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Title

Investigating the human hip dislocation using a complex three-dimensional finite element human hip model

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Abstract

Hip dislocations are created by the large sudden applied dynamic forces like motor vehicle accidents or the pedestrian struck by automobiles [1] or even during some athletic activities [2]. Diagnosing and treating this, required to analyse how these dislocations can affect other tissues to understand its behaviour, form and function in different daily activities. For this purpose, a three-dimensional hip model was created from the MRI scans of one human subject based on constructing the entire pelvis and femur. The ball and socket joint was modelled between the hip's acetabulum and the femoral head to analyse the multiaxial loads applied in the hip joint. The three key ligaments that reinforce the external surface of the hip to help to stabilise the joint were also modelled which are the intertrochanteric line, the pubofemoral and the ischiofemoral ligament. Each of these ligaments wraps around the joint connection to form a seal over the synovial membrane, a line of attachment around the head of the femur. Major muscles, the Iliopsoas, Gluteus Medius and Maximus, Piriformis, Obturator Internus and Externus muscles and also the femoral insertion of the Gluteus Maximus, were modelled to simulate the muscle loads. The selection of these muscles is due to their importance in the movement of the hip joint, mapping these muscles in a finite element model is crucial to gain a realistic analysis of the hip joint, its movement and the mechanical properties of the joint itself.
After the MRI data set was acquired from a 20-year-old female subject with no medical issue involving the spine or the hip, 360 images of the right-side hip were used to construct the bio-realistic structures of the aforementioned human hip tissue. The developed finite element model is an asset for further research in investigating new methods of total hip arthroplasty, to minimise the recurrence of dislocations and discomfort in the hip joint, as well as increasing the range of movement available to a patient after surgery. The developed finite element model was tested for different loading and boundary conditions to analyse their sensitivities; while the initially assigned material properties and loading values on different model tissues were obtained from the literature.

References:

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