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Review on Different Methods used to Detect Osteoporosis

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Abstract: ***Osteoporosis is a condition in which bones become weak and brittle, due to the reduction in the inorganic constituent of bone. Spongy portion of affected bone becomes a solid block of calcified cartilage. Osteoporosis is characterized by low bone mass and micro-architectural bone fragility. Osteoporotic fractures include increased pain, physical impairment, decreased quality of life, increased risk for new fractures & increased mortality. It is a silent disease as there are often no symptoms and a person may not know until they experience a fracture after a minor incident such as fall or even cough or sneeze. In this review there are different approaches adopted to detect osteoporosis among which analysis of stress waves which are developed by an impact force on long bone is found to be useful in assessment of osteoporosis. This technique provides better understanding of dynamic behaviour of bone under impact force, and the natural frequency of stress wave signal is a clear indication of mechanical stiffness of the bone. Hence stress wave analysis gives better opportunity to diagnose osteoporosis.***
Keywords: Osteoporosis, Bone fragility, Long bone, Stress wave, Impact force.

I. INTRODUCTION

It has been estimated that worldwide an osteoporotic fracture will occur in every three seconds. Among those who had osteoporotic fractures nearly 50% of them have experienced the risk of another new fracture in their near future and the risk keeps on rising exponentially with each fracture occurring [1]. The numbers of patients suffering from osteoporosis are 8.7 % among men in the age group of 50 - 60 years and 20.7 % among women in age group of 40 - 60 years, out of total population of India. Even conservative estimates suggest that out of these, 20 percent of women and about 10 -15 percent of men would be osteoporotic. These are the highest numbers among the diseases that cause many people to become bed ridden due to severe fractures leading to severe complications in their life style and affecting day to day activities.

Healthcare services are heavily burdened by the costs of treating fractures and their complications due to undetected and untreated osteoporosis [11]. Early diagnosis and timely treatment is the way of preventing further complications and fractures. However the lack of a simple and practical screening test has been a major concern, with current methods not fit for this purpose. The most common diagnostic method to detect osteoporosis is using dual energy X-ray absorptiometry (DEXA/DXA). It uses radiations like x-rays which is harmful for the human tissue, as well as it is expensive. Hence it is necessary for different alternative approaches which is inexpensive and can be used to detect osteoporosis without any radiations.

II. DIFFERENT APPROACHES IN DETECTING OSTEOPOROSIS:

A. Nonlinear Ultrasound Detection of Osteoporosis

In this method a short R.F. pulse is sent via transducers as acoustic energy through the patient's heel which is submerged in a water bath, and the received signal is analysed for frequency contents. Correlation between amplitude of the pulse and osteoporosis state was found. Mechanism responsible for variation in the amplitude of the pulse was not clear [2].

B. Finite Element Analysis of Femur in the Evaluation of Osteoporosis

In this study the images of femur taken from x-ray are imported to MIMICS software which initiates the analysis. Segmentation tool is used for the conversion of 3d model. The 3D model is exported to a software ANSYS for the Finite element analysis. Stress and strain values of normal and osteoporosis bone is obtained. The verification required from the biological experiments for the structure analysis makes the process little difficult [3].

C. Handheld Device Tests Bones Micro Indentation To Spot Osteoporosis

It works by pushing the needle into a bone and measuring how far it is able to penetrate the tissue. Measured electronically, the amount of penetration indicated how fragile the bone tissue is and therefore the risk of experiencing an osteoporotic fracture later in life. It is found that a reading of 20 micro metres is healthy bone and 40 micro metres is osteoporotic bone [4].

Fig: Handheld device to spot osteoporosis
Courtesy: Louise Coutts, University of Southampton [5]

D. An Ultrasonic Instrument for Osteoporosis Detecting

In this method it consist of two ultrasonic probes for testing the bone mineral density (BMD), one transmitting probe for sending the ultrasonic signal and the other receiving probe, for collecting the ultrasonic attenuates detecting signal pass through bone. BMD is obtained which reflects the bone strength. Ultrasonic signals will be absorbed by soft tissues which effect the BMD accuracy so in this design it choose calcaneus and tibia bone as test object for they have less soft tissue [6].

E. Osteoporosis Detection In Postmenopausal Women Using Axial Transmission Multi-Frequency Bone Ultrasonometer

The objective of this study was to evaluate if the bone ultrasonic scanner (BUSS) can detect osteoporosis in postmenopausal women. BUSS is an axial transmission multi-frequency ultrasonometer for acquisition of wave propagation profiles along the proximal anterior tibia. It consists of a probe which includes a pair of wideband ultrasonic transducers and a preamplifier for the received ultrasonic signals. The fact that DXA and multi-frequency scanning BUSS are sensitive to different bone characteristics involved in development of osteoporosis would suggest that the combined approach may have a much greater potential in predicting osteoporosis [7].

F. Detection And Prediction Of Osteoporosis Using Impulse Response Technique And Artificial Neural Network (ANN)

In this study an impulse response test was carried out on the tibial bone for the detection of osteoporosis with the help of Lab VIEW. The vibrations which were generated by the periodic impact of surgical hammer were captured by the accelerometer. The recorded analog signal was examined in frequency domain. The natural frequency of the vibration was significantly decreased in osteoporosis subjects which in turn indicate the loss in mechanical strength of the bone and bone mineral density. Prediction of osteoporosis was performed using a decision making system such as ANN, where factors other than bone mineral density was considered. Focus is to design a completely automated impact hammer to make the impact force periodic [8].

G. Novel Point-Of-Care Device Helps Diagnose Osteoporosis

This ultrasound device works by measuring the cortical bone thickness of the tibia. The devices algorithm uses this data to calculate the density index, an estimate of BMD at the hip [9]

Fig: The Bindex osteoporosis screening and diagnostics device (photo courtesy of bone index)

H. Trabecular Bone Quality Metric from X-ray images for Osteoporosis Detection

This paper proposes a method for diagnosis of osteoporosis disease by analysing the trabecular bone pattern. The degree of disease is calculated by analysing trabecular bone pattern using series of image processing techniques. To understand the degree of bone degradation or porous bone rate, high resolution trabecular and cortical bone patterns features are evaluated. To diagnose the internal bone pattern and degree of disease it is necessary to evaluate image properties with bone strength. The image resolution enhancement technique enhances trabecular bone pattern to calculate the performance metrics [10].

I. Detection of Osteoporosis from Percussion Responses Using an Electronic Stethoscope and Machine Learning

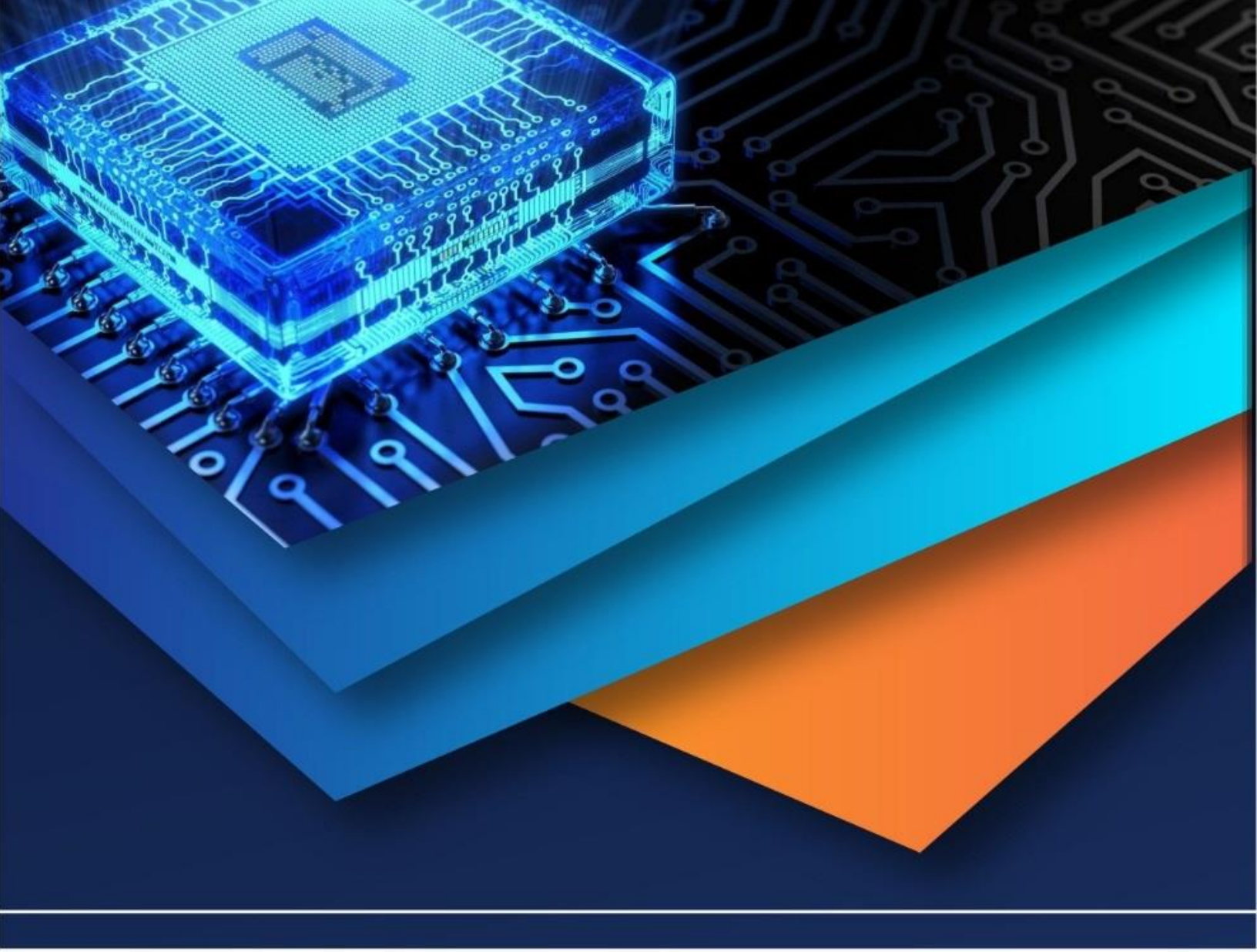
It uses a reflex hammer to exert testing stimuli on a patient's tibia and an electronic stethoscope to acquire the impulse responses. Signals are imported to decision making system (ANN), which predicts the osteoporosis condition. With further work on the signal-conditioning stage, feature extraction, selection algorithms and ANN architecture this method can be improved and the results of this method can be clinically useful [11].

III. CONCLUSION

This review explains different techniques and diagnosis to detect osteoporosis in its early stage. From the overview it is found that the impulse technique used for monitoring the stress wave based on response generated in bone producing the propagation in bone will be useful for detection of osteoporosis. This method gives better understanding of the dynamic behavior of the bone under the impact hammer and the natural frequency of stress wave signal is a clear indication of mechanical stiffness of the bone under investigation. Further this work could be extended by making the impulse hammer completely automated in order to make the impact force periodic and also to prevent the disturbances which are caused due to human contact and other noises.

REFERENCES

[1] Baim S, Binkley N, Bilezikian JP, et al., "Official position of the International Society for Clinical Densitometry and executive summary", the 2007 ISCD position development conference, J Clin Densitom 2008, 11:75–91.
[2] H. E. Engan, K. A. Ingebrigtsen, K. G. Øygarden, E. K. Hagen , L. Hoff, "Nonlinear Ultrasound Detection of Osteoporosis", IEEE, 2006.
[3] Sahiti lahari M , Vijay , Anburajan M , "Finite Element Analysis of Femur in the Evaluation of Osteoporosis", IEEE, 2011.
[4] Engineering and physical sciences research council (EPSRC). "Portable, low-cost early-warning test for osteoporosis". ScienceDaily. ScienceDaily, 17 September 2013.
[5] "Handheld device tests bones micro indentation to spot osteoporosis", University of California, Santa Barbara, University of Southampton, Medgadget, 2013.
[6] Zhou Hongfu, Zhang Zheng, Lin Chengquan, Juliana Tam M.Y., Zhuang Zhenwei, and Yao Xinpeng, "An Ultrasonic Instrument for Osteoporosis Detecting", Springer International Publishing Switzerland, 2014.
[7] Vladimir Egorov, Alexey Tatarinov, Noune Sarvazyan, Randee Wood, Leonid Magidenko, Shreyasee Amin, Sundeep Khosla, Richard J. Ruh, Jennifer M. Ruh, and Armen Sarvazyan, "Osteoporosis detection in postmenopausal women using axial transmission multi-frequency bone ultrasonometer", Elsevier, PMC, 2015. Published in final edited form as: Ultrasonics, 2014 July; 54(5): 1170–1177, doi:10.1016/j.ultras.2013.08.017.
[8] Tejaswini E, Vaishnavi P, Sunitha R, "Detection and prediction of osteoporosis using impulse response technique and artificial neural network", 2016 Intl. Conference on Advances in Computing, Communications and Informatics (ICACCI), Sept. 21-24, 2016, Jaipur, India.
[9] Bone Index Ltd, "Novel point-of-care device helps diagnose osteoporosis", HospiMedica article, Feb 01, 2017.
[10] Reshmalakshmi C, Sashi kumar M, "Trabecular Bone Quality Metric from X-ray images for Osteoporosis Detection", 2017 International Conference on Intelligent Computing, Instrumentation and Control Technologies (ICICICT), IEEE, 2017.
[11] Jamie Scanlan, Francis F. Li, Olga Umnova, Gyorgy Rakoczy, Nora Lovey and Pascal Scanlan, "Detection of Osteoporosis from Percussion Responses Using an Electronic Stethoscope and Machine Learning", MDPI, bioengineering 2018,5,107; doi:10.3390/bioengineering5040107.



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