Technology Cooperation Office of the Presidency

IRAN

Technological Potential

Ultra Sonic Bone Densimeter

By introducing the Bulletins of "Iran Technological Potential" provided by Technology Cooperation Office of the Presidency (TCO), we intend to encourage international cooperation aiming at sharing technological resources with others. We would put forward more publications of such bulletins in different arenas of science and technology in near future.

As a matter of fact, science and technology has a global nature rather than local or even national, so geographic boundaries has been crossed and as a result, exchanging ideas and maintaining joint research activities has become crucial to many scientists and researchers all over the world. In addition, developments of electronic communication tools as well as IT advances facilitate this process as never before.

The main objective of these bulletins is to improve the international community's knowledge about recent advances of Iran capacities and capabilities in Science and Technology and to facilitate technological collaborations with other countries.

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Research Center for Science and Technology In Medicine (RCSTIM)

Research Center for Science and Technology In Medicine (RCSTIM) is the first center in Iran for application of science and engineering in medicine which was established in Imam Khomeini Hospital, the largest hospital complex of this kind in Iran since 1994. RCSTIM is affiliated with Tehran University of Medical Science (TUMS).

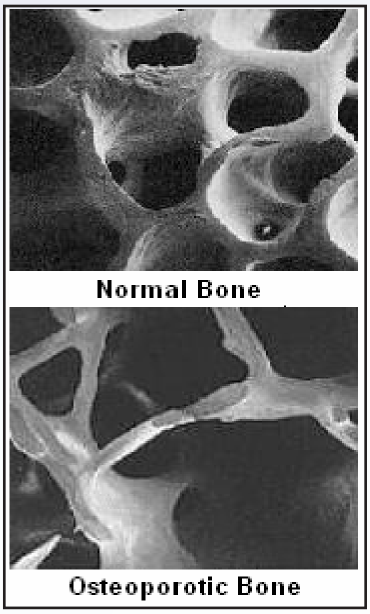
One of the important aims of this center is to provide a common research environment for close cooperation between specialists involved in science, medicine, engineering and industry. This collaboration in one hand highlights RCSTIM research policy direction and on the other hand assure high quality standards required for design and development of medical devices.

Since 1998, in line with the Third Development Plan of I.R. of Iran, the work has been focused on industrial research activities to promote technical knowledge of medical device industry, advanced heath technology and establish joint research programs between universities and industry and science bilateral projects have been worked on. Research labs have been equipped hence to meet these objectives. RCSTIM was officially approved by the University’s Development Council in 2001 and granted its own separate funding by the Management and Planning Organization of Iran.

This project has been done in Research Center for Science and Technology in Medicine (RCSTIM) by Mohammad Djavad Abolhassani and Nima Hemmati . Also we would like thanks Industrial Development & Renovation Organization (IDRO) for financial support. . Also it should be mentioned that patent of BSM-8600 is issued by the I.R.I Patent and Industrial Property.

A Growing Awareness of Osteoporosis:

According to the world health organization, nearly 30% of all postmenopausal women suffer from osteoporosis. Throughout the world there are an estimated 200 million people at the risk of developing osteoporosis. Of those 200 million people only approximately 20% are diagnosed. While osteoporosis can be treated, lack of patient and physician awareness of treatment has been a major factor in lack of treatment for this so called “silent disease”.



Osteoporosis is defined as the loss of bone mass with a concomitant disruption in micro architecture, leading to an increased risk of fracture (Kanis 2002). The most common osteoporotic fractures occur at the wrist, spine and hip. Hip fractures have a particularly negative impact on morbidity. Approximately 50% of individuals who experience a hip fracture never live independently again (Miller 1978). Currently, there are about 200,000 hip fractures yearly in the United States and approximately one million worldwide (Anonymous 2001; Melton 1988).

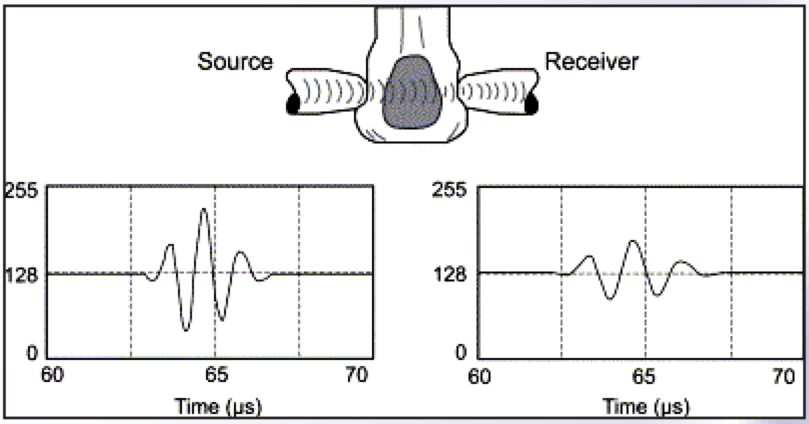
associated fracture risk relies on bone densitometry to measure bone mass (Kaufman and Siffert 2001). The use of bone mass is based on the well-established thesis that bone strength is strongly related to the amount of bone material present and that a stronger bone in a given individual is associated generally with a lower fracture risk (Johnell et al. 2005). Indeed it has been shown that bone mass has about the same power in predicting fractures as blood pressure has in predicting strokes (Kanis 2002). Inherent strength of bone depends on a host of multi factorial components, the amount of mineralized matrix being a major factor. Radiologic densitometry, which measures the (areal) bone mineral density (BMD) at a given site (e.g., hip, spine, forearm) is currently the accepted indicator of bone strength and fracture risk (Johnell et al. 2005; Blake and Fogelman 2003). Clinically, this is often done using dual energy X-ray absorptiometry (DXA), which measures the BMD in units of g/cm2 (Blake and Fogelman 2003). Notwithstanding the fact that X-ray methods are useful in assessing bone mass and fracture risk, osteoporosis remains one of the largest undiagnosed and under diagnosed diseases in the world today (Anonymous

2001). Among the reasons for this is that densitometry (i.e., DXA) is not a standard tool in a primary care physician's office. This is because of its expense and inconvenience, and reticence among patients concerning X-ray exposure, particularly in young adults and children. Ultrasound has been proposed as an alternative to DXA for a number of reasons. These include the facts that it is nonionizing, relatively inexpensive and simple to use. Moreover, because ultrasound is a mechanical wave and interacts with bone in a fundamentally different manner than electromagnetic radiation, it may be able to provide additional components of bone strength, notably its trabecular architecture (Siffert and Kaufman 2007).

Ultrasound in Bone

In recent years, quantitative ultrasound (QUS) technologies have played a growing role in the assessment and management of osteoporosis and are gradually becoming an integrated part of the clinical means of fracture risk prediction. QUS technologies are of interest as they are easily accessible, low-cost, non-invasive, non-ionizing, easy to handle and in some cases portable. In addition, ultrasonic waves are elastic waves that have the potential to probe multiple bone properties, such as bone density, material properties, micro architecture and even macro-structure.

Contact gel coupled method is the best method for ultrasonic densitometry which is sophisticated but more accurate. This method uses two piezoelectric transducers, one acting as a transmitter and the second acting as a receiver. Both transducers are placed on each side of the skeletal site to be tested (heel) along its mediolateral axis.



Ultrasonic waves are used to measure some parameter like speed of sound (SOS), Broadband Ultrasound Attenuation (BUA) and bone's stiffness.
Both transmitter and receiver signals fed to the computer which is placed inside the system, for further processing and parameter extraction. Simple time domain methods have been implemented to calculate speed of sound (SOS), which can be found from the time-of-flight of the signal transmitted through bone and knowing the heel width which is measured automatically by system. It is obviously known that speed of ultrasound is faster in healthy bones than porous bones because it is related to density and elasticity. Typical range of values for SOS (measured along the mediolateral axis) reported for the human calcaneus are 1475–1650 m•s−1.
The frequency-dependent attenuation is obtained from the spectral analysis of these signals, using for example, a Fast Fourier Transform (FFT) algorithm, and by taking the log of the ratio of the receive power spectrum to the transmitted power spectrum. Assuming that ultrasonic attenuation varies approximately linearly with frequency, an assumption comfortably met in the working frequency range of the human calcaneus, the slope of a linear regression fit to the frequency-dependent attenuation in approximately the 0.2–0.6 MHz frequency range yields the BUA value. SOS and BUA parameters can be integrated and introducing "stiffness" as a new parameter which can be used to clinical comparing of patient bone status with normal healthy young (T-Score) and the other people in that same age (Z-Score).

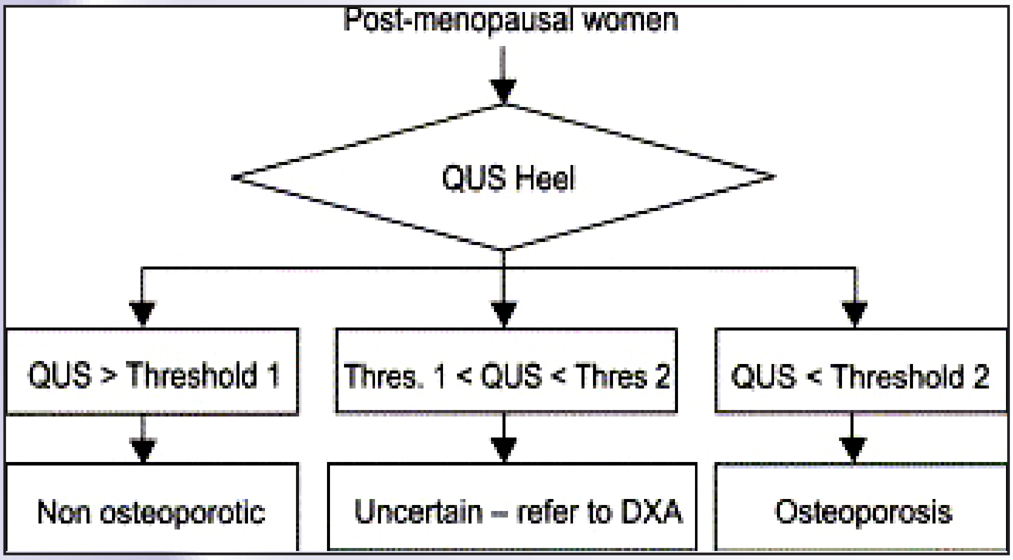


Illustration of the decision-making algorithm for individual patient management

BSM-8600

A complete BMD! BSM-8600 is a PC internal Dry Type QUS (Quantitative Ultrasound) BMD newly developed by Rcstim. As an internal PC device, it can be used in small spaces, and using the internal printer it can produce concise prints that can be conveniently examined anywhere & anytime.
This project has been done in Research Center for Science and Technology in Medicine (RCSTIM) and Industrial Development & Renovation Organization (IDRO) has financially supported it. Also it should be mentioned that patent of BSM-8600 is issued by the I.R.I Patent and Industrial Property.

Excellent Techniques

- Superior Precision
- Permanent coupling pads
- Auto-positioning probes
- Quick Scanning Time (35sec
- Enhanced stabilization

Result Data

- SOS (Speed of Sound)
- BUA (Broadband Ultrasound Attenuation) measurement
- T-score (value comparative to the average bone density of young adults)
- Z-score (value comparative to the average bone density of the same age group)

The product features are listed as table below

Fields of application

- Orthopedist
- Private Radiology Clinic
- Reumatologists
- Family Practitioner
- Obstetrician/ Gynecologist
- Women’s health care
- Nutritionists
- The BSM – 8600 is also optimum for group examination

Performance

Region of Interest heel (Calcaneus)
Scan Method Dry gel coupled technique (no needs to water)
Scan Time 35 sec by average 250 A-mode signals
Output Parameters SOS, BUA, STI, T-score, Z-score
Accuracy 1% (based on QC phantom)
Quality Control Special phantom
Software User friendly with dynamic Access database, also it contains normal reference curves for diverse ethnics

System

Ultrasound Transducers Center frequency: 320 KHz
Inside Computer Processor: Pentium 1GHz
RAM: 256MB up to 512MB
Hard disk: 2GB

Operating System

Windows XP, 98 or higher

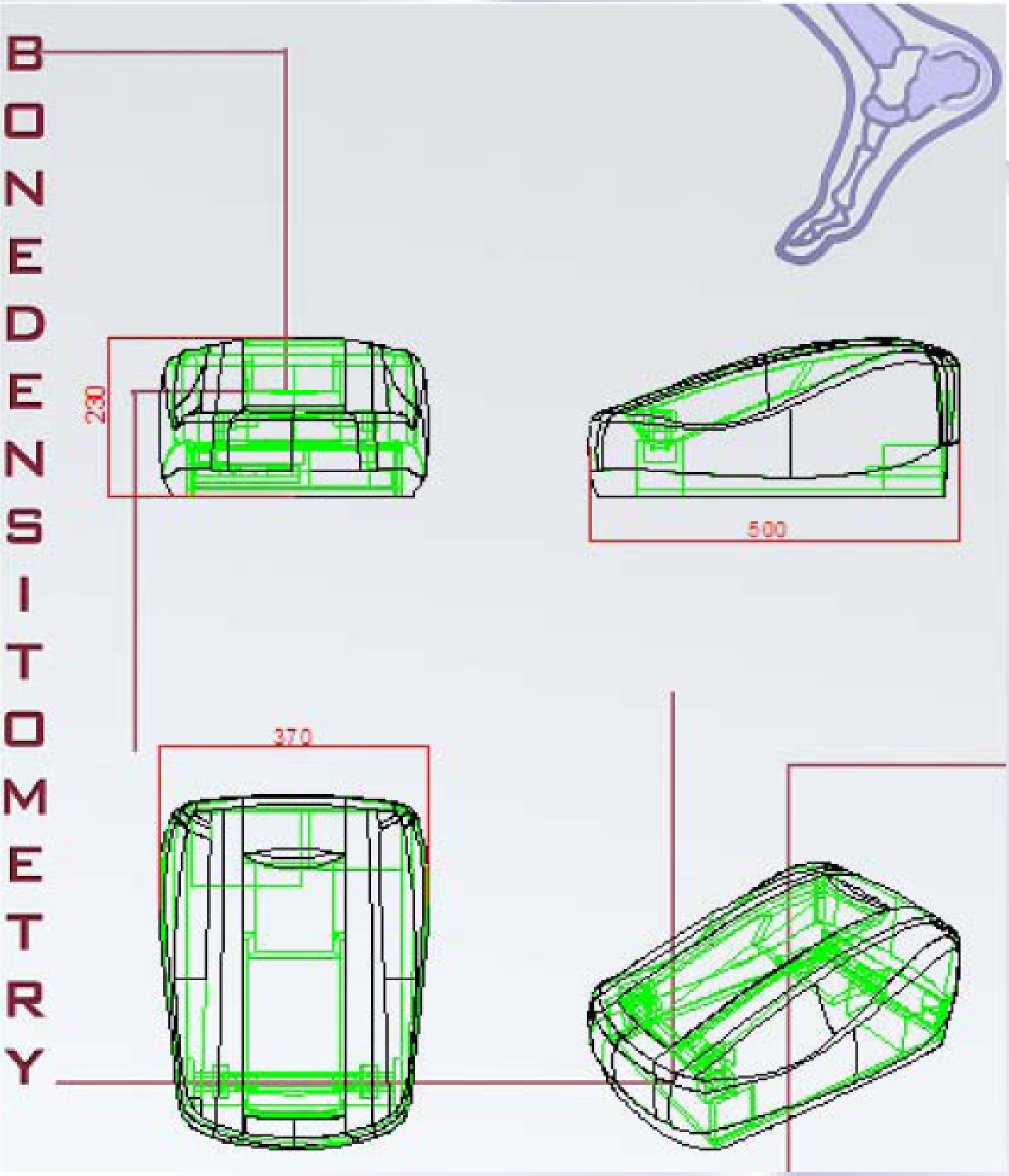
User Interface User can operate the system by keyboard & mouse or by touch screen monitor (optional)
Printer USB port printer for hardcopy of results
Dimensions Portable (L50*W37*H23 cm)
Weight 6 Kg
Input Power 200-240V ~ 50-60 Hz, 95W
100-127V ~ 50-60 Hz, 95W

Opportunities for Cooperation:

Although BSM-8600 has some competitive capabilities, but we are believed that it can be upgraded to meet market demands.

We do look forward to start and develop any cooperation in the fields of joint research, marketing and mass production of this product.

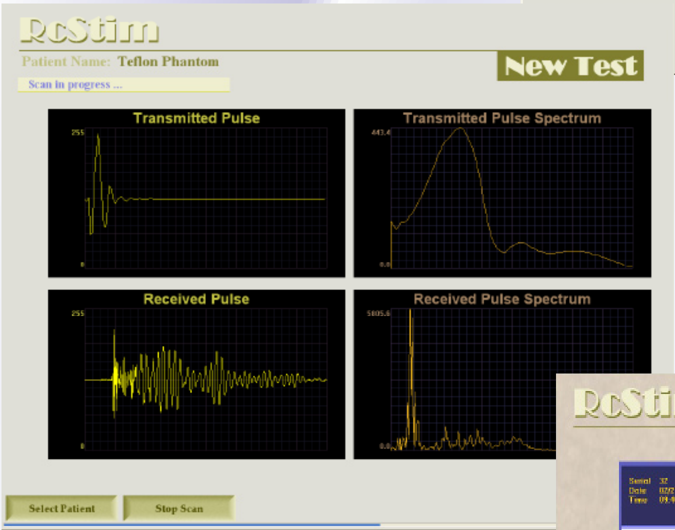
BSM–8600 Innovative Ultrasonic Technology in Peripheral Bone Densitometry



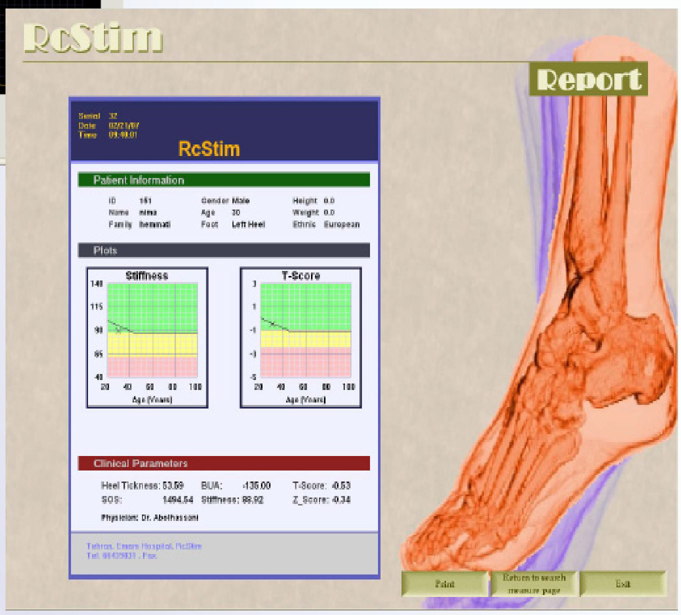
User Friendly Software with Dynamic Database

Main Menu

Search Patient



New Test Window



Results Window