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ANALYZING HUMAN MOVEMENT: COMBINING XSENS AND ANYBODY TO EVALUATE THE PERFORMANCE OF KNEE SURGERY

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1 INTRODUCTION

The anterior cruciate ligament (ACL) stabilizes the knee, ensuring joint alignment [1]. Its rupture can lead to dysfunction and early degeneration, especially in athletes. Combined ACL and anterolateral ligament (ALL) reconstruction has shown improved outcomes, reducing graft failure and enhancing meniscal repair [2]. However, the role of ground reaction force (GRF) in these outcomes remains unclear, highlighting the need for further study. The main goal of this study is to compare two groups of patients who underwent ligament reconstruction: one with surgery on both the ACL and ALL, and the other only on the ACL.

2 METHODOLOGY

2.1 Data collection

In this study, post-operative data from 15 patients was collected using Xsens inertial sensors and processed with MVN Analyze software at the Level I Trauma Centre during walking, running, and stair climbing/descending. The cohort, aged 14–52 years, was evaluated between August and October 2023, an average of 16 months post-operation. Patients also completed the Knee injury and Osteoarthritis Outcome Score (KOOS) and International Knee Documentation Committee Subjective Knee Form (IKDC) questionnaires to assess pain, mobility, and quality of life. The KOOS score is 92.1 (±12.5), while the IKDC score is 88.3 (±9.4). These results indicate high scores, reflecting good knee functionality and recovery, with slightly greater variability in KOOS compared to IKDC.

2.2 Demographic information

Among the patients, 8 underwent ACL surgery, while the rest underwent ACL and ALL surgery. In terms of body mass index (BMI), ten patients had a normal weight, three were overweight, and two were classified as obese class I, according to the World Health Organization (WHO) criteria.

2.3 Data Processing and Analysis

The kinematic data collected during the physical activities was imported into the AnyBody Modeling System (AnyBody Technology A/S, Aalborg, Denmark) using the “BVH_Xsens” model to compute the GRF components: GRF X (medial-lateral), GRF Y (vertical), and GRF Z (anterior-posterior). The data was post-processed in Spyder to remove non-representative

segments, such as turns, and filtered to enhance quality. For each intervention type, normalized gait cycle graphs were generated to compare GRF components.

3 RESULTS AND DISCUSSION

The Figure 1 shows a comparison of the GRF in the medial-lateral and anterior-posterior directions for operated (red line) and non-operated (blue line) patients. Comparing the first two graphs, it can be seen that the addition of ALL reconstruction results in an increase in GRF. With regard to force in the anterior-posterior direction, it is expected that the graphs will show symmetry during gait, reflecting the patients' balanced movement pattern.

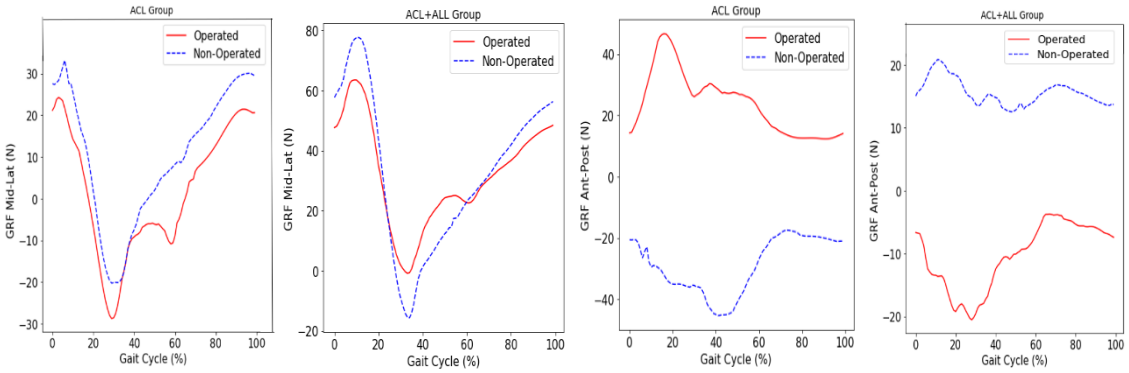

Figure 1-Representation of GRF in the medial-lateral and anterior-posterior directions of patients undergoing ACL reconstruction surgery and of both ACL and ALL ligaments.

The Shapiro-Wilk normality test was used to assess the distribution of data in relation to the groups of patients who underwent different types of surgery. The results showed that all the groups analyzed had non-normal distributions, with p-values of less than 0.05. Considering this non-normality, a non-parametric test would be necessary. Additionally, individual patient characteristics and rehabilitation conditions are essential for evaluating the success of interventions.

4 CONCLUSION

The results suggest that GRF assessment is a valuable indicator of the success of ligament reconstruction surgeries, particularly for clinical and functional recovery. However, as this is a cross-sectional study, further research is required to confirm the causal link between GRF changes and improved outcomes. To enhance post-operative analysis, electromyography (EMG) will be incorporated to measure muscle activation. Combining GRF and EMG data can provide a comprehensive view of knee recovery and muscle force reintegration, crucial for rehabilitation.

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