11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20 - 25, 2014, Barcelona, Spain

A detailed Infant Finite Element Model for measureable cranial deformation

Hoechan Kim[1], Youngho Lee[1], Junghwa Hong[1#]

[1] Department of Control Instrumentation Engineering, Korea University, 2511, Sejong-Ro, Sejong, 339-700, Korea; E-mail : rlaghlcks@korea.ac.kr
[1#]Department of Control Instrumentation Engineering, Korea University, 2511, Sejong-Ro, Sejong, 339-700, Korea; E-mail : hongjh32@korea.ac.kr

Key Words: *infant cranial, FEM, human model, cranial deformation*

Positional Plagiocephaly (deformational plagiocephaly, non-synostotic plagiocephaly, benign positional molding, or flat head syndrome) which is a kind of Plagiocephaly is caused cranial deformation occured by external force.[1] Before-4-month-old infant usually lie in a row in uniform sites of the cranium because muscle strength is not enough to move the head. Especially, as the skeleton of Infant who get sleep 14 to 18 hours per day is composed of cartilage approximately 80% or more, so a correct posture of sleep is necessary in order to prevent Positional Plagiocephaly. Moreover, the cranium have the alcification low level of bone, therefore, the structure is flexible and soft, so likely to be change. Thus, due to the supine position of sleeping for a long time, the number of infant patient whose occipital is repeatedly pressed get the transformation of occipital bone.[2-4] Since the previously developed models (CRABI, Q3, Hybrid III, etc) were designed to evaluate the injury by car accidents. And there is no model that can predict the deformation of the skeleton because they are consisted with multi body. The purpose of this study is to develop the detailed finite element model applying the biological trait of infant and babies based on the literature and video data.

A detailed finite element model of the infant is formed the head part, cervical vertebra part and the upper body. The cranium of a detailed finite element model of the infant consist of the frontal bone, occipital bone and temporal bone. The suture which is connected the ossature along the shape of the cranium, consist of the coronal suture, squamous suture, lambdoidal suture and sagittal suture. The head part is formed the scalp, cranium and meninges. Also, cervical vertebra part formed the vertebra, nucleus pulposus, annulus fibrosus and ligament. Developed a detailed finite element model of the infant was fulfilled the intercomparison with Hybrid Ⅲ 3-year-old child human model. The Hybrid Ⅲ 3-year-old child human model that have been used for validation is the most advanced human model among the currently developed human model. The verification is head part impact simulation using the impact hammer.

The developed detailed infant finite element model was confirmed that the behavior was similar to Hybrid III 3-year-old child human model. In addition to, comparison of deformation simulation result indicated that interface pressure was big differences between developed detailed infant finite element model and Hybrid III 3-year-old child human model.

In this study, detailed infant finite element model which is measurable for occipital region deformation was developed and validated through simulation.

REFERENCES

[1] M. B. Habal "Avoiding the sequel associated with deformational plagiocephaly." Journal of Craniofacial Surgery 14(4), 430-437 (2003)

[2] Timothy R. Littlefield, Jeanne K. Pomatto, and Kevin M. Kelly. "Dynamic orthotic cranioplasty: treatment of the older infant. Report of four cases" Neurosurgical Focus. 9(3), 1-4. (2000)

[3] John M. Graham, Jeannie Kreutzman, Andy Halberg, Carlos Samayoa, and Xiuqing Guo, "Deformational Brachycephaly In Supine-Sleeping Infants." The Journal of Pediatrics February: 253-257 (2005)

[4] Walker ML, Collins JJ. "Nonsyndromic craniosynostosis and abnormalities of head shape." Youmans neurological surgery, 5th edition, Elsevier : 3300-3314. (2004)