NASA TECH BRIEF

Lyndon B. Johnson Space Center

Determination of Bone Mineral Mass In Vivo

The problem:

Radiography can be used to determine bone mineral mass in vivo, but conventional methods include assumptions that can cause errors of up to 8 percent. It is generally assumed that only two types of tissue are present: bone tissue and soft tissue. In fact, there are usually different types of soft tissue present with different attenuation coefficients.

The solution:

By using radiation sources with two different energy levels, bone mineral mass can be determined more accurately.

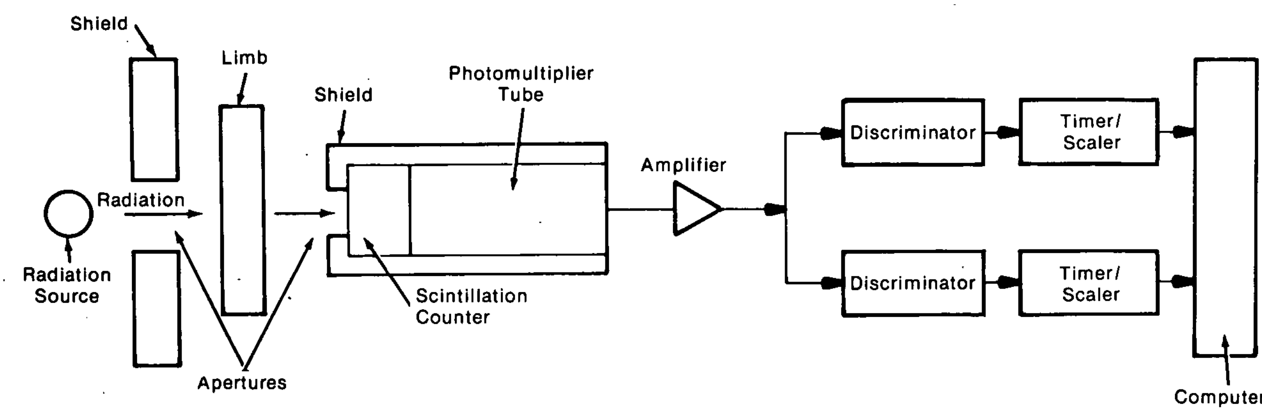
How it's done:

The equipment incorporates two radiation sources generating high-energy and low-energy beams, respectively. The patient inserts his limb in the beam paths. Recording equipment placed on the opposite side of the limb measures the amount of radiation that has penetrated. The data are fed into a computer which then determines the mass of the examined bone.

As shown in the illustration, the radiation sources are placed behind a shield. Different isotope sources can be used to produce the necessary high-energy and low-energy radiation beams. For example, americium-241 can be used for the high-energy output, and iodine-125 can be used for the low-energy output. Alternatively gadolinium-153 can be used as single source of the two energy levels. The beams are transmitted through an aperture in the shield.

The limb to be examined is placed on a mount (not shown) directly in the path of the radiation beams. The recording equipment, on the opposite side of the limb, includes a scintillation counter, a photomultiplier tube, and an amplifier, connected to data-processing equipment. The scintillation counter includes phosphor material which is thallium-activated sodium iodide. Heavy radiation shielding and a narrow aperture prevent stray radiation from entering the counter.

The limb is irradiated at the two energy levels for a fixed period of time. Radiation photons penetrating the limb strike the phosphor material, creating



Equipment for Determining Bone Mineral Mass

(continued overleaf)

discrete flashes. The flashes are sensed by the photomultiplier which converts them to electrical signals. The signal amplitudes are directly proportional to the flash intensities. These signals are amplified and fed into discriminators, timer/scalers, and a computer.

The computer is programed to determine the bone mineral mass from the following relationship:

$$I = I_0 \exp(\mu_{BM} M_{BM} - \mu_{ST} M_{ST})$$

where I is the attenuated beam intensity measured by the counter, I_0 is the initial beam intensity, μ_{BM} and μ_{ST} are the respective attenuation coefficients of the bone and the soft tissue, and M_{BM} and M_{ST} are the bone mineral mass and soft tissue mass, respectively. Using the data obtained from low-energy and high-energy beams, M_{BM} and M_{ST} are determined from two separate logarithmic equations.

Note:

Requests for further information may be directed to:

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Reference: TSP75-10168

Patent status:

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to:

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