A new method to determine rib geometry for a personalized FEM of the thorax

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Abstract (282/300)

The thorax is one of the segments frequently involved in road accidents. Various models of the human chest have been published over the past decades to evaluate injury risks in a car accident and to access innovative safety systems. However, they are limited in their biofidelity due to simplification needed for global testing or computer limitations. The purpose of this study is to propose a method to determine relevant parameters of the human ribcage to be incorporated in a refine FE model.

An original method has been developed by combining medical CT images, 3D laser scan acquisitions, and micro-CT techniques for acquiring the whole geometry of the bone structure of human chest. From these 3 acquiring systems, a surfacic model was generated including the whole geometry modelled by 2 surfaces: an external one defined by the external border of the cortical bone; an internal one obtained by the determination of the limit between the cortical and the trabecular bone. An automatic routine was also developed to generate a neutral surface by calculating distances between these two surfaces with a precision of about one micron. The final step was the generation of a finite element model, characterized by personalized and optimized shell meshing and localized real cortical thicknesses.

All these data were merged to define a geometrical thorax model at a multilevel scale (thorax, rib, bone structure). From this complete geometrical acquisition, a finite element model was obtained. The main advantages of this approach is to provide a FE model which is personalized, biofidelic, CPU-time efficient, and which takes into account the entire geometry and bone distribution. This paper highlights an original and innovative link between medical imaging, 3D reconstruction and FE modeling.