
# Femoral Neck Phantom Imaging Using Time Domain Topological Energy Method

P. Rosa[a,b], D. Cassereau[a], W. Pereira[b] et Q. Grimal[a]
[a]LIB, Sorbonne Universités, 15 rue de l'Ecole de Médecine, 75006 Paris, France
[b]LUS, Universidade Federal do Rio de Janeiro, 2030, Av. Horácio Macedo, Centro de Tecnologia, Bloco H, Sala 327, 21941-914 Rio De Janeiro, Brésil
ptcardozo@gmail.com

Osteoporosis is a systemic disease that degrades bone quality and leads to fragility fractures with a high morbidity. Ultrasound is an alternative to traditional diagnostic methods which lack specificity and use ionizing radiations. Due to impedance mismatch and attenuation in bone, it is currently impossible to obtain an anatomical image of the internal structure of a bone, e.g., to measure the thickness of the cortical shell, with traditional signal processing in medical imaging.The aim of this work is to evaluate the ability of the time domain topological energy (TDTE) method to reconstruct images of the femoral neck and to evaluate cortical thickness. This method is derived from a topological optimization approach. TDTE uses a combination of theoretical models of the inspected medium and experimental signals. Experiments are conducted with a 128-elements probe with 5-MHz center frequency. The samples are immersed in water and positioned approximately 5 mm from the source. Wave propagation is simulated with Specfem 2D. The space and time discretizations are 30 $\mu$m and 1 ns, respectively, selected according to the CFL stability criterion. The method has been tested measuring a plate (thickness = 5 mm) and a femoral neck phantom (thickness = 1 mm) made with a material mimicking bone acoustical properties. The reconstructed images are then used to evaluate the thickness, and the results show an error below 1% for the thickness estimation. These experiments on phantoms pave the way for ex vivo experiments on human femoral neck.