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Original Article

Intraobserver and intermethod reliability for using two different computer programs in preoperative lower limb alignment analysis

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ABSTRACT

Background and objective: Professional graphics editing programs can be used in the preoperative planning of lower limb deformity correction surgery. This study was conducted to test the reliability of using such programs versus FDA approved medical planning software.
Materials and methods: Thirty long standing lower limb radiographs had been selected. Two different computer programs (Adobe Photoshop) versus planning software (MediCAD) were used in the analysis of lower limb alignment. The following angles were measured twice:Lateral Proximal Femoral Angle (LPFA), mechanical Lateral Distal Femoral Angle (mLDFA), Joint Line Convergence Angle (JLCA), Medial Proximal Tibial Angle (MPTA), Lateral Distal Tibial Angle (LDTA) and Mechanical Axis Deviation (MAD). Intraclass correlation coefficient (ICC) was used to assess the intraobserver and intermethod reliability and the mean differences between measurements were calculated.
Results: Intraobserver and intermethod reliability scores were very good (>0.95) for all measurements. The highest reliability was for MAD (0.999). LPFA and LDTA had the highest variability and a range of intraobserver absolute difference up to 4.8° and 3.7° respectively.
Conclusion: Computer assisted lower limb alignment analysis is reliable whether using graphics editing program or specialized planning software. However slight higher variability for angles away from the knee joint can be expected.

1. Introduction

Computer assisted analysis of lower limb alignment offers many advantages including reduction of the total time required for planning, higher reliability and digital storage of images [1]. However, specialized FDA approved planning programs are not available in many institutions and are expensive [1]. On the other hand, reports describing the use of professional graphics editing programs (PGEPs) as Photoshop program do exist and may represent a good alternative [2–4]. None of these reports had already discussed the accuracy of using these graphics editing programs in the medical field.

Furthermore, many studies have tested the intraobserver and interobserver reliability of measuring the

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tibiofemoral angle using either manual or computer assisted methods [5–10]. Nevertheless, identifying the source and magnitude of lower limb deformities requires separate evaluation of different joint orientation angles. Few studies have discussed the intraobserver and interobserver reliability of manual and computer assisted lower limb alignment analysis with regard to the individual assessment of joint orientation angles [1,11]. Furthermore, sources of possible errors and variability in lower limb deformity analysis were not completely discussed.

1.1. Aim of the work

The aims of this study were twofold. The first was to evaluate the reliability (intraobserver and intermethod) of computer assisted lower limb alignment analysis using a professional graphics editing program (Adobe Photoshop version 9.0, Adobe System Incorporated, CA, USA) versus FDA approved medical planning software (MediCAD version 2.0, Hectec GmbH, Altfraunhofen, Germany). The second aim was to identify possible sources of error during digital methods of lower limb alignment analysis.

2. Materials and methods

Thirty long standing lower limb anteroposterior digital radiographs (14 right and 16 left sides) were chosen from our electronic database and were pasted directly to the planning software using standard Picture Archiving and Communication System (PACS) workstations. These radiographs were preoperative imaging studies used for planning of either deformity correction surgeries or total knee replacements. Two different computer programs were used for lower limb alignment analysis: Adobe Photoshop version 9.0 (Adobe System Incorporated, CA, USA) and MediCAD version 2.0 (Hectec GmbH, Altfraunhofen, Germany). The following angles were measured in each radiograph: LPFA, mLDFA, MPTA, JLCA and LDTA as well as measuring the MAD (Table 1) [12,13]. All measurements were repeated twice on 2 different occasions for each computer program. No two sessions of measurements had been done within the same day to avoid memorization of the results. The analysis was performed by a single orthopedic surgeon who has a special interest in dealing with professional graphics editing programs and who is also experienced in the field of deformity correction surgery (MK). All radiographs were taken using the same protocol. The X-ray tube was positioned 300 cm from the film. The hip and knee joints were fully extended while the patient was full weight bearing on both legs. The X-ray beam was centered at the level of the knee joint with the patella facing directly forward, centered between the femoral condyles. A spherical metal X-ray marker, 30 mm in diameter positioned at the same level of the bone, was used to calibrate the radiographs to the actual bone size.

Table 1
Nomenclature of joint orientation angles in the frontal plane mechanical axis planning [1,9].

Nomenclature of joint orientation angles	
LPFA	*Lateral Proximal Femoral Angle* The angle between the mechanical axis of the femur and a line between the tip of the greater trochanter and the center of the femoral head
mLDFA	*Mechanical Lateral Distal Femoral Angle* The angle between the mechanical axis of the femur and the distal femoral knee joint orientation line
MPTA	*Medial Proximal Tibial Angle* The angle between the mechanical axis of the tibia and the proximal tibial knee joint orientation line
LDTA	*Lateral Distal Tibial Angle* The angle between the mechanical axis of the tibia and the ankle joint orientation line
JLCA	*Joint Line Convergence Angle* The angle between the tangent through the two most convex distal points of the femoral condyles and a line along the flat portion of the subchondral bone of the tibial plateau
MAD	*Mechanical Axis Deviation* The distance between the mechanical axis of the whole lower limb and the knee center

2.1. PGEP assisted analysis

The details of using the Photoshop program in the analysis of lower limb alignment were already described by Shiha et al. [4] and we followed these same steps. The femoral head was elected using the elliptical selection tool and its center was identified with the free transform option. The distal femoral and proximal tibial knee joint orientation lines were drawn. The apex of the intercondylar notch and the midpoint between the tibial spines were used as references for the knee joint line midpoints, the femoral and tibial sides respectively. The ankle joint orientation line was drawn and its center was identified by the midpoint between the edges of the medial and lateral shoulders of the talus. The different lines of mechanical axis planning were drawn and the required angles were measured using the ruler tool. The diameter of the spherical metal marker was then measured and the magnification factor of the radiograph was calculated. MAD was measured and calculated according to the magnification factor (Fig. 1a).

2.2. MediCAD assisted analysis

For digital analysis using the MediCAD program, the radiographs were firstly calibrated using the spherical metal marker as a reference for the actual bone size. The center of the head of the femur was identified using (the 3 point circle) option of the program and the tip of the greater trochanter was marked. The distal femoral and the proximal tibial knee joint orientation lines and the ankle joint orientation line were drawn. The mid condylar point of the distal femur, the mid plateau point of the proximal tibia and the midpoint of the ankle joint were identified by the program at the same time. The program automatically generates all angles required for mechanical axis planning: LPFA, mLDFA, MPTA, LDTA, JLCA as well as MAD (Fig. 1b).

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