

A COMPARISON OF PRE- AND POST-OPERATIVE THREE-DIMENSIONAL HIP KINEMATICS DURING LEVEL WALKING IN PATIENTS WITH CAM FEMOROACETABULAR IMPINGEMENT

Nicholas Brisson¹, Mario Lamontagne^{1,2}, Matthew Kennedy¹, and Paul Beaulé³

School of Human Kinetics, University of Ottawa, Ottawa, Canada¹
Department of Mechanical Engineering, University of Ottawa, Ottawa, Canada²
Department of Orthopaedic Surgery, University of Ottawa, Ottawa, Canada³

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INTRODUCTION: Cam femoroacetabular impingement (FAI) is an idiopathic progressive pathological condition of the hip joint characterized by an abnormal bony protuberance on the femoral head-neck junction (Beck, Leunig, Parvizi, Boutier, Wyss & Ganz, 2004). During the limits of hip range of motion (ROM), the protuberance jams into the acetabulum (Ganz, Parvizi, Beck, Leunig, Nötzli & Siebenrock, 2003), resulting in acute hip and groin pain (Beaulé, LeDuff, & Zaragoza, 2007). Impingement has also been shown to occur within normal ROM of the hip during basic tasks such as walking, reducing peak hip abduction angles as well as hip frontal and sagittal ROM (Kennedy, Lamontagne & Beaulé, 2009). Cam FAI primarily affects young and athletic males (Ganz, Parvizi, Beck, Leunig, Nötzli & Siebenrock, 2003), and is common in hockey, football, soccer, rugby, martial arts and tennis athletes (Philippon, Schenker, Briggs & Koppersmith, 2007). Restricted hip mobility during activities requiring low ROM suggests more pronounced limitations during demanding athletic tasks. Surgical procedures have been developed to remove the bony abnormality from the femoral head-neck junction with the objective of attenuating hip pain and restoring normal hip biomechanics, enabling athletes to return to sport. The purpose of this study is to assess the clinical outcome of cam FAI corrective surgery by comparing pre-operative and post-operative three-dimensional (3-D) hip kinematics during level walking.

METHOD: Five participants (4 males, 1 female) took part in the pilot study. Each participant was tested pre-operatively and post-operatively. Posttests were performed a minimum of 11 months following surgical intervention. All surgeries were performed by the same surgeon and involved the dislocation of the hip and debridement of the femoral head-neck junction. An infrared nine-camera high-speed motion analysis system (Vicon MX-13, Oxford Metrics, Oxford, UK) was used to capture the 3-D kinematics at 200 Hz. Participants wore form-fitting spandex shirt and shorts to reduce clothing artefact during motion trials. Retro-reflective markers were affixed to the participants according to a modified version of the Plug-in Gait marker set (Vicon, Oxford Metrics, Oxford, UK). First, a static calibration of the participants was performed to calculate the segment lengths and determine neutral joint positions. Then, participants performed five barefoot level walking trials at a self-selected pace. All five trials were averaged for each participant and then ensemble-averaged. A series of repeated measures analysis of variance (ANOVA) were conducted to compare pre- and post-operative hip kinematics values. Specifically, hip ROM in each plane as well as peak angular displacements in flexion/extension, abduction/adduction and internal/external rotation were assessed. Since multiple variables were compared, a Bonferroni adjustment was made for the α value. Therefore, the significance level for all statistical analyses was set at $\alpha \leq 0.0167$.

RESULTS: Hip angular displacements in the sagittal and frontal planes during level walking are displayed in Table 1. Statistical analyses revealed no significant differences between any of the pre-operative and post-operative hip kinematics values of interest, with p values ranging from 0.274 to 0.916.

Table 1. Hip Angular Displacements during Level Walking

Participant	Time	Peak Flexion	Peak Extension	Sagittal ROM	Peak Adduction	Peak Abduction	Frontal ROM
1	Pre	39.14°	-9.50°	48.63°	13.75°	-0.44°	14.20°
	Post	36.31°	-14.54°	50.85°	11.64°	-1.76°	13.40°
2	Pre	27.58°	-14.37°	41.93°	14.70°	1.44°	13.26°
	Post	27.03°	-11.53°	38.57°	11.29°	-1.14°	12.42°
3	Pre	30.58°	-16.86°	47.45°	5.84°	-7.50°	13.34°
	Post	27.17°	-17.18°	44.35°	7.23°	-5.33°	12.56°
4	Pre	31.14°	-17.82°	48.96°	6.44°	-6.42°	12.86°
	Post	34.09°	-19.44°	53.53°	11.25°	-7.13°	18.38°
5	Pre	30.01°	-13.31°	43.32°	11.19°	-5.02°	16.20°
	Post	34.73°	-10.60°	45.32°	11.32°	-9.97°	21.29°
Average	Pre	31.69°	-14.37°	46.06°	10.38°	-3.59°	13.97°
	Post	31.87°	-14.66°	46.52°	10.55°	-5.07°	15.61°
Standard Deviation	Pre	±4.38°	±3.28°	±3.22°	±4.09°	±3.89°	±1.34°
	Post	±4.42°	±3.72°	±5.86°	±1.86°	±3.70°	±4.01°

DISCUSSION: The objective of this study was to compare pre- and post-operative hip angular displacements during level walking, assessing the outcome of FAI cam impingement surgery. Kennedy, Lamontagne and Beaulé (2009) compared hip angular displacements during level walking between a group of 17 patients with cam FAI and a group of 14 healthy controls matched for age, sex and body mass index. The FAI group was found to have a lower peak hip abduction angle, a reduced hip frontal ROM and a slightly lower hip sagittal ROM during gait at a self-selected speed. These results suggest that corrective surgery for cam FAI should aim to restore these biomechanical parameters to within the normal range of values. Nevertheless, preliminary data from the current study show that peak hip angular displacements as well as hip ROM in each plane are not significantly different from those preceding surgery.

CONCLUSION: Pilot data indicate that corrective surgery for cam FAI does not restore hip kinematics to within a normal range of values during gait. Consequently, these results, perhaps transferable to more demanding athletic tasks, advocate that cam FAI debridement may not help athletes in returning to their normal sports practices. However, a larger sample is needed to solidify these findings, and more demanding activities need to be analyzed.

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