Proceedings of the Institution of Mechanical Engineers, Part H: Journal of Engineering in Medicine. Volume:225. Number: 7. Pages: 688-695. July 2011

Pressure waves in the aorta during isolated abdominal belt loading. The magnitude, phase and attenuation

C. Arregui-Dalmases, E. Pozo de Dios, S. Stacey, M. Kindig, D.J. Lessley, F.J. López-Valdés, J.L. Forman, R. W. Kent

Abstract— While rupture of the aorta is a leading cause of sudden death following motor vehicle crashes, the specific mechanism that causes this injury is not currently well understood. Aortic ruptures occurring in the field are likely due to a complex combination of contributing factors such as acceleration, compression of the chest, and increased pressure within the aorta. The objective of the current study was to investigate one of these factors in more detail than has been done previously; specifically, to investigate the in situ intra-aortic pressure generated during isolated belt loading to the abdomen.

Ten juvenile swine were subjected to dynamic belt loads applied to the abdomen. Intra-aortic pressure was measured at multiple locations to assess the magnitude and propagation of the resulting blood pressure wave. The greatest average peak pressure (113.6± 43.5kPa) was measured in the abdominal aorta. Pressures measured in the thoracic aorta and aortic arch were 70 per cent and 50 per cent, respectively, that measured in the abdominal aorta. No macroscopic aortic trauma was observed.

To the authors' knowledge the present study is the first one to document the presence, propagation, and attenuation of a transient pressure wave in the aorta generated by abdominal belt loading. The superiorly moving wave is sufficient to generate hydrostatic and intimal shear stress in the aorta, possibly contributing to the hypothesized mechanisms of traumatic aortic rupture.

Index Terms— abdomen, aorta, safety belts, biomechanics, motor vehicle crash

Arregui-Dalmases, C.; Pozo de Dios, E.; Stacey, S.; Kindig, M.; Lessley, D.J.; López-Valdés, F.J.; Forman, J.L.; Kent, R. W.; "Pressure waves in the aorta during isolated abdominal belt loading. The magnitude, phase and attenuation", Proceedings of the Institution of Mechanical Engineers, Part H: Journal of Engineering in Medicine, vol.225, no.7, pp.688-695. July, 2011.