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INVESTIGATIONS ON THE BIOMECHANICS OF THE LEGG-CALVÉ-PERTHES DISEASE

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Summary: Legg-Calvé-Perthes' (Perthes') is one of the most common diseases in paediatric orthopaedics, and affects children between the ages of 4-8 years old. Perthes' disease is more common in boys and is characterized by the avascular necrosis of the femoral epiphysis, and consequent collapse and flattening of the femoral head. A Perthes' child also has significant morphological variations in the affected hip, for example, an enlarged femoral head, a shorter femoral neck and have a 1-2 years skeletal retardation when compared with their healthy peers. Approximately 90% of Perthes' cases are unilateral and the permanent flattening of the femoral head can lead to degeneration of the articular cartilage, and early osteoarthritis.

The factors that trigger the disease are still unclear, but the following have been suggested: single or multiple ischaemic events, vascular deficiency or obstruction, coagulation disorders, deviations in geometry, growth impairment and skeletal immaturity, socio-economic conditions and social deprivation, and genetic factors. As a result, several hypotheses describing the possible mechanics that lead to Perthes' disease have recently been proposed, varying from either pure femoral head collapse due to biomechanical overload as a direct consequence of altered morphology of the hip, to epiphyseal vessel obstruction within the intra-articular space.

Our work uses a unique finite element model (FEM) that incorporates the blood vessels to the developing epiphysis of a juvenile subject. First, a finite element model of a juvenile hemi-pelvis and femur was simulated under single-leg stance and drop landing. Nodal displacements obtained from it were then mapped onto a high-resolution FEM of the femoral head, acetabulum, and blood vessels to assess the precise behaviour of the blood vessels under loading. The results obtained so far reveal femoral head collapse due to pure overload is unlikely to occur even in the presence of a skeletally immature epiphysis. In addition, the results show that a skeletally immature hip may experience a significant reduction in the cross-section of the blood vessels supplying the femoral head even in single-leg stance loading. The reduction of the blood flow may lead to necrosis, collapse of the femoral head and to the onset of Perthes' disease.