# A MECHANOSTATISTICAL MODEL OF THE PATELLA

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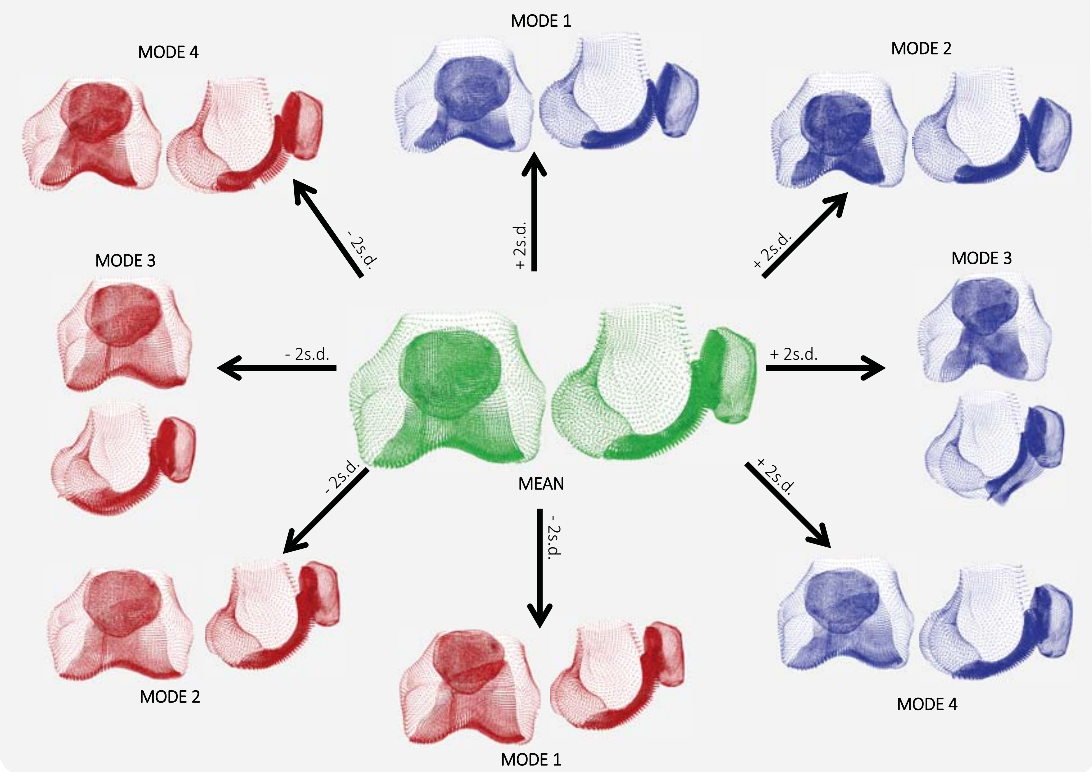
## MOTIVATION

The purpose of this work is to understand the mechanical causes of pathology in the patellofemoral joint and possible osteoarthritis. Usually subject specific analysis is required to determine stress patterns upon loading, however this method is expensive and inefficient. Recently, population models have been used to understand the causes of pathology in the patellofemoral joint as the structure varies largely between subjects. A population model can be built to describe the variation in bone and cartilage geometry using principal component analysis with the key modes.

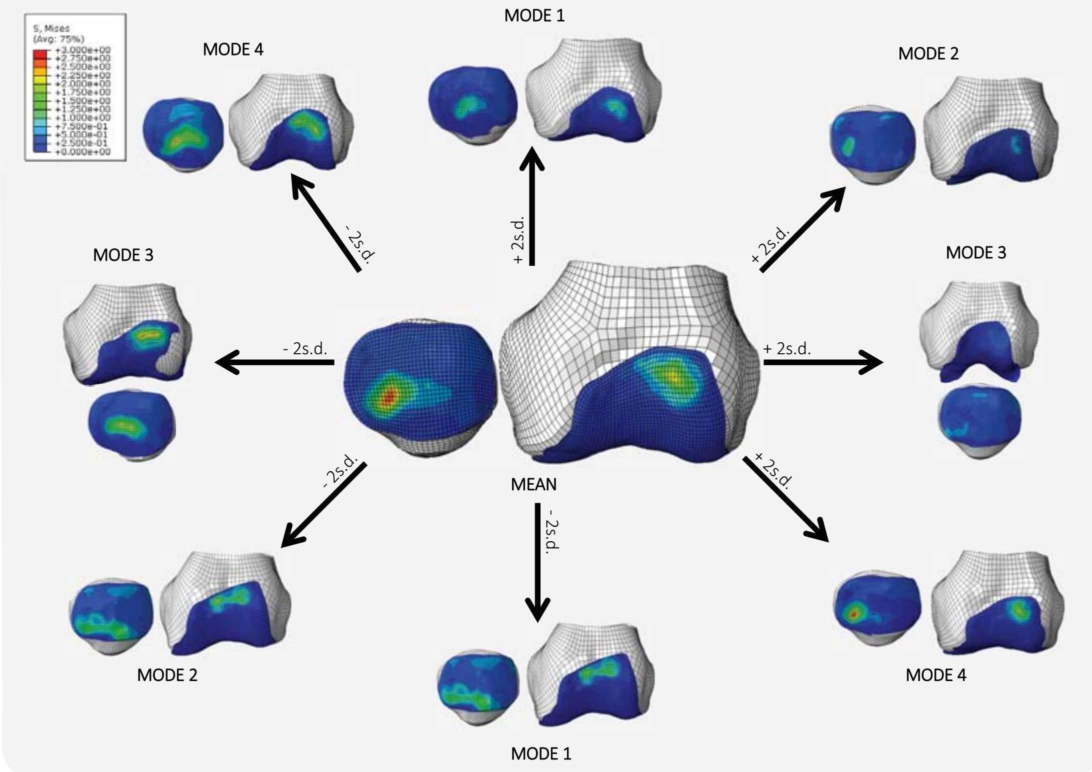
## OBJECTIVES

- Build a statistical shape model to generate bone and cartilage representative of key modes of variation.
- Subsequently, model the contact pressures with finite element modelling.
- Using the shape and stress results, determine the key factors that are likely to cause deviations in contact pressure from a normal healthy joint.
- A key aim is to determine whether knee joint loading is primarily on the lateral or medial side of the patella.

## SHAPE




## STRESS




## CONCLUSIONS

**Mode 1:** Captures vertical variation in patella position relative to the distal femur along with major variation in femoral cartilage morphology. The first mode of stress shows the difference in stress pattern size.

**Mode 2:** The most prominent variation is the size of the structure and the variation of stress patterns from a lateral concentration to a more spread pattern.

**Mode 3**: Captures the variation in posterior femoral cartilage morphology of the distal femur, and the variation of stress intensity.

**Mode 4:** Illustrates the variation in patella size in relation to the distal femur and horizontal position with a variation in stress from a concentrated higher stress pattern on the lateral side to a more spread stress.

## IMPLICATIONS

The key shape and stress modes are illustrated in the figures above to show the physical significance of the first four principal components which capture 87.4% of the variation.

The stress pattern resulting from a patellofemoral joint loading appears to be concentrated primarily on the lateral side of the patella. Where 77.8% of patellofemoral joints show loading on the lateral side of the patella, while 22.2% showed central loading.

This research may be used to develop therapeutic treatment for individuals, or reduce the occurrence and severity of patellofemoral joint disorders.

ACKNOWLEDGEMENTS

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