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Bone metabolism assessment, bone metabolism index designation and the determination of its normal values range in young healthy women

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Data Interpretation
E Manuscript Preparation
F Literature Search
G Funds Collection

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Summary

Background: Bone metabolism assessment requires the determination of bone mass and quality. The bone metabolism was assessed with the modified bone scintigraphy using ^{99m}Tc-MDP. The elaboration of radioisotopic method and program allowed for the assessment of bone metabolism, index of bone metabolism assay and definition of its normal values range with the possibility of clinical application.

Material/Methods: We examined 70 healthy young women with normal BMI, in which bone system was assessed with scintigraphic and densitometric examinations, and bone turnover markers definition together with hormonal and biochemical blood tests were performed. Group exclusion examinations were also performed, including basic, biochemical and hormonal blood tests, bone turnover markers and densitometric examinations with DXA technique. The scintigraphic examinations were performed using a gamma camera after ^{99m}Tc-MDP injection. After the application of the BONS method and program, the normal values range was determined with the STATISTICA 8 program.

Results: The normal results of basic, biochemical, hormonal and vascular tests were obtained. The examinations of bone turnover markers confirmed the balance between bone formation and bone resorption processes. The normal results of densitometric examinations excluded osteopeny or osteoporosis. The normal values range of IBM in young healthy women was between 84.08 and 105.

Conclusions: The elaborated BONS program and method allow for the quantitative assessment of bone quality and definition of IBM normal values range. The quantitative scintigraphic bone examinations provide an alternative to the bone markers examination for obtaining information about bone metabolism.

key words: **metabolism • densitometry • bone scintigraphy • index of bone metabolism**

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BACKGROUND

Normal bone tissue changes depend on many extra- and intrasystemic factors determining normal mass, weight and build of bones at maturity [1]. Bone mineral density (BMD) is assessed with the densitometric method. As a person ages, bone metabolism and mass undergo certain changes. At the end of the third decade of life there is a peak in bone mass. In the diagnostics of bone metabolism, bone turnover markers (resorption and bone formation markers) are also very useful [2–11]. Unfortunately, due to their great inconstancy and high cost, they are rarely used; however, they are very helpful in scientific studies [12]. Thus, the search for alternative methods for use in assessing bone metabolism and quality continues. Inconsistency of densitometric examination results, clinical symptoms and other diagnostic examinations is common. At present, in osteoporosis diagnostics, it is necessity to allow for lower bone resistance consisting of mineral density and bone quality and metabolism [13–15]. The occurrence of fractures with T-score values corresponding to osteopeny cause the broadening of diagnostics by additional risk factors (apart from densitometric examinations) such as body mass index (BMI) value. The assessment of bone metabolism, as opposed to bone mass, is not measured with densitometric methods [16]. The densitometric examination shows the degree of bone loss; however, it doesn't reveal its cause. That is why it is important to look for clinically useful diagnostic methods of bone change assessment. The methods that define bone metabolism and fill the gap in osteoporosis diagnostics are (after the application of the proper program) radioisotopic, scintigraphic, dynamic and static bone examination.

Contemporary nuclear medicine uses markers whose accumulation in bone tissue is directly connected with the occurring metabolic processes. One of these markers is methylene diphosphonate radiopharmaceutic (MDP) marked by TechNet isotope (^{99m}Tc) designed, among others applications, for bone picturing. Its distribution, proportional to the degree of blood flow, is a measurable index of osteoblastic processes intensification. The maximal marker accumulation in bones, 60–80% of the given dose, is observed 2 hours after the injection is given, and it remains unchanged for about 72 hours. Evaluation of results of examinations using ^{99m}Tc-MDP suggests that MDP shows the connection of skeletal blood stream activity to osteoblastic activity. These observations allow for including the Radioisotopic method of bone examination into the spectrum of examinations assessing bone metabolism, in which examination of bone turnover markers has rarely been clinically used. The necessity for the determination of bone mass and bone quality provided for us a motive for the wider application of the scintigraphic method, allowing for the assessment of bone metabolism. The correlation between the whole body bone metabolism and accumulation of ^{99m}Tc-MDP in particular bones has been assessed in few studies [17–23]. The aim of this study was to determine the radioisotopic method and program that could assess bone quality through the determination of Indicator of Bone Metabolism (IBM), establishing its correlation with BMD and bone turnover markers together with the possibility of the application of the method in the complementary assessment of the bone system.

Aim

The aim of this study was evaluation of Radioisotopic bone metabolism assessment (^{99m}Tc-MDP) and to determine the designation of Radioisotopic bone metabolism indicator with its normal values range in young, healthy women.

MATERIAL AND METHODS

Material

Seventy healthy women were assessed, ages 25–40 years (31.73±4,96) with normal body weight (18.44<BMI<24.98), in which densitometric, scintigraphic and bone turnover markers designation examinations of bone system were performed together with biochemical and hormonal blood tests. The examined women confirmed normal everyday physical activity without additional exercise and they were properly nourished, consuming 2000 calories a day on average. All the women were informed of the character and course of the examination and they each gave their consent. The protocol of the examination was accepted by the Ethics Commission of the Medical University in Lodz.

Methods

The exclusion or inclusion to the analyzed group examinations

For the exclusion of bone system metabolic diseases and metabolism disturbances, after taking a precise and thorough history and undergoing biochemical and hormonal blood tests, women were excluded who had the most important diseases predisposing for osteoporosis development – hormonal disturbances of parathyroid glands, hyperthyroidism, sex hormones insufficiency, chronic liver diseases, lymphatic and blood system diseases, malabsorption syndrome, diabetes, stroke, treatment in the area of lower limbs, and chronic drug intake of glucocorticosteroids, thyroid hormone, immunosuppressive or cytotoxic drugs. The women underwent the following:

- Biochemical blood tests: ionized calcium, alkaline phosphatase, phosphates, glucose, total cholesterol, and total protein.
- Hormonal tests performed in the second phase of menstrual period: free thyroxine (FT4), thyroid-stimulating hormone (TSH), and parathormone (PTH) progesterone, testosterone, estradiol. The results were marked with enzyme-linked immunosorbent assay (ELISA) method from the blood taken on an empty stomach at 8–9 a.m.
- Standard vascular examinations: lack of lower limbs perfusion disturbances was verified with Doppler flowmeter VENO®, resistance index (RI) and pulsation index (PI) and maximal blood flow were defined. Ankle-brachial index (W_{k-r}) was also defined.

Basic data collected were age, weight, height, and BMI.

Bone turnover markers

Bone turnover markers were designated in the morning in venous blood serum samples, taken on empty stomach at 8–9 a.m. Serum (without hemolysis or lipemia traces) was obtained as quickly as possible after blood sampling, and then they were frozen and stored at –20°C. Care was taken

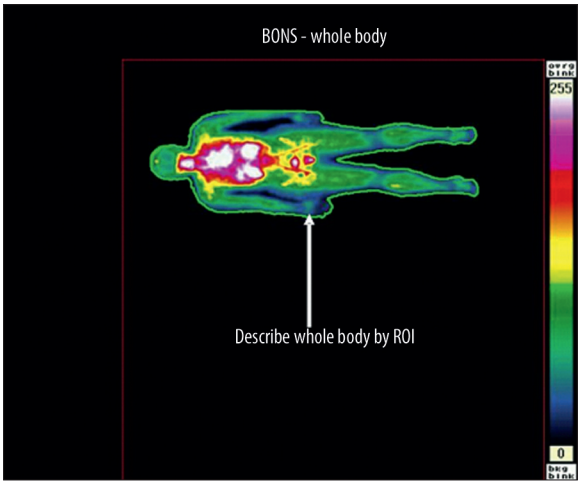

Figure 1. Whole body.

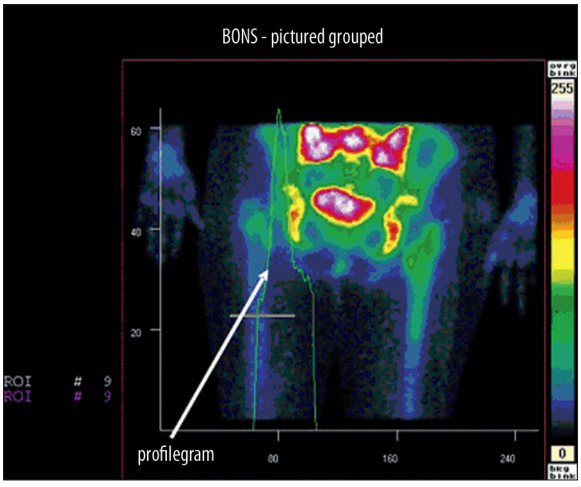

Figure 2. Profilogram drafting.

to ensure that blood samples were not repeatedly frozen and thawed.

For the biochemical assessment of bone system rebuilding, in the blood serum there was assigned the bone-forming marker osteocalcin (bone GLA protein) and bone resorption marker – *Collagen Type I Crosslinked C-telopeptide.*

Densitometric examinations

A measurement error of BMD and soft and fat tissue was defined with dual energy X-ray absorptiometry (DXA) technique and NORLAND XR 46® densitometer calibrated daily with morphology ready-made phantoms. Standard deviation was within accepted value ±2%. The examinations were performed according to the standard protocol, and BMD and T-score of femur bone neck were defined. The mineral density of the whole skeleton was performed with the whole-body technique.

Radioisotopic examinations

Radiopharmaceutic ^{99m}Tc-MDP was used for the bone metabolism assessment. The distribution of the radiopharmaceutic is proportional to the size of the thigh blood flow and the intensification of osteoblastic processes, due to which about 60–80% of the given dose is accumulated in the bones. The maximal accumulation is observed after 2 hours of the injection and it remains unchanged for 72 hours. Radioisotopic examinations of the bone system were performed our own method and the BONS program. The program consists of 3 parts. The first part defines the acquisition parameters and facilitates the correction of the renewed patient's position in the delayed phase for the proper acquisition of the analyzed region of interest (ROI). The second part – femur dynamic examination – was used for verification in the range of perfusion symmetry and the lack of lower limbs perfusion disturbances. The third part was definition of IBM with the applied program. The acquisition consisted of 2 parts (dynamic and static) and was performed with an APEX SP-6HR gamma camera with high-definition 5-HR. After the positioning of the camera head in P-A projection in the area of the femur and the injection of Tc^{99m}MDP with 11.1 MBq/kg b.m. activity, 120 1-second pictures and 56 5-second pictures were registered (the dynamic phase lasted 5 min.). The dynamic acquisition was recorded in a 128×128 matrix. Next, the whole body scintigram was performed in P-A projection with the head constant speed of 38 cm/min. The static acquisition of femurs (delayed phase) was performed after 3 hours in P-A projection in 300 sec. in a 256/256 matrix. The analysis of the registered pictures was as follows. The whole body scintigram was put into 1 picture which, after purification from the background noise and filtration with a 9-point filter, was automatically described by ROI. On the basis of the information contained in this ROI (Figure 1), the number of calculations for 1 pixel of the matrix (in the further part of the program defined as the density of the whole body calculations) was established and registered in the symbol table. Then the pictures from the dynamic part were grouped into 1 5-minute picture for the profilegram of the picture establishment (Figure 2). From the obtained data, the ROI describing the muscles of this thigh in which the maximal accumulation point was defined was traced. The mirror ROI was put onto the other limb.

As a result of multiple analyses of the examinations, 60% of the background separation was established, which guaranteed the automatic ROI generation with the maintenance of the necessary number of calculations for the drawing of curves of the activity changes in the thigh area. To optimize the activity changes in the dynamic phase, the obtained histograms underwent gamma adjusting, in which the point of maximal accumulation was assigned (Figure 3). The beginning of the coordinate system and the point defining the maximum on the curve was joined with the straight and the tangent of the angle between this straight and the ordinate (X axle) was calculated. The values for the right and the left thigh were calculated separately (TG_LEFT, TG_RIGHT) (Figure 3). The value of this parameter describes the speed of the index flow through the vessels of the thighs in vascular phase. The calculated quotient (IN) of those indexes defined the value of the symmetry of the index flow through the analyzed thigh area (Figure 3). It was assumed that for the definition of the normal index values, the full perfusion symmetry should be maintained in all the patients. However, taking into consideration the possible errors in the patients' positioning, ±5% mistake was allowed, therefore the patients

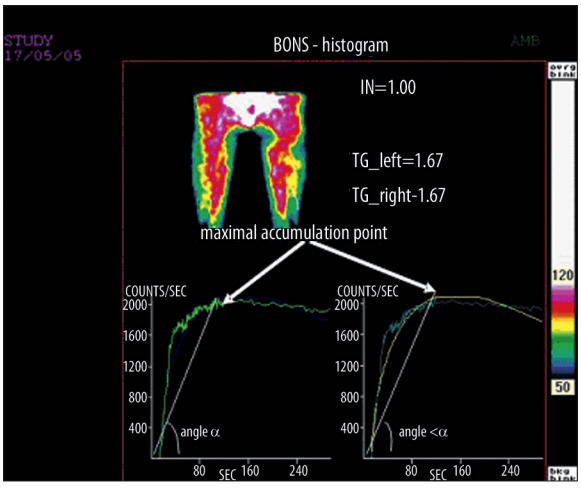

Figure 3. The dynamic examination.

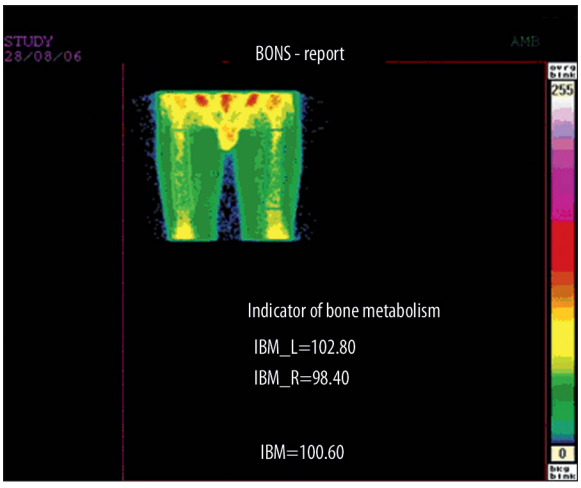

Figure 4. Final report.

in which 0.95<IN<1.05 was confirmed were qualified for further examinations. After the analysis of the dynamic part, the program analyzed the static picture of the delayed phase 3 hours after the index application. The scintigram was purified from the noises with FCLEAN function and then filtered with a 9-point filter. With the generated indexes, the length of the left thigh bone was measured, and after the definition of the maximal point, the profilegram was traced. For the maximal separation of the bone picture, on the basis of the profilegram curve value, the background was isolated at the level of 40% of maximal value. After that, an auxiliary square ROI with the height equaling half of the femur length was generated and using markers it was positioned exactly in the middle of this bone.

Within this ROI, with the marker, an ROI describing half of the femur length was traced, to which the ROI of the background with the established parameters was automatically added. The ROI of the examined femur was copied onto the other limb and the ROI of the background with the parameters identical to the first limb was added. The level of the background was subtracted from the ROI value and the number of calculation for the one matrix pixel was defined. The parameters obtained in the dynamic and static part of the examination allowed for the writing of mathematic dependency defining the quantity of the accumulated MDP in the chosen fragment of the femur in relation to the total quantity of the marker given to the patient. To eliminate the time influence on the calculated value, those parameters were revised by the physical degradation of the TechNet isotope from the beginning of the injection to the performance of the last scintigram. The obtained values reflected the number of MDP inbuilt in both femurs. According to the results of other authors and obtained in our examinations, it can be assumed that in young healthy women, the speed of marker accumulation in certain segments of bone system is stable and the quantity of the inbuilt radiopharmaceutic is directly proportional to the mass.

The obtained result was called the Radioisotopic IBM and was calculated from the formula:

$$IBM\_L(R) = \frac{(G_{tot} - G_{roi}) \times 361{,}2 \times \ln(2)}{G_{tot} \times EXP(T_0 - T_1)}$$

IBM_L(R) – radioisotopic IBM of left (right) femur
G_{tot} – the number of calculations per 1 pixel in the whole body examination
G_{roi} – the number of calculations per 1 pixel in ROI
T_0 – the beginning of the dynamic phase
T_1 – the beginning of the static phase

From the calculated indexes, the mean value of the IBM was calculated separately for the right and left side:

$$IBM = \frac{IBM\_R + IBM\_L}{2} \times 100$$

On the basis of the obtained values of both thighs, the symmetry factor of the osteotropic index accumulation in femurs in delayed phase was calculated and the value is presented as a percentage. This parameter had the auxiliary character and was additionally used in the qualification to the examined group. The patients in which the symmetry factor was <95% were excluded from further analysis. The obtained results were registered in 2 reports ascribed to the given examination. Figure 4 shows 1 page of final report.

The process of the analysis of the obtained scintigraphic pictures was maximally automated for the elimination of subjective operator's mistakes. In most cases the program demanded only acceptance from the person processing the examination, which does not mean there were no possible interferences in the analysis process.

For the assessment of the correctness of the program, 3 phantoms were constructed, in which the described examinations of the whole body and static examinations were performed. The dynamic examinations were not performed on the phantoms. Knowing the activity in the given areas and all the parameters of the acquisition, the results of the program were verified with the results of the hand calculations. The obtained values were identical in both cases and confirmed the correctness of the elaborated program. The recurrence of the results was checked by multiple processing of the same examination. The obtained results differed by only thousandth parts of the calculated parameters and confirmed the proper program algorithm.

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Table 1. The results of basic and bone turnover examinations in women qualified to the examined group.

Examinations			n=70			
Kind	**Unit**	**Range**	**Mean**	**SD**	**Min.**	**Max**
Basic examinations						
Age	Years	–	31.73	4.96	25.00	40.00
Weight	kg	–	62.61	7.35	47.00	80.00
Height	cm	–	164.11	6.02	154	180.00
BMI	kg/m^2	18.4÷25	23.12	1.86	18.44	24.98
Bone turnover markers						
hOST	ng/ml	2÷15	9.21	1.46	6.44	13.28
CrossLabs	ng/ml	0.112÷0.738	0.49	0.03	0.42	0.56

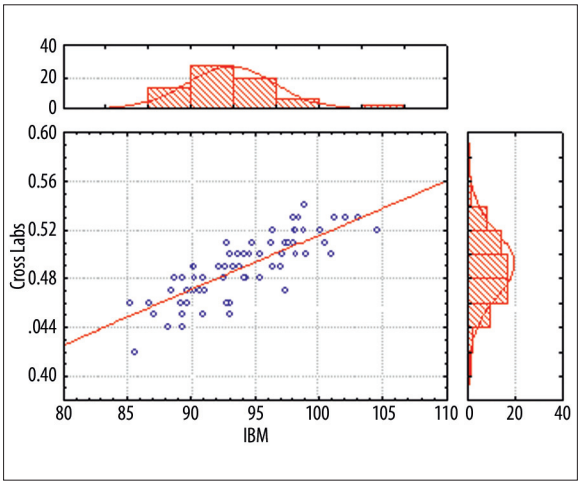

Figure 5. The dispersion of the resorption marker (crosslabs®) in relation to IBM.

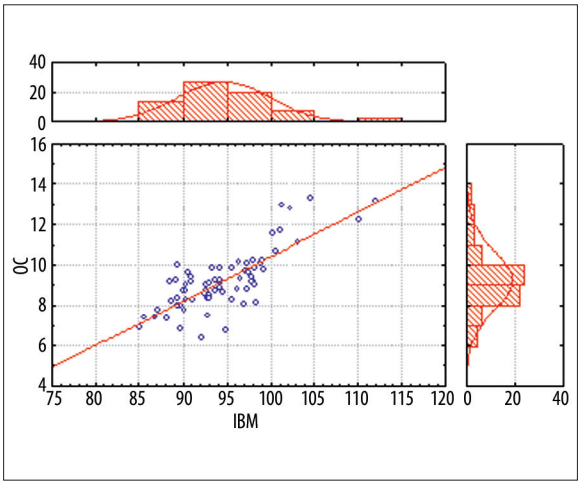

Figure 6. The dispersion of the bone formation marker (hOST) results in relation to IBM.

To confirm the hypothesis of the invariability of MDP accumulation in the bone system within several hours after the injection was given, additional tests were performed. Ten volunteers were chosen from the examined group, in which 3 hours from application of the injection, after the end of the last acquisition, a series of 4 examinations was performed with the interval of 30 min. The acquisitions parameters were analogous to the BONS program. The delineated curve of the activity changes in additional acquisitions, corrected with the physical degradation of ^{99m}Tc, was the straight parallel to the X axle. This confirmed the stability of the accumulated radiopharmaceutic MDP in the analyzed time periods of the examination static phase.

Statistical analysis

All the calculations were performed with the Statistica pl 8.0 statistical software program. For the measurable variables, a mean value together with the highest and lowest one and standard deviation were given. Before the analysis of the measurable variables in the examined groups, a normal distribution hypothesis was verified (normal distribution or its lack influences the choice of the subsequently used statistical methods). The hypothesis was verified with Shapiro-Wilk test. In case of normal distribution, a classic ANOVA test was used, and in case of the lack of normal distribution an ANOVA Kruskal-Wallis test was used. The dependency between the analyzed parameters was defined on the basis of Pearson linear correlation cofactor.

Results

Basic examinations and bone turnover markers

Basic examinations: the values of BMI had normal distribution. The average age of subjects in the examined group was 31.73 years of age. The BMI was 18.44<BMI<24.98, which confirmed the normal body weight of the patients (Table 1). The values of bone formation and resorption markers did not exceed the normal values range (Table 1).

The crosslabs® marker values had normal distribution, confirmed by the chart of the distribution (Figure 5) where the regression line is straight, around which the given results are located.

Table 2. The analysis of the test power for BMD of thigh bone neck of the analyzed group of patients.

	Power BMD thigh bone neck; one mean; test t; H0: Mi=Mi0
	value
Zero hypothesis mean (Mi0)	1.0000
Population mean (Mi)	0.9440
SD in population (Sigma)	0.0500
Standardized effect (Es)	–1.1200
N	70.0000
Probability of mistake I (Alfa)	0.0500
Critical value t	1.9949
Power	**1.0000**

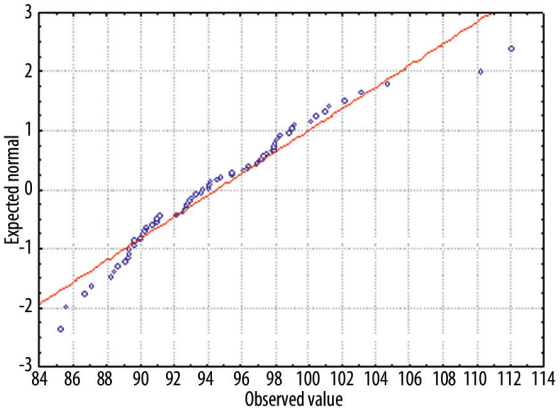

Figure 7. The chart of the probable distribution of normal IBM.

Table 3. The power of correlation between IBM and other results.

	The power and the direction of correlation between IBM with:			
	BMD b.m..	BMD f.n.	Marker hOST	Marker crosslabs®
Pearson's constant [r]	+0.82	+0.86	+0.79	+0.83

Table 4. Basic statistic values of IBM in the examined group of young healthy women.

N=70				
Mean	**Median**	**SD**	**Minimum**	**Maximum**
94.54	93.908	5.23	85.25	112.07

The values of the hOST marker had normal distribution, confirmed by the chart of the distribution (Figure 6) where the regression line is a straight one, around which the given results are located.

Densitometric examinations

In the analyzed group the bone mineral density of the femur neck was 0.868<BMD<1.0 g/cm^2 with SD=0.05. T- score was –0.94÷+0.93 with SD=0.43. The bone mineral density of the whole skeleton was 0.915<BMD<1.14 g/cm^2. The measured densitometric results excluded osteoporosis and osteopeny and confirmed the proper patient selection to the analyzed group. The assessed densitometric parameters had normal distribution. On the basis of this fact, the analysis of the test power for BMD of the femur neck was performed (Table 2).

Table 2 presents the test power for BMD of the thigh bone neck. A very high test power was obtained with the mistake probability of α=0.05. Such high power is connected with a relatively large group of examined women and a very small result dispersion.

Radioisotopic examinations – IBM and its normal values range designation

The shape of the regression line of the results and the position of the given values around this line, presented in Figure 7, confirm that the results of IBM in the examined group had normal distribution.

Table 3 presents the correlative dependency between the designated Radioisotopic IBM and densitometric assessment of bone mineral density and biochemical bone turnover markers. In each, a strong positive correlation was observed.

Table 4 presents basic statistical values of IBM in the examined group.

The obtained results were within a relatively narrow range (85.25–112.07), with a quite small SD of 5.23. This shows the high degree of homogeneity of the analyzed group in the range of the calculated IBM. Following the rule that the norm is established on the basis of mean value and SD, the range of normal values for the radioisotopic IBM was defined on the basis of the obtained values (Figure 4).

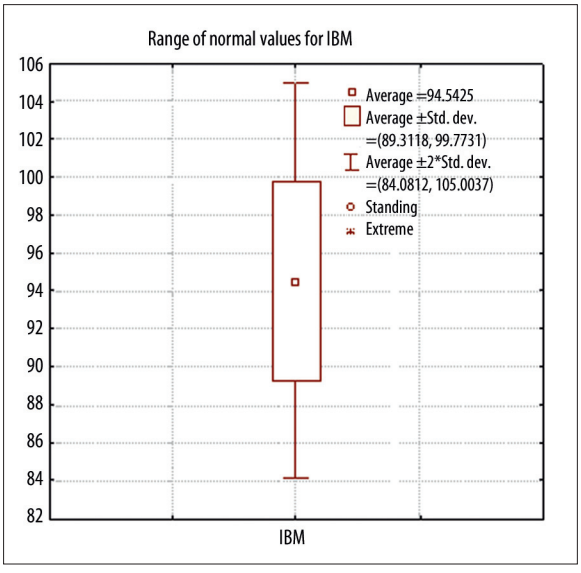

Figure 8. The range of normal values for IBM.

The statistical analysis of the IBM results shows neither extreme nor outstanding values, which is confirmed in Figure 8. The calculated range of normal values for IBM was within: 84.08<IBM<105.

Discussion

Bone metabolism disturbances and bone mass loss consequently lead to osteoporotic fractures and worsening of the patients' well-being.

Bone metabolism is characterized by 2 opposite processes: resorption and new bone formation [13,24,25]. Bone restructuring is a constant process, due to which bone undergoes resorption by osteoclasts and new bone formation due to osteoblasts [26–28]. For example, the 20-day destructive activity of osteoclasts requires 150-day activity of osteoblasts to rebuild the destroyed bone tissue. The bone mass depends on the balance between these 2 processes. The period of consolidation (balance) and reaching peak bone mass is between 25–40 years of age, when the metabolic phenomena of bone tissue formation and destruction are balanced [29,30]. There are many factors that influence bone metabolism. Bone turnover is regulated by many factors, such as mechanical forces, hormones, cytokines, local factors and behavior [26,31–33]. It is very important to provide the body with the quantity of calcium and phosphates necessary for proper bone mineralization. Calcium administration influences the bone mass formation process. The hormones circulating in blood bind with the plasma protein. The most important binding proteins are CBG cortisol and progesterone binding, SHBG (sex hormone-binding globulin) and TBG (thyroid-binding globulin). Estrogens lower the resorption speed by antagonizing parathormone influence on the bones [34,35]. Biochemical and hormonal blood tests are usually assessed at the beginning of the diagnostic process; their aim is exclusion or the inclusion to the analyzed group. The conducted studies excluded the bone system diseases and metabolism disturbances. The diseases predisposing to osteoporosis development were excluded – parathyroid glands hormonal disturbances, hyperthyroidism, and chronic drug intake (glucocorticosteroids, thyroid hormone, immunosuppressive and cytotoxic drugs). The results of biochemical and hormonal tests that could influence the calcium-phosphate changes and bone turnover did not show any deviation from the normal values and confirmed the homogeneity of the examined group. In all women qualified to the examined group, the measured maximal blood flow in lower limbs arteries (Vmax) and designation pulsation and resistance indexes (PI, RI), together with ankle-brachial index, did not exceed the normal values range. The obtained results of vascular examinations excluded the disturbances in peripheral circulation of the lower limbs. The measurement of bone turnover markers is influenced by many external factors; the major ones include strict requirements of sample storage, high daily inconstancy, interindividual inconstancy and the inconstancy of test characteristics, and kidney sufficiency. Moreover, markers examinations are expensive, which lessens their availability and usage in clinical diagnostics [13]. They are used in scientific studies, where all the requirements are strictly followed; they are often necessary as a reference to the examinations performed every 6 months. The examinations of bone turnover markers confirmed the balance between the resorption and bone formation processes.

A positive correlation was observed between the bone formation marker (hOST) and bone resorption marker (crosslabs®).

There was a strong positive correlation (r=0.57) stated between IMB and bone turnover markers (Table 3). All the women had a normal body build (Table 1). The vascular examinations confirmed the lack of disturbances in lower limbs peripheral circulation.

In the examined young women, a slight influence of the BMI value on the femur neck mineral density and the whole body skeleton mineral density were observed. A strong positive correlation was stated between the BMD of the femur neck and BMD of the whole body (r=0.86). The densitometric examination results confirmed the proper selection of the patients. The contemporary definition of osteoporosis changes the diagnostic and therapeutic qualifications from purely densitometric (bone mass assessment) to the whole fracture risk resulting from the total bone metabolism assessment, bone mass and other risk factors. The accumulation of the osteoporotic marker (MDP) in the bone system is a derivative of the bone mass and bone metabolism, and gives important information about bone quality and fracture risk assessment. Thus, it can additionally give diagnostically important information about bone metabolism obtained during radioisotopic bone examinations.

The method which allows definition of bone metabolism in osteoporosis diagnostics is a dynamic and static scintigraphic bone examination. The MDP radiopharmaceutic marked with technet isotope ^{99m}TC, used in our study, shows a high degree of relationship with osteoblastic activity. By measuring the given activity (whole body scintigram in the first part of the study) and by measuring the activity in the selected part of the bone, we obtained information about the amount of radiopharmaceutic inbuilt in bones (the remaining amount is excreted from the body and undergoes degradation).

The examinations with ^{99m}Tc – MDP depicts the combined results of the blood flow through the bones and osteoblastic activity of bone turnover [36].

^{99m}Tc-MDP can be used as a possible marker of accumulation with quantitative scintigraphy or more complicated clearance assessment methods [37]. The results of the most frequently mentioned methods are dependent on kidney clearance and kidney secretion. Our method is free of this complicated and time-consuming measurement technique. On the basis of the whole body scintigram analysis performed in the first part of the study, we assess the quantity of the administered radiopharmaceutic, which is then compared to the actual amount accumulated after 3 hours in the femur. For the more precise assessment, the value of the activity accumulated in the bone is lessened by the activity accumulated in the surrounding tissues and corrected by the isotope's physical degradation. Thus, in this method the examination of kidney clearance is not necessary and it does not diminish the program's value and the processed method. Different techniques were used for the assessment of the whole body bone turnover assessing the daily ^{99m}Tc-MDP accumulation. The alternative approach to the level of the administered marker ^{99m}Tc-MDP accumulation is a quantitative picturing of its accumulation based on the examinations made with a gamma camera [38]. Different trials of radioisotopic assessment of its norm were undertaken. The assessment of ^{99m}Tc-MDP uptake in the whole body showed that the given fragments of the skeleton show different levels of bone turnover speed dependent on age [39]. Regional accumulation of ^{99m}Tc-MDP was compared with densitometric examinations with the DXA method for the whole body. The results of the examinations assessing only the uptake of radiopharmaceutic through the bones did not add much to the quantitative assessment of the bone metabolism [40].

Our own program and BONS radioisotopic method allow for the quantitative assessment of bone quality through the designation of the indexes assessing the bone metabolism. Our studies, of several years duration, and the analysis of the obtained results presented at meetings and in publications, brought us closer to the definition of the IBM normal radioisotopic values range.

The Radioisotopic method of bone metabolism assessment has been used in our institution for many years. With this technique we have performed bone system examination in patients referred for bone scintigraphy. It is very important that the Radioisotopic bone metabolism assessment can be applied to all the patients directed to bone scintigraphy. The patient is not exposed to the additional radiation because they are given the standard isotope dose. The dose absorbed during the Radioisotopic examination is comparable to the one a patient gets during the standard radiological examination. Whereas, during the examination with computer tomography, the total absorbed dose is several times higher than the one taken during the Radioisotopic examination. Using our own program and method, only change the injection method, additional acquisitions performance and analysis of the obtained results undergo modification.

In different conditions, the value of calculated IBM is different from and often contrary to the densitometric examination results [41,42]. Taking into consideration our several years of experience in the assessment of IBM, we decided to evaluate its use in young, healthy women. In this group we obtained a high repeatability of the Radioisotopic IBM results. We also observed a strong correlation in relation to bone mineral density densitometric value. The designated markers of bone turnover also showed a strong correlation with IBM. Taking into consideration the obtained information, we decided to try to establish the normal values range of IMB, which are used in our institution.

Conclusions

1. Our own program and radioisotopic BONS method allow for the quantitative assessment of bone quality and allow for the designation of IBM, as well as during bone scintigraphy performed for clinical indications.
2. The IBM normal values range in young healthy women in the consolidation period is 84.08 to 105.
3. The quantitative scintigraphic bone examination provides an alternative to the bone markers examinations providing information about bone metabolism.
4. The obtained results are representative for the examined group and correlate with the results of BMD measurements.
5. IBM, complementary with densitometry, may complete the diagnostics of bone system in qualitative bone assessment both in the healthy and in patients with osteopeny and osteoporosis, and it can also be used in monitoring the progress of therapy.

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