Effect of Mild Blunt Trauma on Mechanical Properties of Aorta

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Abstract

Traumatic aortic rupture is a significant cause of death in motor vehicle accidents with aortic injuries leading to 20% fatality in motor vehicle crashes. The knowledge of the material properties of aortic wall is fundamental to the understanding of aorta rupture mechanisms and how a local tear propagates through the aortic wall. It is believed that non-fatal injuries may also lead to long-term cardiovascular disorders in many accident survivors, even with no significant structural damage at the time of accident. The aim of this study was to characterize mechanical properties change along the porcine thoracic aorta wall after a mild blunt trauma.

In this study, five porcine aorta specimens were subjected to mild blunt trauma in an existing dynamic bending test setup, and the mechanical properties of aorta wall were characterized using nanoindentation techniques. The indentation tests were performed on the medial and anterior side of the impacted section (between 3rd and 4th intercostal arteries) and 4cm inferior to that section (between 5rd and 6th intercostal arteries). The indentation tests were performed at the same locations for seven intact aortas as control group.

Although there was no sign of structural damage in the histological results, the mechanical properties of aorta significantly changed as a result of impact. Instantaneous Young's Modulus at the site of impact was decreased by 39% (from 112.48±9.51kPa to 81.21±6.10kPa). Moreover, comparison of the inner and outer halves of aorta wall thickness revealed that the elastic modulus was reduced more in the inner half portion, which indicates that the inner layer of aorta is more vulnerable than the outer layer.

Considering the mechanism of partial aortic rupture and the risk of fatality of TAR, the results of this study are important to investigate local mechanisms of aorta deformation, force transmission, tear propagation and failure.