Development and validation of newborn child head numerical model dummy for impact simulations

ABSTRACT

Computer simulation using Finite Element Model (FEM) are often used as a substitute for human experimental head injury studies, especially in predicting car accident injuries, enhance understanding of injury mechanism and develop prevention strategies. The use of FEM in crash test dummies is advantageous over physical dummies because of the lower cost and repeatability. Numerous adult FEM of the head have been developed, but there are relatively few paediatric FEM due to scarcity of material property data for children. Consequently, there are not enough models representing newborn child. Child head injury is a costly problem, both in terms of morbidity and direct medical costs. In fact, it is the leading cause of death and disability for children under the age 18-years-old. Despite its importance and effect on the population, the study of paediatric head injury is obstructed by the lack of available paediatric Post-Mortem Human Specimen (PMHS) data. As a substitute for PMHS testing, Anthropometric Test Devices (ATDs) and FEM have been developed to model the head. However, there is a scarcity of data for the design and validation of these models. This paper presents the development and validation of a newborn (NB) FEM for head dummy and simulated results compared with the child cadaver experimental data under drop test conditions. Itis intended for automotive crashworthiness assessment. The model was developed by using both deformable and rigid body materials. The newborn head anthropometric data were obtained from published journal articles. Using recent published material property data, the infant skull, skin and scalp FEM of the newborn ATD head was developed to study the response in head drop tests. The head assembly was validated by using three different head drop tests set-ups. The three impact locations are one frontal/forehead, and two lateral (right and left parietal) drop tests. All tests with drop height of 130 mm are the certification procedure. The benchmark model used in this study was a modified version of the 6-year-old numerical model developed by Livermore Software Technology Corporation and National Crash Analysis Center. A morphing method within LS-Prepost software was used.