udied are left ventricular (LV) posterior and
al valve, and aortic valve. The LV pressure wave
permitting an estimation of LV mechanical perform
of the QRS, and end of the T wave from the ECG are
de a cardiac cycle frame of reference. Analysis
motion, velocity, mass, and stress, LV volume,
elationships, mitral valve leaflet velocity, and
ent. Future work will be directed toward serial
wall parameters for patients undergoing drug in-
ic studies.

ULTRASONIC VISUALIZATION AND THERAPEUTIC COMPUTER CONTROLLED SYSTEM

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During the last two years at the Fortune-Fry Research Laboratories of the Indianapolis Center for Advanced Research, a major effort has been applied in developing an automated computer controlled multi-purpose ultrasound system. The system offers multifold advantages since it is potentially useful for real time monitoring and controlling of ultrasound instruments and image information acquisition. Particularly, the automated system provides an easy interaction in real time between a physician and the visualization/therapeutic equipment through the assistance of a minicomputer. Presently the described system is in use on a routine clinical research basis, especially, for brain scanning and some very selective brain irradiation procedures.

The complete system is composed of a DEC PDP-11/45 computer running under a Real-Time Executive Operating System, a three-dimensional programmable coordinate scanning device, an IFI M469 5-KW wideband amplifier for high intensity irradiation, an ultrasonic visualization system and a Biomation high-speed digitizer.

The ultrasound visualization system consists of a focused wide aperture transceiver, a wideband linear/logarithmic amplifier and a PEP-400 video-graphic scan converter and associated electronics. The visualization system can be used for B-mode display presentation in linear mode of scanning in x or y coordinate, or in 45° sector scan mode. The echogram displaying appropriate soft tissue details is received on-line and stored on the video-graphic system. The stored echogram can be recorded on a video tape for future usage or these video analog signals can be digitized selectively at a 10 or 20 nsec sampling rate using the Biomation high-speed digitizer. The digitized signals can be fed to the computer

via a direct memory access interface to the computer for processing to determine acoustic parameters which can be utilized in a quantitative evaluation for diagnostic purposes.

The therapeutic system is a closed loop fail-safe unit and contains a focused high intensity ultrasonic lesioning transducer, a 5-KW wideband amplifier, a frequency synthesizer, a programmable attenuator and the feedback circuitry. From the received echogram information a physician can localize the area for high intensity ultrasound treatment and can decide the dosage of high intensity irradiation. The dosage parameters (time duration and intensity) and coordinates information are fed to the computer via a CRT terminal. The computer then presets a programmable counter, and the programmable attenuator with appropriate values, and opens the gate of a frequency synthesizer to feed the sinusoidal signal to the 5-KW amplifier through the programmable attenuator for high intensity irradiation. Also, the same signal is fed to the programmable counter which in turn is incremented at each cycle, and at the end of the preset count, it gives an interrupt signal to the computer, and the computer closes the gate of the frequency synthesizer that in turn stops the source signal to the 5-KW amplifier.

This system is a further evolution of the systems approach to ultrasonic diagnosis and surgery followed in our laboratories for the past two decades.

HOW TO SELECT TRANSDUCERS TO ACHIEVE BEST CLINICAL RESULTS BY USE OF TRANSDUCER BEAM SENSITIVITY PROFILE DATA

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Transducers can now be selected to achieve optimum clinical results by using beam sensitivity profile graphs. Each organ being examined may require different transducer focus, diameter and frequency. With unfocused transducers now being abandoned in favor of a range of focused transducers, it is important to have an accurate understanding of what each transducer beam pattern actually looks like to know when to use it and when not to use it. The beam sensitivity profile is a graph showing how the beam sensitivity varies both with depth from the transducer face and how it varies with lateral alignment. Beam sensitivity profiles give a clear indication of the zone of optimum sensitivity and optimum focus. To examine a particular organ, it is important to select a transducer whose focal zone covers this depth.

Most transducers used in the past were specified by giving frequency, diameter and radius of curvature. The clinician was expected to figure out how these influenced beam profile or accept someone's word for what he should use. Many users believe that a 13 mm diameter, 2.25 MHz frequency and a 10 cm radius of curvature transducer gives best focus at 10 cm when, in fact, it gives best focus in the 4 to 8 cm zone and is rather poor at 10 cm depths. This misconception is avoided when focal zone is specified from a beam profile graph. Presently, many transducers are labeled as having been "focused at so many cm" and a single number given, that number really being a radius of curvature. This practice is misleading and should be stopped since radius of curvature and best focal point are not the same number.

The text book explanations of transducer patterns [illegible] to ultrasound [illegible]

zones and Fraunhofer zones. Usually some rather involved mathematical formulas are given. These are the last things a doctor trying to establish what is wrong with a patient should worry about. A beam sensitivity plot removes this difficulty and gives full scale graphs of actual patterns with no mathematics or arm waving. Another textbook misconception often shows the on axis sensitivity going through several humps and nulls near the transducer face implying inability to detect objects in the null region. The error here is the mathematics is for continuous sinusoidal excitation while the diagnostic ultrasound transducers are driven by very short pulses which avoid such nulls. The beam profile plots are made using the same pulse as the diagnostic ultrasound system so the plots show what really goes on. Still another misconception is side lobes which occur with continuous excitation, but do not exist with medical transducers driven by short pulses.

The talk will cover the following items:

1. Transducer beam measurements
2. How a beam sensitivity profile is obtained
3. How to interpret beam sensitivity profiles in relationship to clinical applications
4. Profiles of commonly used transducers
5. Examples of scans showing transducer effects
6. Optimization of TGC and gain with different transducers to get the best results
7. Common myths about transducers (aging, variation from transducer to transducer, fragility, etc.)