Frontal Plane Projection Angle Variance Explained by Hip and Knee Angles in People Returned to Sport Post-Anterior Cruciate Ligament Reconstruction

Ewan W Galloway[1], Chris Murphy[1], Nathan Urquhart[2], Cathy Coady[2], Scott Landry[3,4], Derek Rutherford[1,4]
[1]School of Physiotherapy, Dalhousie University, Halifax, Canada
[2]Faculty of Medicine, Dept. Orthopeadics, Dalhousie University, Halifax, Canada
[3]School of Kinesiology, Acadia University, Wolfville, Canada
[4]School of Biomedical Engineering, Dalhousie University, Halifax, Canada
Email: egalloway@dal.ca

Summary

This study investigates whether the frontal plane projection angle (FPPA), a 2D measurement, relates to 3D hip and knee movements during single-leg landings in individuals' post-anterior cruciate ligament reconstruction (ACLR). A strong relationship between peak FPPA and knee/hip movements across multiple planes was identified. Results suggest peak FPPA could serve as a practical tool for healthcare professionals to estimate 3D joint movements without expensive motion capture systems, facilitating assessment and rehabilitation for athletes post-ACLR.

Introduction

The FPPA, a 2D measure of the angles of the lower limb, has been related to 3D mechanics of the hip and knee during a single-leg drop landing in healthy individuals [1]. The FPPA has been projected onto individuals post- ACLR [2], however this relationship has not yet been established for these individuals. Researchers have assumed that movements of individuals post-ACLR are like those of individuals with no prior knee injuries, which may not be the case. The purpose is to investigate whether FPPA relates to hip and knee angles and moments during a single-leg drop landing in individuals post-ACLR.

Methods

Twenty-three individuals who had returned to unrestricted activities within two years of ACLR were recruited. Participants completed a single-leg drop landing, five times per leg, from a box height of 30 cm while lower limb motion and ground reaction forces were recorded at 150 Hz using retro-reflective markers and 2100 Hz using embedded force plates, respectively [3].

3D joint angles were calculated using Euler rotations and the FPPA was calculated by finding the angle between vectors created from the ankle joint centre, the knee joint centre and the greater trochanter. A positive FPPA was associated with knee valgus and negative FPPA with knee varus. Moments were determined using inverse dynamics. A linear regression model was used to determine the relation between the peak FPPA and the knee adduction moment, 3D angles of the knee and hips during a single-leg landing. Statistical significance was set to α = .05.

Results and Discussion

The overall model was a significant predictor of the peak FPPA during single-leg landing, (R^2 = 0.633, p = 0.016) with an adjusted R^2 = 0.462. These findings suggest that the model accounted for over 60% of the variance of the FPPA during a single-leg landing in individuals returned to sport post-ACLR. At peak FPPA, the major contributors to the model included knee adduction (R^2 = 0.300, p = 0.048), which had a negative relationship with the FPPA (Figure 1A) and although not significant hip internal rotation (R^2 = 0.158, p = 0.065) and hip flexion (R^2 = 0.115, p = 0.155) which both had positive relationships with the FPPA. Knee flexion, knee internal rotation, knee adduction moment and hip adduction contributed a small amount to the model (0.02%-2.87%). Knee adduction was the greatest contributor, however, there appears to bias in using the FPPA in relation to knee adduction, as can be seen in Figure 1B. The FPPA is on average 10° greater than the knee frontal plane angle.

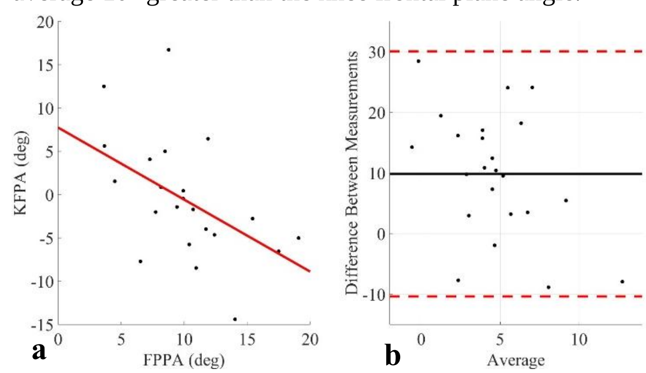

Figure 1 – (a) Scatter plot of the FPPA and knee frontal plane angle (KFPA) at peak FPPA (R^2 = .300), in which positive angles represent adduction and negative angles abduction. (b) Bland-Altman plot demonstrating the limits of agreement (95% confidence interval) between the FPPA and the knee adduction angle at peak FPPA.

Conclusions

Findings suggest that peak FPPA during a single-leg landing could be used as a tool to estimate the 3D movements of the knee and hip of individuals returned to sport post-ACLR. These findings suggest that the FPPA could be used by health care professionals to assume 3D movement at the knee without the need for 3D motion capture systems.

References

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