# INTRA-RATER RELIABILITY OF MEASURING ANTERIOPOSTERIOR STABILITY OF KNEE JOINT USING KT-2000 ARTHROMETER

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## INTRODUCTION

Knee ligament arthrometer is used frequently to quantify anterioposterior (A-P) displacement of the knee joint in the individuals suspected with injury of anterior cruciate ligament (ACL) or posterior cruciate ligament (PCL). Previous studies had examined the reliability and validity of some parameters visual-read from the dial of KT-1000, including anterior displacements at 15lb, 20lb and 30lb loadings, side-to-side difference at 20lb and posterior displacement at 30lb. The major advance of KT-2000 from KT-1000 was to provide analogue output, which can transmitted to a plotter or a computer [1].It allows us to obtain more information regarding to the mechanical property of ACL and PCL. However, the agreement of visual-read and computerized-extracted results has not been established. Besides, the reliability of many parameters calculated from the analogue output has not been documented. The purposes of this study were to establish clinical validity of the computed results by comparing to the visual-read, and to evaluate the intra-rater reliability of the computed parameters from the force-displacement diagram in healthy subjects.

## METHODS

Forty-two healthy young subjects (21 males and 21 females) were enrolled voluntarily. Each subject was evaluated with KT-2000 arthrometer (MedMetric Co., USA) to measure the laxities of both knees at 30° and 90° of knee flexion. A testing trial is necessary to ensure relaxation of the subject and obtain the starting reference position after installation of the arthrometer for each condition. A successful trial consisted of anterior pull then posterior push both up to 30lb, and ending with the dial returning to ± 0.5 mm of the starting reference position. Three successful trials were collected for each condition. During the testing, the force and displacement data were recorded via an A/D card (IO tech, DaqCard 216B) to a laptop computer with sampling rate of 1000Hz. The data were then analyzed with a self-design MATLAB program (MathWorks, USA) by fitting the force-displacement curve with 5-order polynomial [2]. Specific parameters were further extracted from each curve, including maximal anterior displacement (Max AD), maximal posterior displacement (Max PD) and anterior side-to-side difference at 20lb (ASSD20) , posterior side-to-side difference at 20lb (PSSD20), and compliance indices of 15 to 30lb and 15 to 20lb in both anterior and posterior directions (ACI20, ACI30, PCI20, and PCI30). Interclass correlation coefficient (ICC) analysis was used to compare the vision-read and computed maximal displacements and to examine the intra-rater reliability of the specific parameters of the force-displacement diagram. The statistical significance level is set at 0.05. To further examine the reproducibility of three trials, root-mean-squared error (RMSE) between the fitted curves in anterior loading phase and posterior loading phase were also calculated.

## RESULTS AND DISCUSSION

In clinical, visual-read results mainly included the maximal displacements in both anterior and posterior direction. By comparing these reading with the computed results, all parameters demonstrated high level of agreement with ICC range from 0.86 to 0.99 (Table 1). It suggested that our computed results possessed good clinical validity.

**Table 1:** The ICC between visual-read and computed results

| | Max AD 30 | Max AD 90 | Max PD 30 | Max PD 90 |
|---|---|---|---|---|
| **R't 30 °_ 1** | 0.97 * | 0.93 * | 0.97 * | 0.97 * |
| **R't 30 °_ 2** | 0.96 * | 0.96 * | 0.98 * | 0.97 * |
| **R't 30 °_ 3** | 0.96 * | 0.96 * | 0.95 * | 0.95 * |
| **L't 30 °_ 1** | 0.96 * | 0.89 * | 0.97 * | 0.94 * |
| **L't 30 °_ 2** | 0.97 * | 0.90 * | 0.99 * | 0.90 * |
| **L't 30 °_ 3** | 0.95 * | 0.87 * | 0.96 * | 0.86 * |

* $p<0.05$

In the intra-rater reliability analysis, all specific parameters were high reliable (Table 2). These computed results included not only the documented parameters but also extra information in the force-displacement diagram regarding the mechanical property of the knee ligaments. In addition, the mean RMSE of 5-order polynomial curves in anterior loading phase (1.42 ± 0.79 mm) and posterior loading phase (2.38 ± 1.50 mm) were also very small. In the further study, we will compare the interrater reliability and try to evaluate the injured knees. It is hoped these information can be used to assist clinical diagnosis of the type of ACL and PCL injury.

## CONCLUSIONS

The computed results from the analogue output of KT-2000 have clinical validity and high level of intra-rater reliability. This method can be a valid and reliable tool for further clinical application.

## REFERENCES

1. Vauhnik, R., et al. *Zdrav Vestn,* **74**, 285-288, 2005.
2. Maitland, M. E. , et al. *Clin.Biomech,* **10**, 93-97, 1995.

**Table2:** The ICC of intra-rater comparison (* $p<0.05$)

| | Max AD | Max PD | ACI30 | ACI20 | PCI 30 | PCI20 | ASSD20 | PSSD20 |
|---|---|---|---|---|---|---|---|---|
| **R't 30 °** | 0.99 * | 0.99 * | 0.97 * | 0.94 * | 0.95 * | 0.94 * | 0.76 * | 0.91 * |
| **L't 30 °** | 0.99 * | 0.99 * | 0.94 * | 0.95 * | 0.93 * | 0.95 * | | |
| **R't 90 °** | 0.99 * | 0.99 * | 0.81 * | 0.95 * | 0.93 * | 0.96 * | 0.94 * | 0.90 * |
| **L't 90 °** | 0.98 * | 0.98 * | 0.75 * | 0.95 * | 0.93 * | 0.94 * | | |