Angiology
The Journal of Vascular Diseases

VOLUME 49 OCTOBER 1998 NUMBER 10

Shock Waves in Vascular Diseases

An in-Vitro Study

G. Belcaro, MD, PhD
A. N. Nicolaides, MD, MS
E. H. Marlinghaus, PhD
M. R. Cesarone, MD
L. Incandela, MD
M. T. De Sanctis, MD
S. Dhanjil, MD
G. Laurora, MD
G. Ramaswami, MD, PhD
L. Artese, MD
G. Ferrero, MD
A. Ricci, MD
A. Barsotti, MD
A. Ledda, MD
R. Steigerwalt, MD
and M. Griffin, MD

PESCARA and CHIETI, ITALY and LONDON, ENGLAND and KREUZLINGEN, SWITZERLAND

ABSTRACT

Three human aortic specimens were used for this in-vitro study on the effects of shock waves on the arterial wall. Specimen one was from a normal (for age) healthy aorta. The full abdominal lengh was used (including mesenteric and renal arteries and the aortoiliac bifurcation), divided into six pieces (3 cm). The pieces were placed and fixed into degassed water. Shock waves (SW) were focused onto the aortic wall by means of a B-mode ultrasound imager. An SW generator (Minilith SL1, Storz Medical AG, Kreuzlingen, Switzerland) was used for setting of energy flux density between 0.03 and 0.5 mJ/mm². The six aortic pieces (excluding piece 1, placed in water and left untreated as control) were treated with SW at increasing energy levels. A second aortic specimen of a man with arteriosclerotic plaques was also used and the experiment repeated at energy levels 1, 5, and 8. Another specimen of normal thoracic aorta was exposed at energy levels 1 and 8 only. Energy levels delivered onto the aortic walls were selected from theoretically destructive levels to minimal levels known not to alter vascular tissues. High-resolution ultrasounds of the aortic segments were performed with a 10 MHz high-resolution, broad-band (ATL 3000, USA) probe in water before and after SW application to detect structural changes in the wall after SW. Histology was performed with a standard hematoxylin-eosin staining. *(continued on next page)*

From the Angiology and Vascular Surgery Departments, Clinical Trials Unit, Pierangeli Clinic, Pescara; the Cardiovascular Institute, and School of Cardiology, and the Institute of Pathology, Chieti University; the Irvine Laboratory, St. Mary's Hospital Medical School and Imperial College, London, UK; and Storz Medical AG, Kreuzlingen, Switzerland.

(Abstract continued)

Results: The aortic pieces did not show macroscopic damages at visual examination, and at the ultrasound examination no visible changes were observed even at higher levels of SW energy. Also no effects were seen by histology. In conclusion, no damaging effects were observed, visually, by ultrasound, or by histology. At these energy levels SW appear to be safe and do not produce any damage to the aortic wall. Therefore, SW could be considered a safe, nondamaging procedure for potential treatment (ie, thrombolysis) in which vessel walls could be involved. Theoretically it is possible that functional changes could be observed in vivo including cell permeability modifications and other alterations (including changes in the potential of the cells in SW fields to modify themselves and to divide). At the energy levels described in this study SW could, theoretically be, safely used for vascular applications (ie, treating venous and arterial thrombi or in arterial plaques modification) without altering major, structural, arterial wall characteristics. Lesions or alterations that have a different density from the normal wall (thrombi or plaques) could be differently sensitive to the same dosage of SW. These differences in acoustic impedance characteristics could be used for potential treatments with SW without damaging the arterial wall.