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Sliding distance during cam-type femoroacetabular impingement: quantification from in vivo data and assessment of in vitro effect.

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Introduction

- Cam impingement in the hip has been linked to pain and tissue damage.
- Damage to the cartilage and labrum is related to an increase in contact pressure caused by the cam moving into the acetabulum (Figure 1).
- Details of the damage mechanisms and the influence of individual mechanical factors are poorly understood.

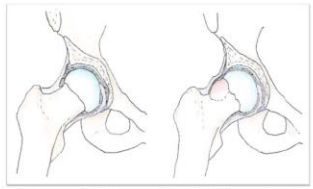


Figure 1: (Left) 'Normal' hip. (Right) Cam hip .

Aims:

(1) to use a parametric experimental natural hip simulation to assess the effects of sliding distance on damage to the acetabular surface,

(2) identify the cam sliding distance during impingement for different activities in the hip joint.

Findings

- Experimental results failed to generate damage and therefore alternative conditions are required to test whether sliding difference is a differentiating factor.
- Computational analysis revealed two activities with higher sliding distances than those represented experimentally and one activity with a lower sliding distance.

Experimental study to assess damage under different loads and motions

- 12 porcine hip joints were mounted into a single station hip simulator.
- Simulator inputs consisted of a single peak axial force (900N or 1130N) and dwell period. Angular sliding distance of +/-20° or +/-10° was applied (Figure 2).

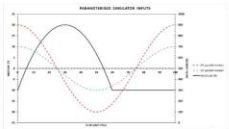


Figure 2: Experimental simulator inputs.

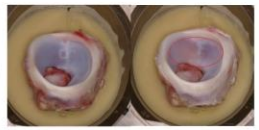


Figure 3: (Left) Untested porcine hip. (Right) Sample D2 slight blushing (circled)

- Limited/no damage observed in samples tested, slight blushing and scratching were predominant (Figure 3 & Table 1).

Angular sliding distance (°)	Axial load (N)	
	900N	1130N
+/-20	A1 – Scratching/blushing	C1 – Scratching/blushing
	A2 – No Change	C2 – Scratching/blushing
	A3 – Blushing	C3 – Dislocated
+/-10	B1 – Scratching	D1 – Scratching
	B2 – Scratching	D2 – Blushing
	B3 - Blushing	D3 - Blushing

Computational study to calculate sliding distance for different activities

- Motion data for 12 different motion activities from 18 subjects, were applied to a hip shape model (representing a large anterior cam lesion).
- Hip model comprised of a pointwise representation of the hip (Figure 4).
- Movement of femoral points tracked in 3D, impingement recorded when overlap between a cam point and the acetabular rim occur (Figure 5).
- Recorded maximum sliding distance of a point passing through the acetabulum.

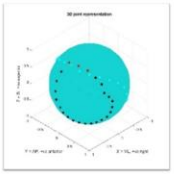


Figure 4: Pointwise representation of femur and acetabulum.

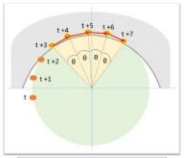
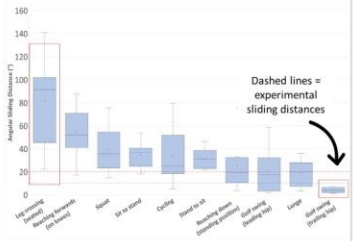


Figure 5: Track and calculate sliding distance function calculated in MatLab.

- The highest mean (±SD) sliding distance was for leg-crossing (43±18mm) and lowest the trailing hip in golf swing (2±1mm).

Cross leg: Longest mean sliding distance, most variable

Golf Swing: Shortest mean sliding distance, least variable.



Conclusions

This study provides quantification of the mechanical effect of sliding distance in cam-type hip impingement, where understanding of the multifactorial damage mechanism is an ongoing challenge.

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