26-47
Mass (kg) Telesna teža (kg)	63.9	10.02	54-88
Height (cm) Telesna višina (cm)	168.5	5.07	164-178
BMI (kg/m <sup>2</sup> ) Indeks telesne teže (kg/m <sup>2</sup> )	18.92	2.58	16.27-25.14

Key: SD - standard deviation / standardna deviacija (standardni odklon).

the joint line of the knee. The Knee Ligament Arthrometer was rotated in a way that a pressure of the sensor pad stabilised the patella. The joint line arrow was always checked for the level of the joint line and the pressure on the patella was checked for the stabilisation of the patella in the femoral trochlea. To induce a relaxation response in the muscles the proximal part of the calf muscle was manually oscillated several times. Prior to each data collection the zero and testing reference position was tested as advised by the manufacturers. Anterior tibial translation was tested with the knee between 20° and 30° of knee flexion and with the foot in the neutral position. Measurements of knee anterior tibial translation (ATT) were performed at 20 lb, 25 lb and 30 lb forces, and were repeated three times per session with the three values averaged. Testing occurred in two sessions, one day apart. Means and standard deviations for ATT measured at the three forces were calculated for both knees.

**Results**

Means and standard deviations are summarised in Table 2 and Table 3. Anterior tibial translation ICCs are summarised in Table 4.

All ICCs except the ICCs for 20 lb are higher than 0.90 which is considered indicative of highly reliable clinical measurement protocols (8).

**Discussion**

These reliability data are comparable to other similar studies (10, 11) and demonstrate high intra-rater reliability for the KT 2000. One possible reason for the lower ICCs score at 20 lb could be the skin movement underneath the patella sensor pad. Stabilisation of the patella sensor pad starts at 20 lb and stays constant through pulling at 25 lb and 30 lb force. An ability to apply consistent pressure to the sensor plate to stabilise the patella sensor pad, as well as the magnitude of force application was reported to be associated with hand dominance. Sernert et al. (2) suggested that hand dominance of the examiner might influence the results of the KT measurements. They reported a significant increase in anterior tibial translation in right knees compared with left knees in ACL injured, ACL reconstructed and as well as in healthy subjects. The examiner was right-hand dominant. Similarly, the examiner in the present study was right-hand dominant and mean values of anterior tibial translation were greater at the left knees as compared to the right knees.

The position of force application when using the KT arthrometer should be at the tibial tuberosity. Taking into consideration the tibia length, position of the patella and position of the tibial tuberosity in each individual, variations in positioning of the KT can occur and thus affect the amount of anterior tibial translation. Hurley and co-workers (12) examined the

Table 2. *Means and standard deviations (SD) of the anterior tibial translation (mm) for the right knees at 20, 25 and 30 lb test forces, respectively.*

Razpr. 2. *Povprečne vrednosti in standardni odkloni (SD) sprednjega premika golenice za desna kolena pri silah 20 lb, 25 lb in 30 lb.*

Force Sila	Right knee Desno koleno					
	Mean 1 Povprečje 1	SD 1	Range 1 Rang 1	Mean 2 Povprečje 2	SD 2	Range 2 Rang 2
20 lb	1.4	0.3	1.0-1.9	1.5	0.3	1.0-1.9
25 lb	1.9	0.4	1.2-2.6	1.9	0.4	1.2-2.3
30 lb	2.5	0.6	1.7-3.5	2.5	0.5	1.4-3.4

Table 3. *Means and standard deviations (SD) of the anterior tibial translation (mm) for the left knees at 20, 25 and 30 lb test forces, respectively.*

Razpr. 3. *Povprečne vrednosti in standardni odkloni (SD) sprednjega premika golenice za leva kolena pri silah 20 lb, 25 lb in 30 lb.*

Force Sila	Left knee Levo koleno					
	Mean 1 Povprečje 1	SD 1	Range 1 Rang 1	Mean 2 Povprečje 2	SD 2	Range 2 Rang 2
20 lb	1.6	0.3	0.8-1.9	1.6	0.3	1.0-2.0
25 lb	2.0	0.3	1.2-2.4	2.0	0.3	1.5-2.3
30 lb	2.6	0.4	1.8-3.3	2.5	0.4	1.7-3.2

Table 4. *Anterior tibial translation (ATT) ICCs for right and left knees at 20, 25 and 30 lb, respectively.*

Razpr. 4. *Korelacijski koeficienti (ICC) za merjenje sprednjega premika golenice v desnem in levem kolenu pri silah 20, 25, 30 lb.*

Force Sila	ICC right knee ICC desno koleno		ICC left knee ICC levo koleno	
	20 lb	0.83 95% CI (0.46-0.94)	0.88 95% CI (0.60-0.96)	
25 lb	0.92 95% CI (0.74-0.97)	0.93 95% CI (0.78-0.98)		
30 lb	0.95 95% CI (0.85-0.98)	0.93 95% CI (0.79-0.98)		

Key: CI - confidence interval / interval zaupanja, ICC - intraclass correlation coefficient / korelacijski koeficient

influence of hand placement during the Lachman test technique on anterior tibial displacement. Their result suggested that »distal« tibial hand placement alters tibial displacement during the Lachman test. The more proximal force application, regardless of the magnitude of force application, consistently resulted in greater anterior tibial displacement. Using the more distal hand placement may not stress the ACL sufficiently in order to accurately assess anterior tibial displacement.

Another very important factor when using KT is examiner's experience. In the study by Berry and co-workers (13) the ICC for novice examiners was 0.65 and the error was ± 3.52 mm, and ICC for experts was 0.79 with the error ± 2.94 mm. The examiner in the present study had two years of previous experience working with KT as well as experience working with Knee Signature System (KSS). In addition, all ICC values were greater than 0.80.

KT arthrometer is commonly used in clinical settings and therefore it is of crucial importance to establish a high reliability of testers prior to usage. Only then KT knee arthrometer can be used as either a diagnostic tool to assess integrity of the anterior cruciate ligament or as an evaluation tool after anterior cruciate ligament reconstruction.

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