A new method for the diagnosis of osteoporosis based on standing waves

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Background and aim: The main task of this work was to develop a new method of bone densitometry, based on the effect of resonance (standing waves), and assess reliability of new method for assessment of bone density at the lumbar spine.

Materials and Methods: The applicability of the effect of standing waves for bone density estimation was tested in a group of 15 male volunteers from 50 to 70 years of age. In these subjects, the parameter of bone density at the lumbar spine generated by resonance method, was compared to the bone mineral density (BMD) assessed by dual-energy X-ray absorptiometry (DEXA).

MATERIALS AND METHODS

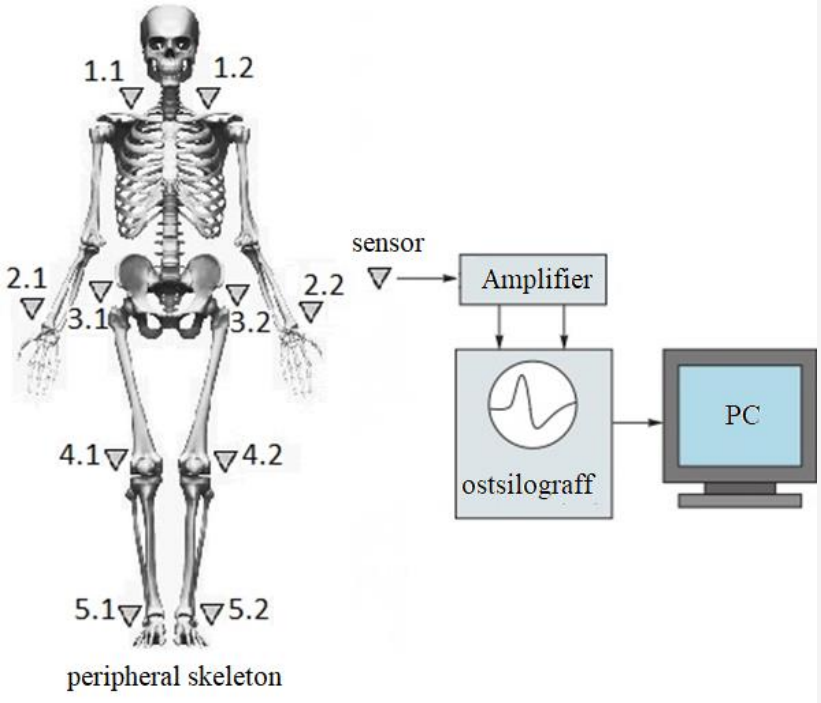

Fig. 1. The experimental setup. The numbers indicate the installation location of the sensor (In addition to these points and sections of the spine from L1 to L4).

Visual measurement video can be viewed here https://www.youtube.com/watch?v=CWB-xz-Qwi0&t=1s (in Russian)

Kolesnikov Y.I., Fedin K.V., Luckymore N. (2019) Direct determination of resonant properties of near-surface sediments using microtremor // Soil Dynamics and Earthquake Engineering. 2019. T. 125. – C. 105739-105739 (8 pages).

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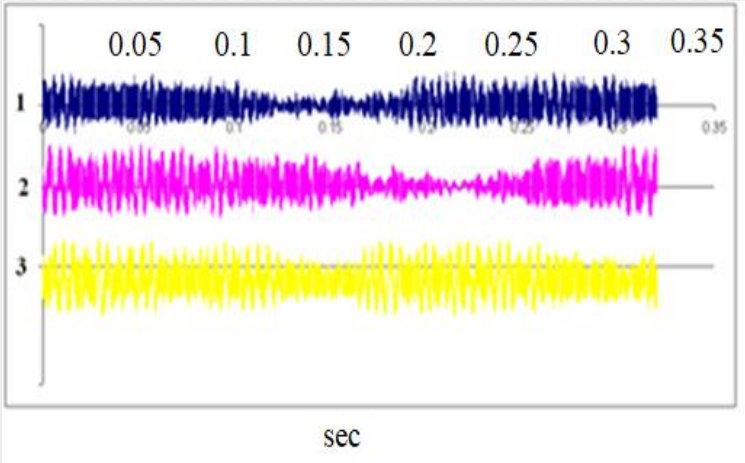

Fig. 2. Three examples of recordings of natural acoustic noise.

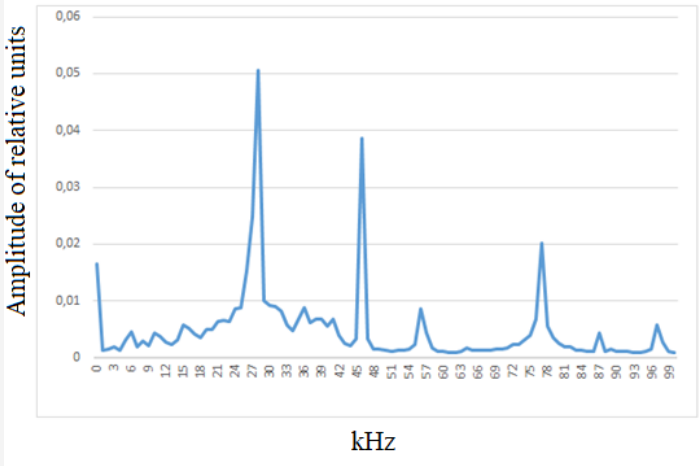

Fig. 3. An example of a spectrum of noise recordings on a peripheral skeleton.

Visual measurement video can be viewed here https://www.youtube.com/watch?v=CWB-xz-Qwi0&t=1s (in Russian)

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RESULTS

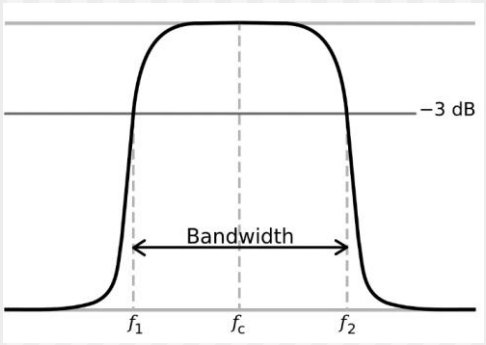

Fig. 4. A filter's gain magnitude, illustrating the concept of −3 dB at a voltage gain of 0.707 or half-power bandwidth.

Resonance quality factor demonstrated close positive correlation with BMD obtained by DEXA (r=0.92, p<0.00001).

Subject	DEXA (BMD, g/cm2) / resonance method (quality factor)			
	L1	L2	L3	L4
1	1.256/6.749	1.357/7.29	1.353/7.26	1.46/7.84
2	1.138/5.89	1.383/7.21	1.343/7	1.345/7.01
3	1.201/6.565	1.211/6.61	1.271/6.94	1.123/6.13
4	1.495/8.38	1.6/8.95	1.713/9.56	1.669/9.32
5	1.01/5.23	1098/5.716	1.188/6.20	1.223/6.39
6	1.34/7.07	1.551/8.2	1.718/9.11	1.656/8.77
7	1.158/6.17	1.378/7.35	1.403/7.5	1.124/5.98
8	1.046/5.68	1.135/6.16	1.253/6.81	1.012/5.50
9	1.13/5.84	1.284/7.03	1.24/6.98	1.33/7.2
10	1.22/6.83	1.33/7.24	1.518/6.18	1.57/6.2
11	1.363/7.1	1.446/7.68	1.656/8.99	1.602/8.7
12	1.465/8.29	1.332/6.9	1.342/7.23	1.265/6.53
13	1.21/6.7	1.23/6.9	1.32/7.14	1.43/7.68
14	1.234/6.76	1.378/7.44	1.543/8.36	1.454/7.76
15	1.34/7.04	1.68/9.08	1.73/9.38	1.612/9.18

TABLE I. The results of BMD assessment at the lumbar spine (L1-L4) performed by new (resonance) method and DEXA in men aged from 50 to 70 years

CONCLUSION

As a result of this study, a new approach for the bone density assessment based on standing waves was generated, as well as its hardware implementation. Our preliminary data indicate that the results of the bone density estimation (quality factor) at the lumbar spine generated by wave resonance method are comparable to those from DEXA. The advantages of the proposed method are the low cost and the absence of radiation exposure to the patient. The applicability of the technique to other parts of the skeleton requires further study.


Thanks for your attention