EFFECTS OF AGE IN CRANIOCEPHALIC TRAUMA; MECHANICAL PROPERTIES

Dr David Sánchez Molina

Escola Tècnica Superior d'Enginyeria Industrial – Universitat Politècnica de Catalunya

Dr Mehdi Shafieian*

Amir Kabir University of Technology – Teheran

*In the signing of the agreement, due to the legal impossibility of transferring the first year's funds assigned to the institution managing the subproject, University of Iran, because of the legal restrictions that the European Union (EU) has imposed on the country in which the institution is located, it is not possible to make the corresponding payment to this centre. The coordinating investigator and his research centre proposed to the Board of the Fundació La Marató de TV3 to achieve from a single research line the part of the objectives proposed for this subproject, which would become a single-centre project.

1. Summary

The project 289/C/2017 *Effects of age on traumatic brain injury; mechanical properties* is an experimental research of the biomechanical properties of human brain biological tissues in order to draw conclusions of practical interest, especially to predict the result of serious traumas associated with falls, collisions or traffic crashes.

The main initial concern was to understand how the mechanical properties of the parasagittal bridging veins changed with age. However, during the research we found a certain number of new and often unexpected aspects and results that partly reoriented the work towards objectives of wider scientific scope.

2. Results obtained

Among the main findings we have:

- The realization that a nonlinear Fung model adequately represents the behavior of bridging veins in fast traumatic collisions (the model's reference values were experimentally found, which is very useful for the scientific community).

- The discovery that there is a small viscoelastic effect that had previously gone unnoticed by other researchers in the field. Due to this, we developed different tests to see this effect more clearly, measure it and build a more complete quasilinear viscoelastic model based on Fung's hyperelastic model. Hence, the first published study that systematically studied this effect on parasagittal bridging veins and clearly demonstrated their viscoelastic behavior.

- The corroboration that there is a significant effect of age on mechanical properties. As was expected, there is a significant reduction in maximum axial tensile force and strain before mechanical failure of bridging veins. Our study is the first study to demonstrate a significant correlation of this type.

3. Relevance with possible future implications

The study made it possible to obtain high-quality data that greatly refined the accuracy of the previous data. These data can be used to improve the safety retention systems in cars and other vehicles, reducing injuries associated with certain potentially traumatic situations. In addition, the data make it possible to refine the computational software for biomechanical simulations that has various forensic purposes, as well as the development of retention and research systems. Moreover, the data allowed us to develop a new precise injury metric to determine the possibility of occurrence of acute subdural hematoma during various traumatic events.

4. General Scientific Bibliography

The data of this research have led to a number of scientific articles in high impact international journals that publicize the findings. These publications would not have been possible without the funding and work carried out by the Fundació de La Marató de TV3. The three published papers are mentioned below; some additional ones are expected over the next two years:

Sánchez-Molina, D., García-Vilana, S., Llumà, J., Galtés, I., Velázquez-Ameijide, J., Rebollo-Soria, M. C., & Arregui-Dalmases, C. (2021). "Mechanical Behavior of Blood Vessels: Elastic and Viscoelastic Contributions". *Biology*, 10(9), 831. doi: 10.3390/biology10090831.

García-Vilana, S., Sánchez-Molina, D., Llumà, J., Galtés, I., Velázquez-Ameijide, J., Rebollo-Soria, M. C., & Arregui-Dalmases, C. (2021). "Viscoelastic Characterization of Parasagittal Bridging Veins and Implications for Traumatic Brain Injury: A Pilot Study". *Bioengineering*, 8(10), 145. doi: 10.3390/bioengineering8100145.

García-Vilana, S., Sánchez-Molina, D., Velázquez-Ameijide, J., &Llumà, J. (2021). "Injury metrics for assessing the risk of acute subdural hematoma in traumatic events". *International journal of environmental research and public health*, 18(24), 13296. doi: 10.3390/ijerph182413296.