A computational simulation of approach on patella development

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ABSTRACT

The process of the formation of sesamoid bones, bones embedded in tendons, is not well understood. The most known sesamoid is the patella, and how it forms is still unknown. The function of the patella is to help the force transmission between the tibia and femur. There are few theories and computational models that explore the process of the formation of the patella. Generally, it is accepted that the patella develops inside tendons in response to the mechanical environment provided by the attaching muscles. However, some researchers argue that this theory lack of substantiation.

Recently, a theory suggested that the patella is formed initially as a bone eminence, attached to the anterodistal surface of the femur, while the quadriceps tendon is forming. Later, a joint form between the eminence and the femur, regulated by mechanical load.

The aim of this work is to develop a computational model that simulates the formation of the patella, considering the biochemical and mechanical aspects that are present during the quadriceps tendon and patella development. We modeled biomolecular reactions between tendon progenitors cells and the surrounding tissues. Certain molecules induced differentiation into chondrocytes (BMPs); others induced differentiation into tenocytes (FGF). We incorporated the role of mechanobiology by including the mechanical loads of the attached tendon. This work provides a novel and relevant understanding of the process of sesamoid bone formation, while integrating biochemical and mechanical aspects implicated in the development process of sesamoid bones.