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ORIGINAL ARTICLE

The effect of Cerebrospinal Fluid on the Tension Contours of the Brain and Skull

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ABSTRACT
In this analysis, the brain and skull considered to be solid material also the cerebrospinal fluid (CSF) to be fluid. The relationship between the skull and brain and CSF was determined by attention to complex geometry of the brain and skull. Solids analysis is performed by Ansys software and fluids analysis is performed by Fluent software. Also modeling of fluids was possible by using of majors of Ansys software, but it didn't have high power for modeling, therefore a transient-fluids couple analysis must been performed on this complex geometry, and then gradient effects, that was due to cube clash to skull bone, was studied. In attention to, the goal of this paper was a studying of effect of CNS on tension counters upon the brain and skull, modeling was constructed by using fluent software and applying CSF again, then the results from this examination were shown on the brain status and CSF.
Keywords: *Tension contours, Cerebrospinal fluid, Brain, Annoys software, Fluent software*

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INTRODUCTION

Human head is composed from Central Nervous System (CNS) and a hard membrane (skull) and then is covered by a soft layer (scalp). CNS is containing of the brain and a Spinal cord. The brain is separated from the skull by a membrane layer and CSF. You can refer to anatomy books for reading more details about anatomy conditions of human head [1]. A lot of researches are performed in field of biomechanical injuries in order to determining of the injury mechanism. By studying of injury mechanism can describe, How is the loads entered to body tissues? And, what is deformed in tissue? Three kind of nervous injury is recognizable: The first of component is publication type of injury that affects a significant volume of the brain. These injuries are including nervous injuries, Axon and micro vein injuries

Distribution of injuries is due to loads that make deformation pattern on the brain different parts. A type of nervous injury that occurs in a large part of head injuries affects axons and, returns to nervous injury center [3-4]. Jinzhou [15] reviews different types of head models and Phyfe. This research focused on advances and past researches results [5].

Dong-kokum (2012) represented design of human head model by touch sensor; similarly, it can recognize the contact forces and location of them, that was composed from three units of touch force sensor.[6]

Daniel [7] made finite element model that was extracted from 64 of accidents of motor bicycle drivers and pedestrians and American football players. This model determined limitations of human head against of pressure.

Most work to date, the effects of contact between the brain and skull are not considered. In this paper, parametric studies and contact effects between brain and skull were performed.

SIMULATION PROCESSES

In this paper, polygon mesh method or sub D is used for modeling of the brain and skull tissue. At the first, the polygonal mesh model of the skull and brain were prepared, (figure 1, 2). This mesh was corrected, simplified and optimized by Rapid Form OXR. In addition, necessary changes were performed in order to conformity of model with CT figures (scan 3, 4).

The brain and skull model was simulated by Rhino (figure 5), and then final mesh has been prepared for analysis in ANSYS software by ICEM CFD software, that is specialized software in field of mechanical and fluid meshing.

Membrane elements to form of rectangular and triangle to numbers of 1544 and 392 respectively, due to the thin thickness of wall compared to the overall size, have been used for skull mesh in order to increasing of the accuracy and speed of solving of finite element.

Brain tissue has been meshed to volume elements in order to increasing of calculations speed and decreasing of needed elements, this elements are internal core, external layer and medial section that are meshed by hexahedral, tetrahedral and pyramid elements, to number of (260, 11079, 814) respectively. (Figure 6)

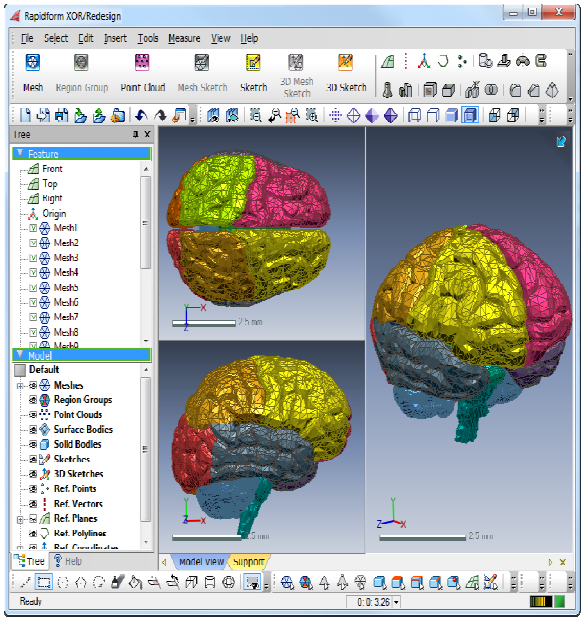

Figure 1: Initial model of the brain

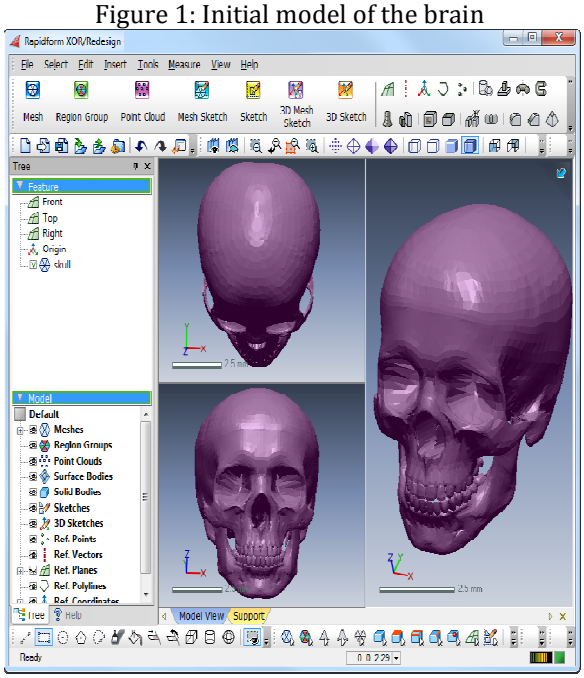

Figure2: Initial model of the skull

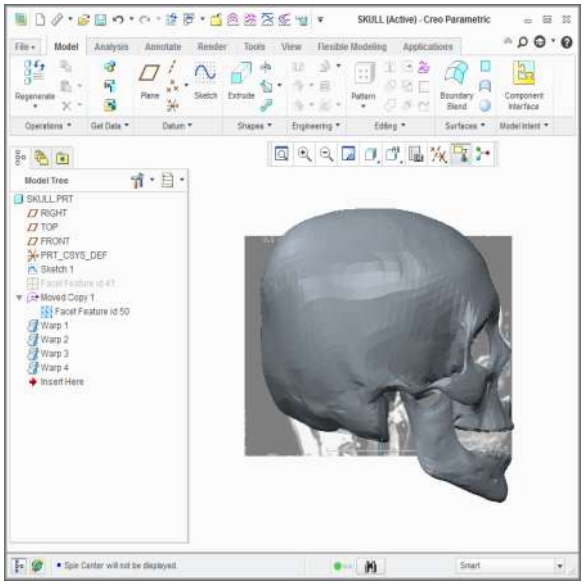

Figure 3: conformity of skull lateral section by CT scan in pro Engineer (Cero parametric) by warp.

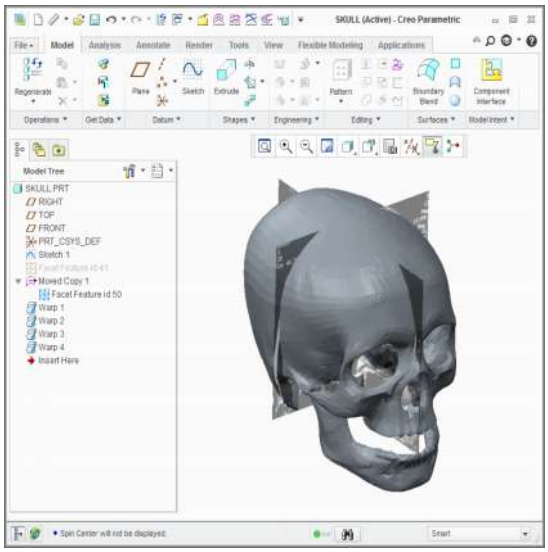

Figure 4: conformity of skull lateral sections by CT scan on pro Engineer (Cero parametric) using warp.

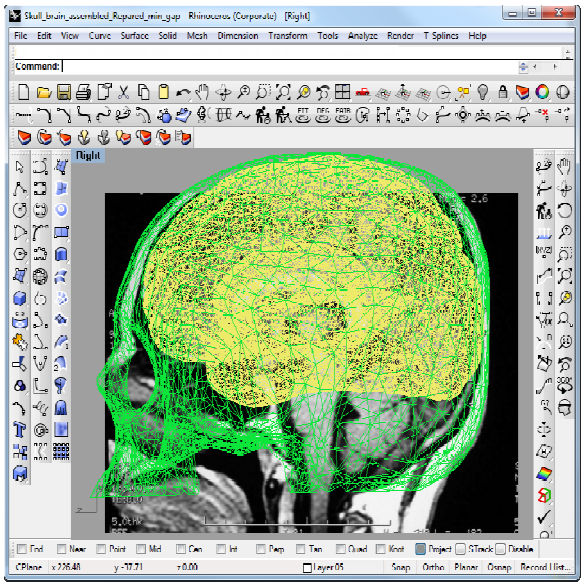

Figure 5: brain and skull symbolized model along with CT section on Rhino soft ware.

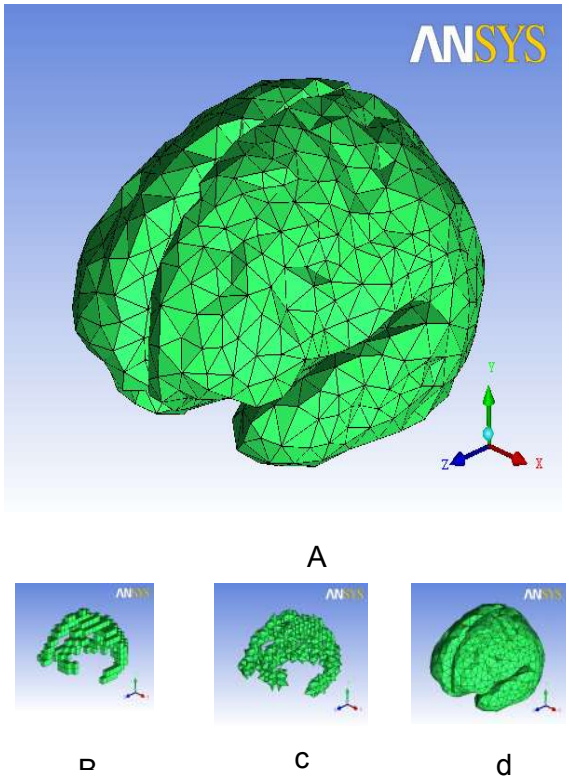

Figure 6 :(A) Full meshing of limited parts of the brain, (B) Hexahedral mesh in center, (C) medial pyramid mesh, (D) external Quad mesh

IMPROTING MODEL TO ANSYS:

In this simulation touched and non-touched loadings have been applied. Buoyancy has been considered as a non-touched loading and collision of body to skull has been considered as a touched Loading. Since the simulation is transient, effects of acceleration on skull and brain have been investigated. Some of the stress that has been showed in counters due to acceleration is caused by the collision object into the skull to the brain. Properties of skull and brain can affect the results, so in this simulation isotropic material has been applied. Number of elasticity module and Poisson's coefficient come from previous works. Grid of the model has been showed in figures (7-10).

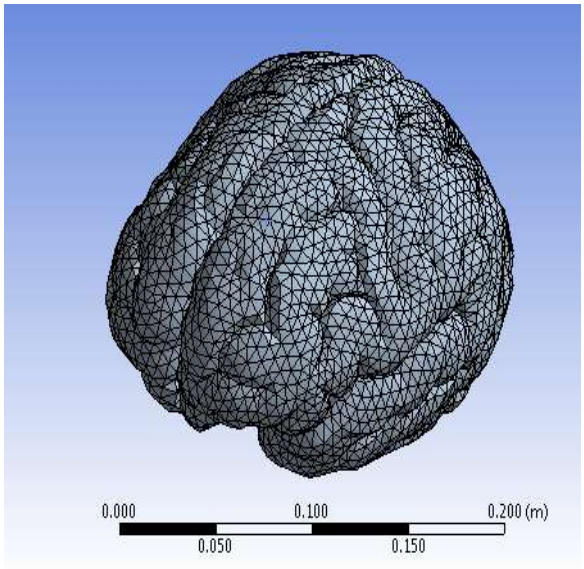

Figure (7): isometric view from brain alimented model

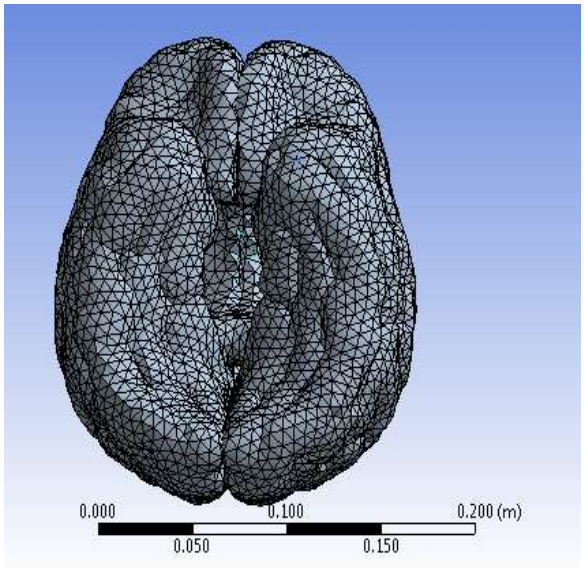

Figure (8): below view from brain alimented model

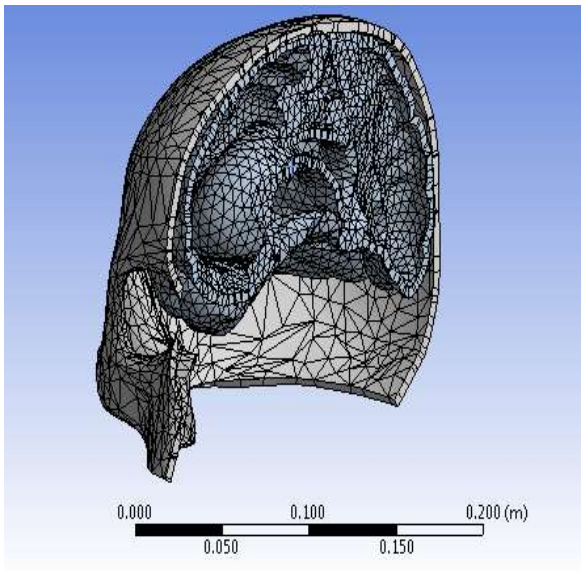

Figure (9): sniped view from brain alimented model

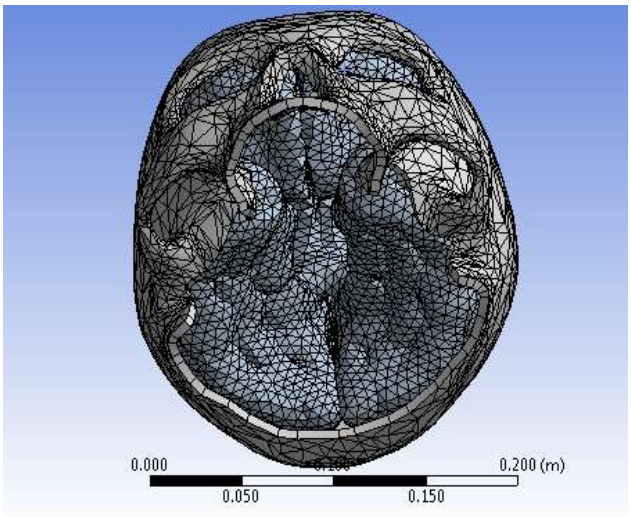

Figure (10): ahead view from brain alimented model associated with skull model.

CONCLUSIONS

Figures (11,12) showed Von Mises stress when the cube has the most sinking into skull and brain.
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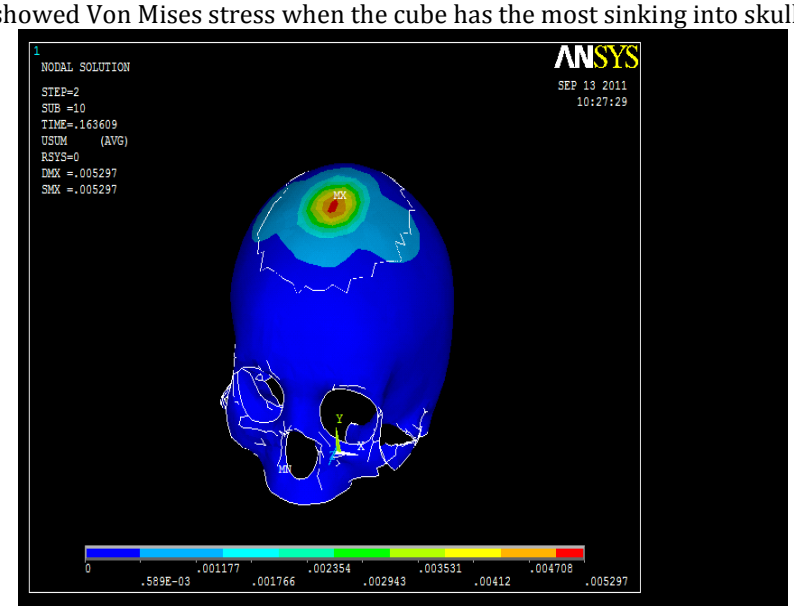

Figure (11): deformation counter of skull membrane at most indentation moment

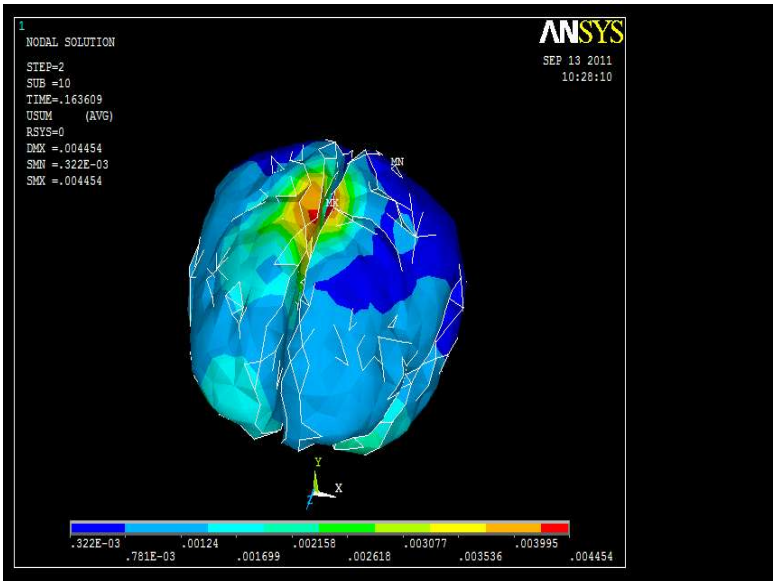

Figure (12): deformation counter of brain at most indentation moment

1- The most Von Mises stress on skull membrane is 230MP and occurred on the upper section of skull.
2- The most Von Mises stress on brain is 51 KP and occurred on the upper section of brain.
3-The most deformation in skull membrane is 5mm.
4- The most sinking in brain is 4mm.
5-Deformation and Von Mises stress on the upper side of skull membrane are more than other places.

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