

RELIABILITY OF A TECHNIQUE FOR DETERMINING SAGITTAL KNEE GEOMETRY FROM LATERAL KNEE RADIOGRAPHS

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INTRODUCTION

Over the years, several techniques have been proposed to quantify the knee extension mechanism using radiographs. Among these techniques, the one proposed by Grood et al. (1984) is very appealing because it considers the lines of action of the patellar and quadriceps tendons relative to the tibiofemoral and patellofemoral contacts, respectively, in determining the effective moment arm of the quadriceps force (d_e). Although the application of this technique using radiographs has been reported, the detailed analysis procedures have not been described. The purpose of this study was to examine the reliability of an analytical procedure performed on knee radiographs that is based on the Grood technique.

METHODS

Five sagittal view knee radiographs were obtained from the left knees of 2 males and 2 females (age 18-22 yrs). The 5 X-rays were taken at different knee flexion angles (20° to 85° at intervals of 15°). To load the knee joint, the subject sat on a stool located next to an x-ray film and performed isometric knee extensions with maximal effort when the radiographs were taken. A metal pin with a length of 10.15 cm was placed on the anterior surface of the patella tendon for spatial reference.

Each radiographic image was analyzed by 7 analyzers (age 20-35 yrs) using the same procedures/instructions (Figure 1):

- a. Mark the ends of the linear scale (Points 1 and 2).
- b. Use Points 3 and 4 to define the line of action of the patellar tendon (Line 1).
- c. Points 5 and 6 define the posterior surface of the patella. The patellafemoral contact (Point 7) is a point located midway between Parallel Lines 1 and 2 on Line 2.
- d. Mark the distal attachment of the quadriceps tendon (Point 8) and establish the line of action of the quadriceps tendon (Line 3). Lines 1-3 should intersect at the same point (concurrent forces).
- e. Draw a line along the superior surface of the tibia (Parallel Line 3) and create 2 parallel lines that are tangent to the medial and lateral condyles of the femur (Parallel Lines 4 and 5) (Figure 2). Construct a line that is perpendicular to Parallel Line 3 and pass through the midpoint between Points A and C (Point B). The tibiofemoral contact is the midpoint between Points B and D.

The coordinates of the 12 points were used to determine d_e and other parameters (Table 1). For each radiograph, intraclass correlation coefficients (ICCs) were computed for combinations of 2-7 analysts.

RESULTS AND DISCUSSION

Overall, the high ICC values indicate an excellent inter-analyst reliability (Table 1). The results indicate that the new technique is reliable and can be used for both clinical

and research purposes. Because employing multiple analysts may not be feasible in some clinics and laboratories, we performed similar tests using fewer analysts. The average ICC values for 2-6 analysts combinations are comparable to those ICCs in Table 1 but the standard deviation slightly increased when fewer analysts were used. For example, the average ICCs for the 6- and 2-analyst combinations were 0.9985 ± 0.0003 and 0.9985 ± 0.0015 ,

respectively, for the 25° radiograph. It is our opinion that a single experienced analyst is sufficient for most applications.

However, 2-3 analysts are recommended for research purposes.

REFERENCE

Grood, E.S. et al. (1984). *J. Bone Jt. Surg.*, **66-A**, 725-734.

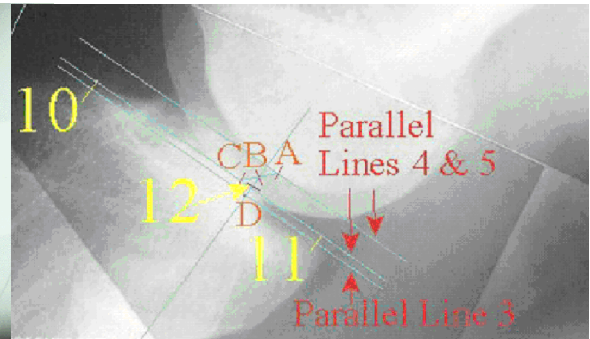
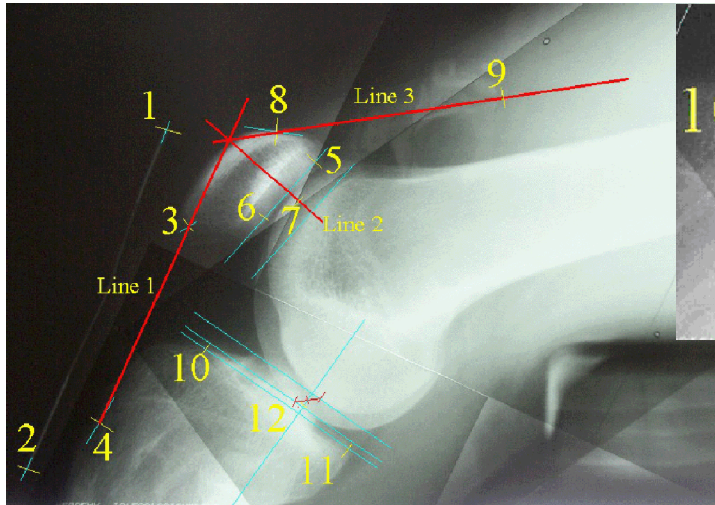


Figure 2. Tibiofemoral contact.

Figure 1. Points and lines identified on an X-ray.

Table 1. Means (standard deviations) and ICC values for 7 analysts.

Knee Flexion Angle (°)	Effective moment Arm (cm)	Patella Height Ratio	Patellar Tendon Length (cm)	Tibio-femoral Joint Space (cm)	Patello-femoral Joint Space (cm)	Patellar Mechanism Angle (°)	Patellar Tendon Angle (°)	ICC
25	4.43 (0.37)	0.48 (0.07)	4.46 (0.22)	0.46 (0.07)	0.50 (0.06)	150.8 (2.6)	17.6 (5.1)	0.9985
40	4.23 (0.22)	0.51 (0.06)	4.88 (0.22)	0.40 (0.10)	0.62 (0.16)	148.3 (6.3)	12.3 (1.8)	0.9980
55	4.16 (0.30)	0.55 (0.07)	5.52 (0.28)	0.49 (0.16)	0.66 (0.32)	124.6 (6.0)	16.7 (3.4)	0.9967
70	3.22 (0.31)	0.60 (0.05)	6.17 (0.23)	0.46 (0.14)	0.58 (0.14)	116.2 (4.4)	12.7 (3.8)	0.9974
85	3.24 (0.16)	0.55 (0.09)	5.26 (0.26)	0.54 (0.23)	0.68 (0.12)	111.2 (5.3)	12.0 (3.3)	0.9967