JOURNAL OF CARDIOVASCULAR DIAGNOSIS AND PROCEDURES
Volume 15, Number 2, 1998
Mary Ann Liebert, Inc.

Real-Time 3D Ultrasound: A New Look at the Heart

GEORGE D. STETTEN,[1] TAKAHIRO OTA,[2] CHIKAI J. OHAZAMA,[1] CRAIG FLEISHMAN,[2] JOHN CASTELLUCCI,[1] JOHN OXAAL,[3] THOMAS RYAN,[2] JOSEPH KISSLO,[2] and OLAF T. VON RAMM[1]

ABSTRACT

Matrix array ultrasound is a medical imaging modality in which a 3D volume is scanned electronically without physically moving the transducer, permitting rapid continuous 3D scanning of the heart. Unlike reconstructive 3D ultrasound, which relies on physically moving a linear array and acquires data during multiple cardiac cycles gated to the ECG, matrix array ultrasound has no moving parts, resulting in a scan rate rapid enough (22 frames/second) to smoothly sample heart motion within a single cardiac cycle. Therefore, these cardiac studies have been described as real time, and the modality itself has been labeled Real-Time 3D (RT3D) ultrasound. We review the first application of matrix array ultrasound to *in vivo* cardiac imaging of normal volunteers, describing methods of displaying the data during the scan, as well as afterwards on a graphics replay station. We conclude that by introducing the capability of real-time 3D cardiac imaging, matrix array ultrasound provides an important new clinical tool.

INTRODUCTION

At Duke University we have developed an imaging technology known as Real Time 3D (RT3D) ultrasound, based on a matrix array transducer that scans a 3D volume electronically.[1–5] Replacing the single row of elements found in conventional linear (1D) transducers (see Fig. 1A), the elements in a matrix array transducer are arranged in a two-dimensional grid (see Fig. 1B). As with the linear array, the direction in which the matrix array transmits and receives ultrasound energy is controlled by timing individual transducer elements during transmission and reception of the ultrasound. With a linear array, only the direction within a slice, the so-called azimuth, can be controlled, whereas a matrix array offers steering in both the beam's azimuth and elevation, permitting interrogation of an entire pyramid-shaped volume. Using the prototype of matrix-array ultrasound machine known as "T4" (see Fig. 2), we have conducted *in vivo* studies and explored methods of displaying the volumetric data.

[1]Department of Biomedical Engineering and [2]Department of Cardiology, Duke University, Durham, NC.
[3]Volumetrics Medical Imaging, Inc., Durham, NC 27701.