Advances in the development of an Instrumented Human Head Surrogate for Brain Strain Experimental Evaluation during Impacts

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INTRODUCTION. The development of biofidelic head models is crucial since head injuries represent the most likely outcome after a traumatic event, often leading to brain damage or death. To predict injuries and test protective gear, several criteria were developed [1]. To improve the knowledge in this field, we developed an Instrumented Human Head Surrogate (IHHS) [2]. New developments of this surrogate are aiming to improve the robustness of the model with a redesigned skull, increase anatomical bio fidelity with the inclusion of falx cerebri and tentorium cerebelli, and add more feedback with the inclusion of innovative sensors[3].

METHODS. An MRI scan of a 50^{th} percentile male human head (scalp, skull, and brain) was imported into Meshmixer and simplified for 3D printing. The skull model was divided in two parts joined and sealed thanks to an indent and screws. A flat bottom base allows for connecting neck surrogates. The skull was 3D printed in PA12 using SLS technique. Brain and scalp models were used to generate moulds used for rubber casting of soft tissue surrogates. Surrogate brain was casted using Platsil Gel 0030 silicone rubber and a Deadener in a multi-step process embedding 3-axial accelerometers, gyros, and triads/hexads of miniature pressure sensors such as the MAPS [3]. Skin was casted using Platsil Gel 10. Falx Cerebri and Tentorium Cerebelli were derived from the brain model using Boolean operators and casted using Platsil gel 25. Pendulum and a drop test bench were set-up.

RESULTS. The brain with embedded sensors will be casted and assembled with skull, and skin in order to perform impact tests with and without neck involvement. Preliminary results will be presented at the conference.

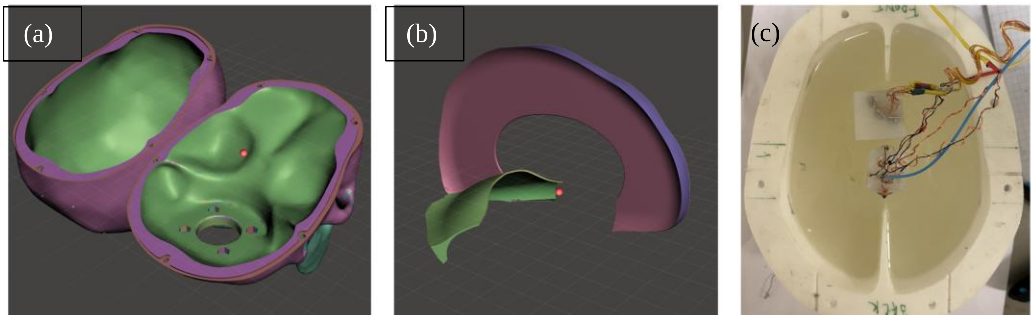

Figure *a) improved skull closure; b) falx and tentorium geometry; c) MAPS, accelerometers, and gyro embedded in the Platsil Gel brain center of mass,*

DISCUSSION AND CONCLUSIONS. We expect that these advances will improve the anatomical detail with the inclusion of falx and tentorium and skull robustness against repeated impacts. Moreover, MAPS sensor will allow studying dynamic multiaxial stress states in the brain during complex impact situations.

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