CHAPTER VII
CONCLUSIONS AND RECOMMENDATIONS

According to the specific objectives there were achieved:

It was experimentally determined the impact toughness and hardness of the alloy.

It was made a finite element analysis on the knee joint.

It was made a finite element analysis on the behavior of the alloy in fixing application in knee joint.

It was written an analysis of the FEM analysis result.

From the results and information obtained during this research it can be concluded that:

The higher percentage of metal – bone contact in Ti-6Al-4V alloy produces a higher wear and therefore higher concentrations of Titanium in the blood of patients than vitallium implants do.

Hardness values are not too far from each other which indicates a good machining process and homogeneity of mechanical properties along the piece.

Vitallium alloy is harder than Ti-6Al-4V and 316L Stainless Steel. This means that Co-Cr-Mo has more resistance to be scratched or penetrated. This is important in joint prosthesis.

Taking into account the numbers strictly, vitallium has a lower impact toughness resistance than the other two alloys.

Volume and shape of the samples are also important factors in impact test in order to compare different materials

Fatigue endurance limit is inside the elastic range of the material, which means that while the application load does not reach the limits of the elastic range of the material, it will not fail by fatigue.

Fatigue results were obtained on an axial load fatigue test, but it can be concluded the same for the flexural test, while the applied load is in the elastic range of the material, it will not fail by fatigue.

Since the screws have a maximum 7 MPa shear stress, and the yield shear stress for vitallium is 25 MPa; vitallium screw in tibia fixation will not fail by fatigue.

Anterior and actual studies of the biomechanics of the human body are not yet a total imitation of the behavior of it since they present a high amount of assumptions, but they give a good approximation.

Safety factor of walking is 10^3, for a healthy middle age person. This makes sense because it can not be possible that a person can break his leg just walking.

A fracture is not presented because only a high axial force or a moment but because of the combination of an unusual moment or force applied to the joint for which the joint is not designed.

A small difference in the axial force applied can produce high changes in the stresses absorbed by the lower part of the tibia. Since, it is the first part to receive the impact.

Axial force affect the tibia, moment affect the contact point. A highly unexpected axial force may produce a fracture in the tibia as much as a shear impact while a bad taken step or a torque may affect the joint dislocating or fracturing the bones involved.

The difference in stresses presented in first and second stage of the step are not very significant, it can be said that it is equally dangerous the full foot strike stage than the toe off stage.

Stresses grow slowly and uniformly through the bone from the contact point to the center of the bone until it reaches a neutral zone. This due of a good natural design.

There are no stresses presented in the center of the bone at any height or load conditions which makes us think that in the real case, where the bone is not completely solid but has a hole in the center, there are no stresses either and that is why there is no need to have material there.

The difference in size of both parts of the low femur also affects the way stresses are distributed; this may be because one side always receives the high torque at the toe off stage and requires more mass to absorb that impact.

Safety factor of the vitallium screw used for fixing the tibia after a fracture is 3.5.

Screw will never present a negative shear stress.

First middle threads in contact with the bone receive most of the stresses and diminish while going up the screw.

Shearing stresses in the screw are mostly superficial.

Design a new model of screw is not only a mechanics matter, bur also are involved factors as anatomy, isotropy of the bone, anatomy of the fractures, surgical methods and medical considerations. This is why as much as it could be done a suggested design of a new screw, this design would not be anatomically correct for the application.

RECOMMENDATIONS

1. To make a hardness test on vitallium samples than are not previously forged in order to obtain a result of the properties of the alloy by itself.

2. To carry out fatigue analysis of vitallium screws according to the standard method of testing.

3. To make fatigue tests to biomedical alloys, including Ti-6Al-4V, 316 SS and CoCrMo.

4. To perform impact test with samples of the same volume in order to obtain a forceful conclusion about which material presents the best toughness properties.

5. To do the analysis of the knee joint, taking into account the real flexion angle.

6. To make a finite element analysis of the total knee replacement.

7. To make a finite element analysis of an axonometric screw model.