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Research Article

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Numerical Investigation of Semi Elliptical Crack in Human Femur Bone Under Weight Effect

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Abstract The femur bone model has been analysis by finite element (FE) and ANSYS workbench version .16 was used in this numerical analysis Where stress distribution in cracked femur bone under critical and dangerous load case. Results shown that body weight effect on stress with different behavior but in general even though results are obtained using a load case obtained from literature as well as average material properties, it is considered that they give an indication of critical places considering equivalent stress in a femur using this modeling approach. This study can be utilized to predict stress in cracked human femur bone at specific positions that helped the designer of hip prosthesis to imagine critical stresses values.

Keywords Static analysis, Cracked Human Femur Bone, Hip prosthesis, ANSYS work bench 16

Introduction

Stress fracture is a type of biomechanical failure of bones caused by repetitive skeletal loads during intense physical training. it has been a well-recognized problem for athletes and military personnel it has been a well-recognized problem for athletes and military personnel The incidence of stress fractures in female recruits during Army basic training is more than twice that reported for males so that the study will be on female have 25 years old and 100 Kg weight [1]. Delays in diagnosis can cause a fairly major stress fracture, which is a catastrophic event for a young soldier but also results in a medical discharge with lifelong disability and liability [2].

Finite Element Model

Model of femur bone had been used in this study where it is imported as (CAD Model [IGES], Sawbones, Vashon, WA, USA) which was consist from cortical bone, lower and upper cancellous bone. It is available in public domain derived from a CT-scan dataset of a synthetic human femur. It is imported to (ANSYS workbench software program version .16) where modeling process femur geometry was accrued by introducing the meshing properties and material properties and then by generating mesh to whole model. The femur in this stage consisted of element. In several cases, there were none continuous and non-smooth curves in the model that induced errors in the output model; hence, a curve smoothing approach was implemented to avoid such incidence and to allow mesh generators more flexibility [3]. Static analysis for jogging, up and down stairs climbing, and stumbling load case had been studies. Based on common geometry, it is practical to compare results from different FEM studies worldwide and besides, FE model could be calibrated with data from experimental tests available in the literature. The latter one is of great importance as it is not always possible in biomechanics to do experimental tests for validating and verifying the numerical tests. More information about the physical object from which the standardized femur model has been derived is available from M. Viceconti, [4].

Material Properties

The material properties of FE intact femur bone that analyzed in present work are illustrated in Table.1. Where bone model was modeled as an isotropic material A.

Table 1: Material Properties

Type		**Young's Modulus[Gpa]**	**Poisson's Ratio**
Isotropic	Cortical Bone	12.4	0.3
	Cancellous Bone	0.104	0.3

Loading and Boundary Condition

Static analysis for the most important and dangerous load case on femur bone where the load reached to 8.7 times the body weight, and for jogging, down, up – stairs climbing load cases, the ratios of these loads times body weight were represented in Table.2. In this work the body weight assumed to be equal to 100 kg. Distal end of intact femur model was fixed. For each reconstruction, the force was applied vertically on the upper cortical part S. Shaha, et. al., [5].

Table 2: Load ratios with respect to body for different activities

Activity	**Load times body weight per area (pa)**
Jogging	7.6×33.8
Up – stairs climbing	5.9×33.8
Down – stair climbing	5.1×33.8
Stumbling	8.7×33.8

Results

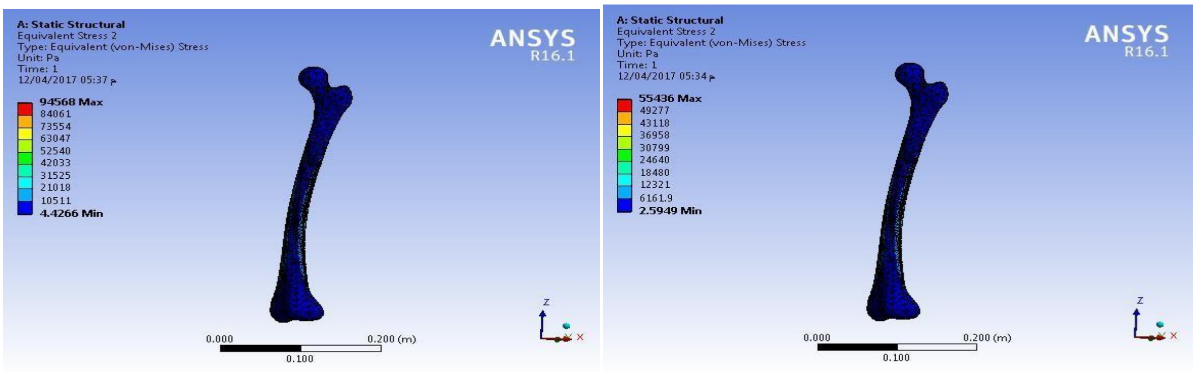

Figure 1.1: The maximum difference in von misses stress on the bone without crack

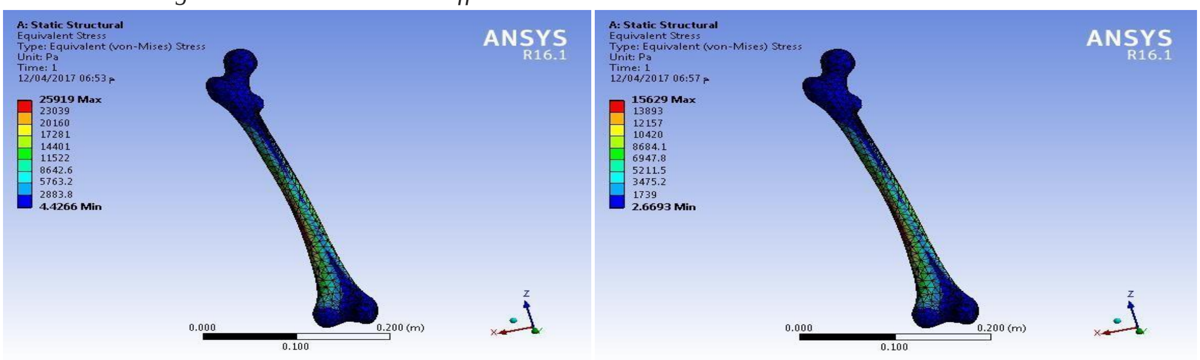

Figure 1.2: The maximum and minimum von misses stress on the bone without crack

The FE Von Mises stresses (static analysis) distributions for different types of loading had been represented for different body dangerous load case on the cracked bone that the maximum difference in von misses stress reaches (94568 pa) when the bone under stumbling load case that the minimum difference in von misses stress reaches (55436 pa) and it were Down – stair climbing load case as shown in figure (1.1). Where the maximum and minimum in von misses stress on the bone without crack were also for the same cases and the result were respectively (25919 and 15629 pa) as shown in figure (1.2) the result of the search can shown clearly in figure (1.3).

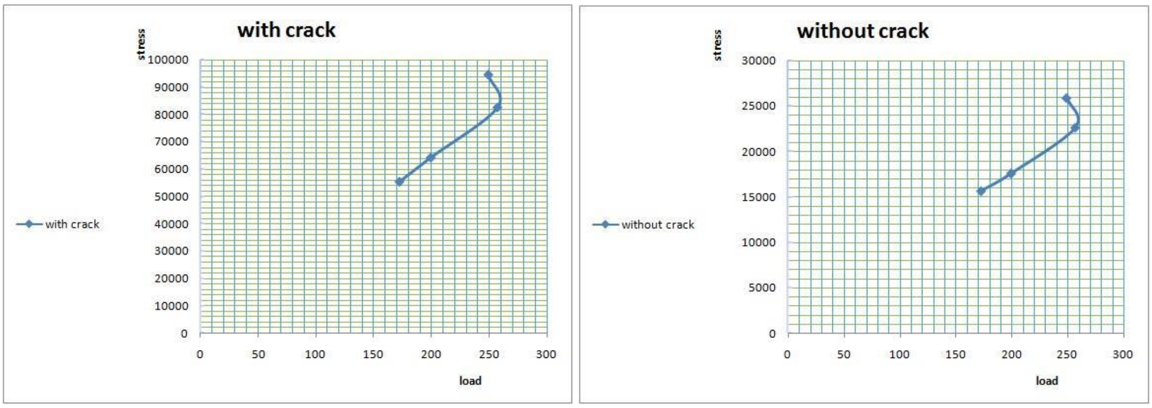

Figure 1.3: The results

Conclusions

The aim of this study was to find the effect of semi crack on the femur bone and the worst case of the applied load and the result was stumbling load and the second aim of the study was to develop a practical FE model and to estimate the risk of bone failure during gait based on static analysis type especially for excessive load case that was stumbling in order to simulate this critical load type that any femoral bone can be loaded by it, then to take account of patient activity when designing total hip replacement based on critical positions of stress concentration by working on reducing it as possible.

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