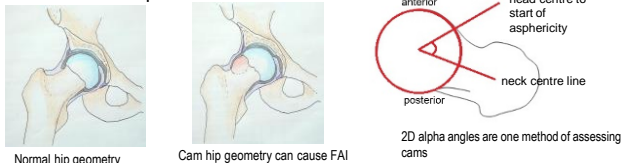


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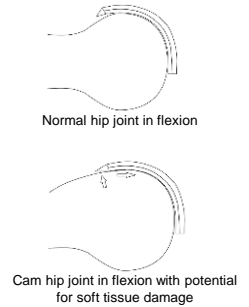
Introduction

Abnormal geometry of the hip joint is associated with femoroacetabular impingement (FAI), in which repeated contact between the femoral head / neck and acetabular rim can lead to pain and intra-articular damage [1]. Alpha angles used to assess femoral head asphericity are limited to providing an approximate indication of the cam size in a single 2D view, making them unreliable measurements to use to stratify a population by cam size and shape.



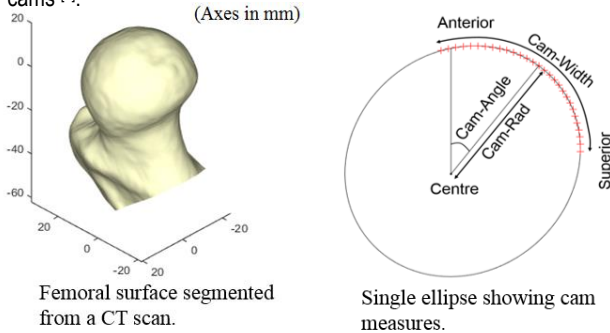
Aims

- 1) Develop a novel method for generating parametric surfaces matching individual femoral heads and 3D severity measures of cam deformity.
- 2) Assess the ability of the method to distinguish between cam and control femurs.
- 3) Compare 3D measures on cam patients with 2D alpha angle measures.
- 4) Use the 3D system to assess for differences between male and female cam patients.

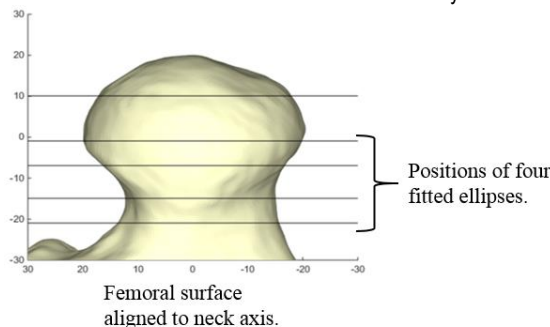


Parameterisation Methods

Femoral geometries from 20 patients (10 female, 10 male) diagnosed with cam deformity and 18 controls (10 female, 8 male) were segmented from CT images using Simplware ScanIP (Synopsis). Equivalent parametric models were generated by capturing the femoral head, neck and cam using fitted spheres and ellipses with a custom made code in MATLAB (MathWorks) and Python with Abaqus (SIMULIA). Measurements were defined to describe the size and position of the cams [2].

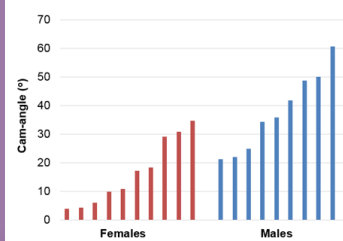
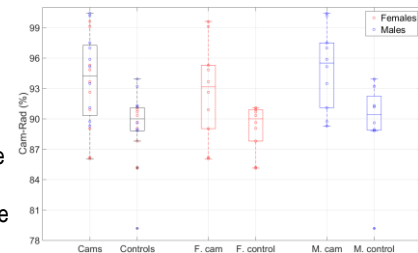


Cam-rad indicates the level of offset between the head and neck in the cam region. Cam-angle describes the position of the point on the ellipse where cam-rad is defined; an angle of 0° represents an anteriorly centred cam, and greater angles indicate more superior positions. Cam-width indicates the extent to which the circumference of the neck is affected by the cam.



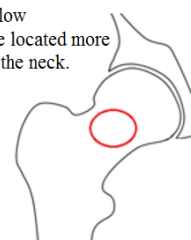
Results and Outcomes

The average cam-rad was higher in the patient group than in the control group, for both the male and female groups as well as overall. Alpha angles measured in the patient group were only moderately correlated with the 3D cam measures, emphasising the challenges in assessing cams in a 2D view.

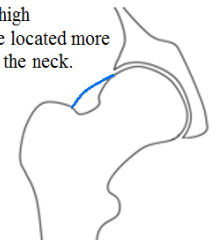


The average cam-angle was higher in male cam patients (mean 40.5°) than in female cam patients (mean 16.5°). Male subjects were more likely to have a superiorly located cam ('pistol grip' deformity), whereas cams in female subjects were more likely to be in an anterior position.

Cams with a low cam-angle are located more anteriorly on the neck.



Cams with a high cam-angle are located more superiorly on the neck.



SIGNIFICANCE: As well as distinguishing between subjects more clearly than is possible using 2D imaging and measures, the geometric hip parameterisation facilitates the flexible and rapid generation of a range of realistic hip geometries including cam deformity. Combined with material property models, these stratified cam shapes can be used for further assessment of the effect of the geometric variation under impingement conditions.

References

- 1: Ganz R et al. Clin Orthop Relat Res., 2003; 417:112-120.
- 2: Cooper RJ et al. Int. J. Numer. Meth. Biomed. Engng., 2017; doi: 10.1002/cnm.2867