15th International Symposium on Computer Methods in Biomechanics and Biomedical Engineering
and
3rd Conference on Imaging and Visualization
CMBBE 2018
P. R. Fernandes and J. M. Tavares (Editors)

Abstract ID-167

FINITE ELEMENT ANALYSIS OF THE RADIAL ARTERY COMPRESSION DEVICES TO INVESTIGATE RELATIONSHIPS BETWEEN AN INFLATION VOLUME AND COMPRESSION PRESSURE OF WRIST TISSUE

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Keywords: radial artery compression device, finite element analysis, radial catheterization

Summary: Background: The radial artery compression devices are used to achieve hemostasis after transradial catheterization procedures. The devices are applied around the wrist, and the balloon on the inward side is inflated with air to compress a puncture site. Although various design of compression devices are available, little is known about influences of air volume injected into the balloon on amount of compression of wrist tissue in different devices.
Objective: The aim of this study was to investigate relationships between pressure and volume inside the balloon, and to investigate influences of the amount of air volume injected into the balloon on compression of wrist tissue using finite element analysis.
Method: Two commercial compression devices, TR band (Terumo, Japan) and TRAcelet compression device (Medtronic, United States) were modeled. The devices consisted of dual compression balloons, and the curved plates and straps which were wrapped around the wrist. Membrane element was used for the balloons, and tetra element was used for the plates and straps. The models were analyzed as an elastic material. The wrist was modeled as an elliptic cylinder composed of four layered regions with skin, adipose tissue, muscle, and bone. Adipose tissue and muscle were modeled as Neo-Hookean solid. Skin and bone were modeled as elastic materials. Pressure was imposed on the internal surfaces of the balloons. Quasi-static analyses were performed using the ABAQUS/Explicit.
Result: The relationship between the pressure and air volume inside the balloon, and the relationship between the pressure and amount of compression of the wrist tissue were revealed. The volume inside the balloon of the TR band was larger than that of the TRAcelet device. We calculated the injection volume of air into the balloon based on the ideal gas law. The results revealed that the larger compression of the wrist tissue was obtained by the TR band in comparison with the TRAcelet device.
Conclusion: Regarding the two radial artery compression devices, the relationship between pressure and volume inside the balloon were successfully obtained. The finite element analysis presented here would be useful to determine an appropriate air volume injecting into each device with different design.