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Application of the finite element model using 3D modeling of a human bone system with osteoporosis for biomedical and mechanical analysis

Abstract

In the past, medicine was limited to developing diagnoses of the human beings' skeletal system, especially considering that surgical operations would pose a risk to the health of the human being. However, today technology has evolved in such a way that a diagnosis and prediction of the health of the individual can be done, carrying out different analyses through computational numerical simulations and 3D modeling in order to study, evaluate and solve bone problems of the current human being without the need for surgical interventions even with the presence of degenerative diseases such as osteoporosis, which enables to obtain the most appropriate and specific solution for the human being, considering specific characteristics of the human body when diagnosing.

Keywords: 3D modelling, diagnosis, osteoporosis, skeletal system

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Introduction

This analysis will be directed towards developing and evaluating the increase in porosity in the structure of the 3D biomodelling of the organic system, which was selected as the object of study (human hip). This was done to observe its behavior in the structure by applying loads in its geometry from a numerical simulation governed by the Finite Element Method (FEM).[1,2] By studying the behavior of this modification to the structured design of the human hip, it will be possible to determine the most vulnerable locations of each of the bone elements that compose it.[3] All the elements of the coxofemoral system will be affected by the presence of a disease (osteoporosis) and obtain a better visualization of a possible solution (such as the subsequent development of a possible prosthesis to improve the function of some element that is within the components of the selected hip system). It is important to mention that the following study is focused on a particular person, since, although the human skeleton is represented in the same way for the large number of human beings in the world, there are different complexions of the human body such as size, gender, age, body weight, height, etc.[4] In which the results could vary (Figure 1). However, the study shown below will structure the process and analysis to determine any structure type in the human hip depending on the carrier. Providing a technological breakthrough in complex system analysis and compared to the beginnings of prosthesis implementation.[5]

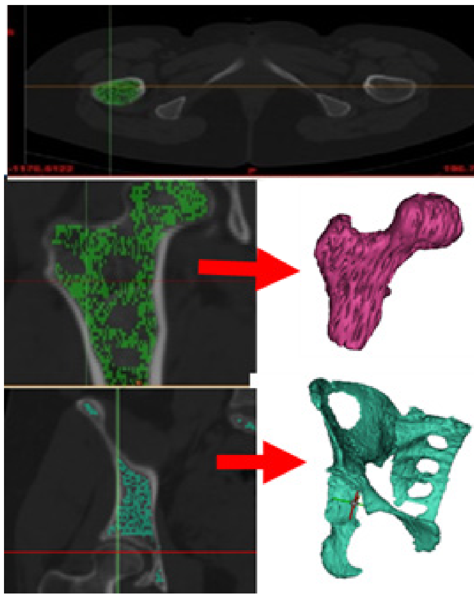

Figure 1 Healthy human hip sketch.

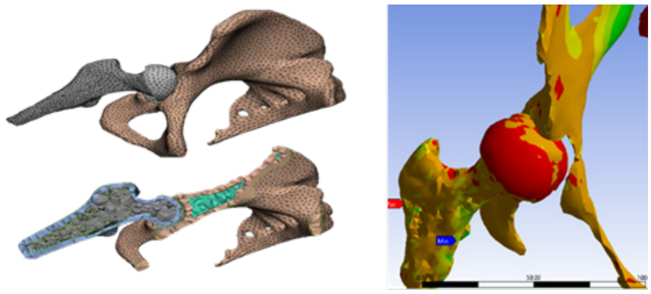

Figure 2 Concentration of effort and wear of human hip cartilage.

Conclusion

The user will also tend to suffer wear and tear on his joint so that, as it evolves positively to the spread of osteoporosis, the user will evolve negatively by losing mobility in his joint, so it is concluded that in a medium or long term, it will be necessary to replace the acetabular contact area with a complete fall prosthesis,[6] this phenomenon can be seen in Figure 2. Based on the results mapped during this numerical analysis based on the Finite Element Method (FEM), it was correctly observed from classical mechanics it was determined that the most compromised locations in the coxofemoral system are the femoral neck and the lower part of the greater trochanter. So it is proposed that the beginning of a crack will begin in these locations starting at the top of the femoral neck and propagating to the other end of it since it is known in the area of classical mechanics that a crack will start from the point of maximum effort and propagate perpendicular to the spectrum of maximum main effort, which is also known as isopachic lines or parallels to the main minimum stress spectrum or also called isostatic lines.

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Conflicts of interest

Authors declare there are no conflicts of interest.

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