Comparison of Biomechanical Parameters Between Individuals With Patellofemoral Pain and Healthy Subjects

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Summary

This study explores the biomechanical and neuromuscular changes in individuals with patellofemoral pain (PFP). Four female PFP patients and four healthy controls participated in the study. The knee and ankle angles, muscle activations, and ground reaction forces (GRF) were measured during maximal isometric contractions in a semi-squatting position. The results revealed increased knee valgus and reduced ankle dorsiflexion in PFP patients compared to healthy controls. Additionally, the affected side's vastus medialis (VM) muscle showed lower activation, while the vastus lateralis (VL) muscle showed greater activation. These alterations suggest a compensatory mechanism contributing to joint instability and abnormal loading. The study highlights the importance of addressing these biomechanical and neuromuscular imbalances in PFP patients, emphasising the potential for targeted interventions to improve stability, reduce pain, and enhance functional outcomes. These findings provide insight into the underlying mechanisms of PFP and the need for personalised rehabilitation strategies.

Introduction

PFP is a common musculoskeletal condition that affects functional mobility and lower extremity biomechanics [1]. Understanding the biomechanical and neuromuscular alterations associated with PFP is critical for developing effective interventions [2]. This study investigated changes in GRF of the quadriceps muscle group on the affected and unaffected sides and differences or similarities in knee and ankle joint angles and muscle activation patterns in individuals with and without PFP. These findings aim to provide insights into the underlying mechanisms contributing to functional impairments in this population.

Methods

Four female right-sided PFP patients (mean age: 33.25 ± 5.50 years; mean height: 162.75 ± 8.05 cm; mean weight: 67 ± 8.52) and four healthy right-dominant female subjects (mean age: 34.50 ± 4.43 years; mean height: 164.75 ± 3.94 cm; mean weight: 58.25 ± 4.99 kg) participated in the study. The height of a 160 kg loaded bar resting on supports was adjusted so the participants' knee angle was 65 degrees in a semi-squatting position. Twenty reflective markers were placed bilaterally on the lower extremities, and surface electromyography (EMG) electrodes were placed on the VM and VL muscles. In three consecutive sessions, participants performed maximal isometric contractions to lift the bar on an AMTI force plate. Marker trajectories were recorded using a motion capture system. Knee and ankle joint angles were calculated utilising the OpenSim "gait2392_simbody" model [3].

Results and Discussion

In the PFP group (PFPG), there were increased knee valgus (VA) angles and less ankle dorsiflexion angles (DF) in both knees compared to the healthy group. The affected side VM muscle activation patterns were lower compared to the healthy group (HG), whereas VL muscle activations were higher (Table 1). The observed increase in knee valgus and reduced ankle dorsiflexion angles, combined with altered activation patterns of the VM and VL muscles in individuals with patellofemoral pain, suggest a compensatory mechanism that may contribute to joint instability and abnormal loading patterns, highlighting the need for targeted rehabilitation strategies to restore balanced muscle activation and optimise lower extremity biomechanics.

Conclusions

These findings emphasise the importance of addressing altered joint mechanics and imbalanced muscle activation patterns in individuals with PFP, underscoring the potential for targeted interventions to improve stability, reduce pain, and enhance functional outcomes.

References

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Table 1: The mean and standard deviations for VA, DF, VM, and VL of healthy and PFP groups.

	VA Right	VA Left	DF Right	DF Left	VM Right	VM Left	VL Right	VL Left
HG	-5.76±11.96	-7.78 ± 9.59	22.06 ± 3.13	18.51 ± 2.50	10.03±2.29	8.81 ± 3.40	7.69±1.38	9.87±2.88
PFPG	-10.54±7.87	-11.23±5.57	3.26 ±17.24	10.81 ± 3.28	6.82±2.42	7.58 ± 1.87	10.49±3.57	9.55±2.96
p value	0.686	0.686	0.114	0.029*	0.005*	0.713	0.060	0.671

*p<0,05; Mann Whitney U Test, HG: Healthy group, PFPG: Patellofemoral pain group, VA: Knee valgus angle, DF: Ankle dorsiflexion angle, VM: Vastus medialis, VL: Vastus Lateralis