In-silico evaluation of 3D printed orthosis for the treatment of positional skull deformities

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Introduction: Nowadays 1 in 3 of all babies are showing positional skull deformities due to the new recommandation against the sudden infant death syndrome. To correct these deformations, orthopedic treatment exists however the orthotists do not possess any tool to evaluate their orthosis without trying it on their patient. This paper is presenting a project answering the following question: How to evaluate the classical orthopedic treatments and the innovative ones (3D printed) before manufacturing?

Materials and Methods: In order to try new designs and materials and to validate the correction made by the orthotist before the fabrication step, a simulation tool has been created. This tool has to provide the orthotist with the pressures induced by the custom made helmet on the infant skull in different positions. To build such a tool, numerical simulation is used: a finite element model of the studied infant and of his cranial orthosis is created. Different forces are applied to simulate the closure of the helmet and the infant position. The different characteristics implemented in the simulation are based on previous projects (BraceSim) and on literature researches. To validate the model, experimental tests were carried out on test bench and on real infants.

Results and Discussion: The builted simulation tool allows to simulate the effect in term of pressure of the orthopedic treatment on the infant skull. An example of result is given in the Figure 1. It also enable the orthotist to verify that the helmet will stay in place once installed (Figure 2).

Figure 1. Pressures on a deformed head supine on back with and without the orthopedic treatment. With the helmet, the deformed zone is released of all pressure.

Figure 2. Simulation of the helmet installation. On the left, the helmet falls forward, it must be rectified. On the right, the helmet remains in place on the head of the baby.

Translational Impact: Such results enable the orthotist to confirm or not the future efficiency of the custom made helmet: no pressure must be exercised on the deformed zones in all the positions and the helmet must stay in place. This tool acts like a “virtual fitting” of the helmet allowing the orthotist to iterate on the numerical conception in order to optimize his treatment and avoid any post-fabrication modification. This ability to realise “virtual fitting” will also allow the orthotist to try new designs and materials and to validate them in-silico.

Disclosure Statement: This study is a project of Rodin SAS: CAD/CAM provider for orthotists.