Three-dimensional imaging and characterisation of bone using a novel omnidirectional ultrasound array: proof of concept.

Duncan F Campbell (Monklands District General Hospital, Airdrie, Scotland)

David K. Smythe (Emeritus Professor of Geophysics, University of Glasgow)

Introduction/Aims

Fundamental to bone surgery is our inability to assess the progression of bone healing. Currently we have to wait for rigid union. Ideally, when is the best time to remove fixation? How successful are bone morphogenic proteins and other advanced techniques? In short, we need better ways to see healing bone.

Material/Methods

We have built and tested a novel prototype 2D ultrasound array in association with the Universities of Strathclyde and Bristol, employing principles derived from seismic reflection imaging. The 550 elements in our planar array are omnidirectional. Each is activated in turn as a point source illuminating the whole volume beneath the array, while all 550 simultaneously receive the backscattered echoes. The conversion of the resulting dataset into a true 3D volumetric image is done using standard geophysical industry software. The full image is obtained within an inverted pyramid about 60 mm below the 48 mm x 42 mm array. Resolution is 1 mm horizontally and about 0.3 mm vertically, but in contrast to conventional ultrasound methods does not degrade with depth.

Results

Imaged inorganic phantoms and cut samples of bovine bone show that the technology transfer of 3D imaging from the seismological to the medical ultrasound domain is successful, even though the elements at present have limited omnidirectionality and a centre frequency of only 2 MHz.

Conclusions/Clinical Relevance

The imaging not only makes allowance for the widely different sound velocities of bone and tissue; the elastic properties (and hence strength) of bone can be estimated directly from the data.

British Association of Oral and Maxillofacial Surgeons Meeting, Bournemouth, Abstract no. 176, Programme 12.