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Case Report

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Proposed Use of Digital Software in Outpatient Evaluation of Simple Lower Limb Rotational Deformities: A Case Report

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Abstract

Rotational deformities of the lower limbs, such as in-toeing, are common in children and adolescents and can affect function and quality of life. Objective gait assessment is essential to determine the extent of the deformity and plan surgical interventions, but traditional methods require expensive equipment and specialized personnel, limiting their use in the office setting.

Objective: To describe the usefulness of the Kinovea digital software as a complementary tool for the evaluation of simple rotational deformities of the lower limbs in the office setting, quantifying functional gait parameters before and after surgery.

Case presentation: We report the case of a 13-year-old female patient with in-toeing and bilateral femoral anteversion. The patient underwent bilateral proximal femoral derotational osteotomy with fixation using locking intramedullary nails. Gait was assessed pre- and postoperatively using Kinovea, recording angles and spatiotemporal parameters.

Discussion: Analysis with Kinovea allowed for the measurement of the gait progression angle, which became positive postoperatively, demonstrating the correction of the intrarotated gait and functional improvement. This free and easy-to-implement software allows for the objective documentation of gait parameters, offering an economical and accessible complement to advanced studies such as 3D laboratories or complex radiological imaging.

Conclusion: Kinovea is a reliable tool for the clinical evaluation of lower limb rotational deformities, facilitating surgical planning, functional follow-up, and communication with patients and their families. Its free availability and simplicity make it a valuable tool for daily clinical practice in reconstructive orthopedic surgery.

Keywords: Lower limb rotational deformities, Intoeing gait, Femoral derotation osteotomy, Gait analysis, Kinovea/Motion analysis software.

Introduction

In the reconstructive orthopedic surgery clinic of the CORECO unit (Central Western Orthopedic Reconstructive Surgery, by its Spanish acronym) it is common to see parents concerned about their children's gait, as well as adults who consult about progressive alterations that have developed over the years and that they finally wish to correct. The most common clinical manifestation in this group of patients is in-toeing or out-toeing gait (1).

Rotational deformities are common during childhood and, in most cases, simply represent a physiological variation in the growth pattern. When the deformities are symmetrical and are not accompanied by pain, joint stiffness, neuromuscular disorders, or systemic syndromes, they are usually considered benign conditions with an excellent long-

term prognosis. Conversely, the presence of asymmetrical deformities, associated with pain, stiffness, or systemic conditions, may indicate a pathology that requires detailed evaluation and, in some cases, surgical treatment (2–4). The study of kinematics forms the basis for the objective evaluation of gait, as it allows for obtaining quantifiable and comparable data between different subjects and time points, such as pre- and post-surgical assessment, training, development, and growth (3–5). Among the most rigorous and scientifically validated systems is the three-dimensional (3D) motion analysis laboratory, capable of providing highly accurate information (4–7). However, its use presents significant limitations: high cost, the need for highly trained personnel, and technical complexity, which restricts its availability in both research and everyday clinical practice.

Given these limitations, the use of accessible digital tools has become an attractive alternative. Among these, Kinovea stands out, a free and low-cost software for 2D motion analysis, developed in 2009 under the GPLv2 license thanks to the international collaboration of researchers, athletes, coaches, and programmers (2). Kinovea allows for the analysis of distances, angles, coordinates, and spatiotemporal parameters frame by frame from video recordings (2–4). Previous comparative studies, conducted in controlled environments such as gait laboratories equipped with high-end analysis systems and operated by expert personnel, have shown that Kinovea is a valid, accurate, and reliable tool as an intra-assessment method for obtaining angular data, distances, and biomechanical measurements (3–7). Its accuracy in angular and linear measurements, derived from the digitization of anatomical axes, has been documented and supports its clinical use (3).

In this context, and with the aim of disseminating a reliable, free, and accessible method to support the assessment of rotational deformities of the lower limbs, the use of Kinovea software is proposed as a complementary tool to traditional clinical and radiological evaluation**.**

Case Presentation

We present the case of a 13-year-old female patient referred for consultation due to a gait disturbance clinically characterized as in-rotation gait. Following the initial orthopedic evaluation, which included a detailed physical examination and complementary paraclinical studies, increased bilateral femoral anteversion was evident, a condition that explained her gait pattern and the functional limitations reported by the patient and her guardians.

During the preoperative physical examination (Figures 1A and 1B), significantly increased ranges of internal hip rotation were observed, with relative limitation of external rotation, a typical finding in pathological femoral anteversion.

Given the persistence of the symptoms, the magnitude of the deformity, and its functional impact, a bilateral proximal femoral derotation osteotomy was performed, with fixation using locked intramedullary femoral nails. This technique was selected for its stability, lower morbidity, and faster recovery compared to extramedullary methods (Figures 1C and 1D).

Figure 1: Preoperative physical examination. A. Prone position. B. Supine position. Postoperative radiographs. C. Right femur radiograph. D. Left femur radiograph.

As part of the functional assessment, Kinovea software was implemented for gait analysis both preoperatively and postoperatively, following a standardized protocol:

1. Gait recording: Recordings were made in the consultation room, in a straight, well-lit hallway with a homogeneous surface. The patient walked barefoot, at a self-selected speed, while being filmed using a smartphone.

2. Capture criteria: Consecutive gait cycles were recorded, selecting the one with the best foot visibility and minimal external interference. The camera remained fixed, perpendicular to the plane of gait. Footage was also taken in the supine position to evaluate internal and external rotation (Figure 2).

3. Analysis in Kinovea: The recordings were imported into the software, plotting a progression axis and a longitudinal axis of the foot during the stance phase. The preoperative gait progression angle (GPA) was -16.5°, indicating significant internal rotation (Figure 3). Postoperatively, the GPA became positive, reflecting correction of the intrarotated gait and normalization of the foot-progression axis. Additional parameters such as initial foot contact position, knee-foot relationship, and symmetry of the stance pattern were also recorded, allowing correlation between functional findings and anatomical deformity.

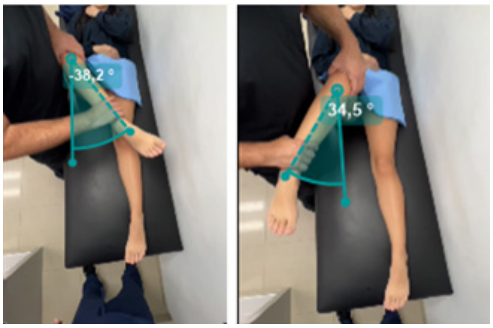

Figure 2: Postoperative physical examination. Evaluation of external and internal rotation of the hips.

The integration of Kinovea software allowed for the objective quantification of the deformity and its correction, demonstrating the patient's functional improvement and offering an accessible complement to the traditional clinical evaluation.

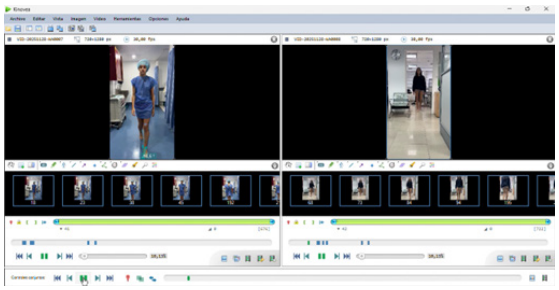

Figure 3: The pre- and postoperative gait progression angle analyzed with Kinovea.

Discussion

Gait assessment is a fundamental pillar in determining the origin and magnitude of rotational deformities of the lower limbs, always complementing the physical examination (1). These deformities, although frequently representing physiological variations of development, can

generate significant intrarotated gait patterns that affect the patient's function and quality of life (3). Accurate identification of the magnitude and type of rotation is essential for planning surgical interventions, such as proximal femoral derotational osteotomy, which has been shown to significantly improve intrarotated gait in pediatric and adult patients (4–5,8).

Traditionally, the objective quantification of rotational deformities is performed using costly and complex complementary studies, such as computed tomography, magnetic resonance imaging, or three-dimensional gait analysis laboratories, which require specialized personnel and expensive equipment. This limits its availability in outpatient settings and hinders immediate assessment during the consultation (6–7).

In this context, Kinovea software represents an accessible and reliable alternative for 2D gait analysis. Previous studies have demonstrated its validity and reliability in obtaining angles and distances using coordinates in multiple perspectives (2). Implementing Kinovea allows specialists to immediately perform objective measurements of hip rotation and gait progression angle without requiring expensive equipment, and to document gait patterns on video before and after the intervention. This tool facilitates communication with the patient and their family, showing the disorder and the correction achieved after surgery in real time.

The case presented demonstrates the clinical utility of Kinovea in outpatient practice. The patient showed a preoperative gait progression angle of -16.5°, indicative of significant intrarotated gait, which evolved to a positive value postoperatively, confirming the functional correction of the deformity through bilateral proximal femoral derotational osteotomy. This aligns with findings reported in the literature, where surgical correction of femoral anteversion improves intrarotated gait and lower limb function (4–5,8).

Furthermore, the use of Kinovea allows for the reproducible documentation of relevant clinical gait parameters, offering a cost-effective alternative to advanced and portable technologies, such as inertial sensors or three-dimensional analysis systems, whose availability and cost can be limiting factors in daily practice (6–7). In this sense, Kinovea serves as an immediate complement to the consultation, allowing for the quantification and communication of rotational deformity, intervention planning, and objective postoperative follow-up.

Conclusion

The use of Kinovea software in the evaluation of lower limb rotational deformities in the office setting constitutes an accessible, reliable, and easy-to-implement tool. It allows for the objective quantification of gait parameters, such as the angle of progression, and the video documentation of alterations before and after surgical intervention. In the case presented, Kinovea facilitated the identification of a significant intrarotated gait and demonstrated the functional correction achieved after bilateral proximal femoral derotational osteotomy, showing the progression to a positive angle of gait in the postoperative period. This result confirms the software's usefulness as a complement to traditional clinical assessment, optimizing surgical planning and functional follow-up.

In conclusion, the implementation of Kinovea in the office allows for an immediate, objective, and reproducible evaluation of rotational deformities, improving communication with the patient and their family, and constituting a valuable resource for specialists in reconstructive orthopedic surgery. Its free and low-cost nature makes it a practical option for clinical settings with limited resources.

Conflicts of Interest

I declare that none of the authors received funding for this study. We have no Conflicts of interest.

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