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## Calcium-Phosphorus Metabolism and Markers of its Regulation in Patients with Rheumatoid Arthritis with Violation of Bone Mineral Density: Character and Diagnostic Value

**Introduction.** Rheumatoid arthritis (RA) is a systemic autoimmune disease of unknown etiology with a chronic inflammatory process that usually affects the joints with increasing severity and causes extra-articular lesions [19]. Chronic inflammation in patients with PA affects bone tissue metabolism and disrupts the normal cycle of resorption, reducing bone mineral density (BMD) [15]. One of these lesions is osteoporosis (OP) [9], the prevalence of which in patients with RA is almost twice as high as in the general population [10, 16, 18]. In the United States of America, the study was conducted and the results of which indicate that osteoporotic fractures are the cause of death in about a third of patients with RA [8]. Bone fractures due to OP increase mortality, reduce the quality of life, the ability of individuals to function independently, especially when it comes to elderly people, and as a result – increased economic costs [13, 17]. Spinal fractures are among the most common fractures due to a decrease in BMD [5, 7]. It is well known that bone strength depends on mineral substances, which are mainly represented by calcium hydroxyapatite microcrystals [20]. The main role in the regulation of calcium-phosphorus metabolism is played by vitamin D and parathyroid hormone (PTH), which regulate the balance of calcium and phosphorus in the body. Vitamin D induces the assimilation of calcium and phosphorus in the intestine, and causes an increase calcium reabsorption in the renal tubules, both these actions increasing concentration of calcium and phosphorus in the blood [3]. It is noteworthy that the action of vitamin D on bones is closely associated with the activity of PTH, since vitamin D needs PTH to fulfill its role in bone formation. Vitamin D inhibits the proliferation of parathyroid cells and determines their sensitivity to calcium by increasing the transcription of calcium sensing receptors (Calcium Sensing Receptor-CasR) [6].

Therefore, detection of calcium-phosphorus metabolism indicators and markers of its regulation provide important information reflecting the presence of BMD lesions in patients with RA.

**The aim of the study.** To investigate the activity of calcium-phosphorus metabolism and markers of its regulation in patients with rheumatoid arthritis with violation of the bone mineral density and to find out their diagnostic value.

**Materials and methods.** In the study, after signing the voluntary consent to participate in it, as required by the Helsinki Declaration of Human Rights, the Council of Europe Convention on Human Rights and Biomedicine, in a randomized manner with preliminary stratification according to the presence of RA (seropositive (rheumatoid factor, antibodies to citrulline vimentin, antibodies to cyclic citrulline peptide), polyarthritis (with damage of the small joints of the hands, wrist, shoulder, knee joints, X-ray stage II-III, functional insufficiency of the joints II); active phase, activity II degree), diagnosed according to the Order of the Ministry of Health Law of Ukraine No. 676 dated 12.10.2006 «On approval of medical care protocols in the specialty "Rheumatology"» [2], criteria of the American College of Rheumatology and the European League against Rheumatism in 2010) for women in the premenopausal period and men of mature age, included 76 patients (64 women (84.21 %) and 12 men (15.78 %) aged 38 to 60 years (average age at the time of examination of women –  $48.67 \pm 2.34$  years, men –  $45.42 \pm 2.78$ )), treated (receiving methylprednisolone in a dose from 4.0 to 24.0 mg/day and not receiving medications for the treatment of OP) in the rheumatology department of the Communal Non-Commercial Enterprise of the Lviv Regional Council "Lviv Regional Clinical Hospital" from 2013 to 2019.

All patients with RA underwent BMD assessment using ultrasound bone densitometry of the calcaneus using the SONOST - 2000 device (OsteoSys Co., Ltd, Seoul, Korea).

BMD was evaluated using the T-criterion, which is calculated automatically and corresponds to the number of standard deviations in the difference between the average indicator of the studied area for persons aged 20 to 45 years and the result obtained from the examined patient.

All patients underwent a BMD study, with the determination of the T-criterion according to the recommendations of the World Health Organization [3], and the diagnosis of a BMD disorder if its value is less than -1.0 standard deviation (standard deviation - SD) (osteopenia - from - 1.0 to -2.5 SD (osteopenia of the I degree from -1.0 to -1.5 SD, osteopenia of the II degree from -1.5 to -2.0 SD, osteopenia of the III degree from -2.0 to - 2.5 SD), OP is less than or equal to -2.5 SD), and BMD norms if the value was greater than or equal to -1.0 SD. The T-index was evaluated only as a result of each of the applied densitometry methods in a separate study area, and not as a clinical diagnosis of OP [1]. According to the obtained results, the patients were stratified into three groups: 1) patients with RA and osteopenia (34 patients whose T-criteria value was in the range from -1.0 to -2.5 SD) – research group 1 (RG1) ; 2) patients with RA and OP (24 patients whose T-criteria value was less than or equal to -2.5 SD) – research group 2 (RG2); 3) patients with RA and without a violation of the mineral density of bone tissue (age norm) (18 patients in whom the T-criterion value was greater than or equal to -1.0 SD) - the comparison group (ComparisonG).

The control group (CG) was created from 22 healthy people (18 women (81.81%) and 4 men (18.18%), the average age of women at the time of examination was  $42.95 \pm 2.14$  years, men -  $38.69 \pm 2.11$  years) of similar sex and age. In whom, according to the results of ultrasound densitometry of the calcaneus, no violation of BMD was detected and the T-criterion value was greater than or equal to -1.0 SD.

To assess calcium-phosphorus metabolism, the content of PTH and vitamin D in blood serum was determined. The study was carried out using a biochemical analyzer "COBASINTEGRA400 plus" from the company "Roche" (Switzerland) according to standard methods. The reference indicators were based on the reference values provided by the manufacturer of the test systems in the instructions: ionized calcium (blood serum) - 1.15-2.27 mmol/l, calcium (blood serum) - 2.10-2.60 mmol/l, calcium (urine) - 2.50-6.20 mmol/24h, phosphorus (blood serum) - 0.87-1.45 mmol/l, phosphorus (urine) -12.90-42.00 mmol/24 hour, vitamin D - 30.00–150.00 ng/ml, PTH - 15.00-65.00 ng/ml.

Achieving the goal was realized by carrying out two consecutive stages of the research.

The first stage was devoted to study markers of calcium-phosphorus metabolism and their regulation by evaluating the content of ionized calcium, total calcium, calcium in urine, phosphorus, phosphorus in urine, vita-

min D and PTH in patients with EG1, EG2, ComparisonG and in patients with CG. The actual material was processed on a personal computer using MSeExcel and SPSS programs using descriptive statistics using correlation analysis according to K. Pearson, as well as determining the p-value for the correlation coefficient in order to establish the reliability of the strength and direction of the relationship between the two criteria, the difference was considered statistically significant if  $p < 0.05$ .

The second step was to determine the diagnostic value of ionized calcium, total calcium, urinary calcium, phosphorus, urinary phosphorus, vitamin D, and PTH. A research group (RG) was also created, which included RA patients with osteopenia and OP. To achieve the goal, a conjugation table analysis was performed to calculate the sensitivity, specificity and diagnostic efficiency (accuracy) and the association coefficient among patients with RA. The true probability of the determined indicators was determined using indicators of sensitivity (true positive proportion, which reflects the proportion of positive results, correctly identifying a sick subject as a patient), specificity (true negative proportion, which reflects information about the proportion of negative results, correctly identifying a healthy subject) object as such) and accuracy (the proportion of a correctly diagnosed diagnosis based on information about a positive or negative result), the association coefficient (AC) (or the contingency coefficient (CC)), which characterizes how close the stochastic relationship is between qualitative features - alternative random variables [1]. The relationship between the presence of the disease and the value of the indicator was considered to be confirmed under the conditions of exceeding AC module 0.5 (or 0.3 for CC).

**Results and discussion.** The results of the first stage of the study are shown in table 1, which shows the average content of ionized calcium, total calcium and phosphorus in the blood and urine, PTH, vitamin D in patients with RA (RG1, RG2, ComparisonG) and healthy individuals.

Table 1

**Average values of indicators of calcium-phosphorus metabolism and markers of their regulation in the experimental groups and the control group (M±m, n, %, p)**

Indexes	RG1 (34 patients, 44.74 %)	RG2 (24 patients, 31.58 %)	Compari- sonG (18 patients, 23.68 %)	CG (22 health indi- viduals)	<i>p</i>
1	2	3	4	5	6
Ionized calcium (serum)	1.20 ± 0.01	1.19 ± 0.01	1.17 ± 0.01	1.18 ± 0.01	-
Total calcium (serum)	2.19 ± 0.10	2.14 ± 0.03	2.04 ± 0.05	2.15 ± 0.03	$p_6 > 0.05$
Calcium (urine)	4.37 ± 0.34	3.87 ± 0.47	3.70 ± 0.62	2.51 ± 0.03	$p_{4,5} > 0.01$ $p_6 > 0.05$
Phosphorus (serum)	1.25 ± 0.09	0.96 ± 0.03	1.00 ± 0.05	1.09 ± 0.03	$p_{3,5} > 0.01$

Table 1 (continued)

1	2	3	4	5	6
Phosphorus (urine)	22.62 ± 1.93	20.73 ± 0.03	20.01 ± 1.81	20.21 ± 1.53	-
25-(OH)D	18.18 ± 2.64	10.59 ± 2.06	17.16 ± 0.01	20.55 ± 2.30	$p_{2,3} > 0.05$ $p_5 > 0.01$
PTG	26.93 ± 6.37	36.95 ± 4.78	26.93 ± 6.37	44.10 ± 3.36	$p_{4,6} > 0.01$

**Notes:**  $p_1$  – reliability of differences between RG 1 and ComparisonG;  $p_2$  – reliability of differences between RG 2 and ComparisonG;  $p_3$  – reliability of differences between RG 1 and RG 2;  $p_4$  – reliability of differences between RG 1 and CG;  $p_5$  – reliability of differences between RG 2 and CG;  $p_6$  – reliability of differences between ComparisonG and CG.

According to the information presented in table 1, the following changes in calcium-phosphorus metabolism were detected:

- the average value of total calcium in the serum is significantly higher in CG individuals ( $2.15 \pm 0.03$ ) compared to ComparisonG ( $2.04 \pm 0.05$ ) ( $p > 0.05$ );

- the average value of calcium in urine was significantly higher in patients with ComparisonG ( $3.70 \pm 0.62$ ) compared to patients with CG ( $2.51 \pm 0.03$ ),  $p > 0.01$ ; was also higher in patients with RG1 ( $4.37 \pm 0.34$ ) in comparison with CG ( $2.51 \pm 0.03$ ),  $p > 0.05$ , and in patients with RG2 ( $3.87 \pm 0.47$ ) in comparison with CG ( $2.51 \pm 0.03$ ),  $p > 0.05$ ;

- the average level of phosphorus in the blood was significantly higher in CG individuals ( $1.09 \pm 0.03$ ) compared to RG2 ( $0.96 \pm 0.03$ )  $p > 0.01$ , and was also significantly higher in RG1 ( $1.25 \pm 0.09$ ) in comparison with RG 2 ( $0.96 \pm 0.03$ )  $p > 0.01$ .

As for markers of mineral metabolism, it was found that the average value of vitamin D is significantly higher in CG patients ( $20.55 \pm 2.30$ ) than in RG2 patients ( $10.59 \pm 2.06$ ),  $p > 0.01$ , and it is also significantly higher in patients with ComparisonG ( $17.16 \pm 0.01$ ) compared to RG2 ( $10.59 \pm 2.06$ ),  $p > 0.05$  and is significantly higher in patients with RG1 ( $18.18 \pm 2.64$ ) in comparison with RG2 ( $10.59 \pm 2.06$ )  $p > 0.05$ .

The average value of PTH is significantly higher in CG individuals ( $44.10 \pm 3.36$ ) in comparison with ComparisonG ( $26.93 \pm 6.37$ ),  $p > 0.01$ , as well as in comparison with RG1 ( $26.93 \pm 6.37$ ),  $p > 0.01$ .

Analysis of the results of the first stage of the study allows us to state that the concentration of total calcium in blood serum is higher in healthy individuals than in patients from ComparisonG. The concentration of calcium in urine is higher in patients with RG1, RG2, and ComparisonG compared to healthy people (CG). The concentration of vitamin D is significantly lower in patients with RA and OP compared to RA patients without BMD disorders or osteopenia, as compared to healthy individuals. The concentration of PTH is higher among healthy individuals compared to patients with RA without BMD abnormalities or with osteopenia.

The implementation of the second stage of the study, which consisted in determining the sensitivity, specificity, and accuracy of indicators of calcium-phosphorus me-

tabolism and markers of its regulation in RA patients with and without BMD disorders.

Table 2

**The results of a comparison of the diagnostic value of indicators of calcium-phosphorus metabolism and markers of its regulation in the research group and in the comparison group (% sensitivity; % specificity; % accuracy; association coefficient, contingency coefficient)**

Index	Sensitivity, %	Specificity, %	Accuracy, %	CA	CC	The odds ratio
1 Ionized calcium (serum)	36.84	66.67	44.00	0.07	-	1.16
2 Total calcium (serum)	72.41	33.33	63.15	0.13	-	1.31
3 Calcium (urine)	49.12	44.44	48.00	-0.12	-	0.77
4 Phosphorus (serum)	27.58	66.67	36.84	-0.13	-	0.76
5 Phosphorus (urine)	33.33	72.22	42.67	0.13	-	1.30
6 25-(OH)D	97.36	11.11	69.64	0.64#	-	4.62
7 PTH	43.10	38.89	42.10	-0.34	-	0.48

**Notes:** # – statistically significant relationship between ComparisonG and RG indicators (RG1+RG2) (CA 0.5 and more).

Violation of the content of ionized calcium in the blood serum is 1.16 times more common in patients with RG compared to ComparisonG. The sensitivity of the indicator as a marker of the presence of osteopenia and OP is 36.84 %, specificity - 66.67 %, and accuracy - 44.00 %. No significant relationship was found between the content of ionized calcium and belonging to the group with osteopenia and OP (direct relationship, CA 0.07).

In patients with osteopenia and OP, an increase in total calcium content is 1.31 times more common than in patients with ComparisonG. The sensitivity of the indicator as a marker of the presence of osteopenia and OP is 72.41%, specificity - 33.33 %, accuracy - 63.15 %. No significant relationship was found between the content of total calcium and belonging to the group with osteopenia and OP (direct relationship, CA 0.13).

The sensitivity of calcium content in urine is 49.12 %, specificity - 44.44 %, accuracy - 48.00 %. No significant relationship was found between the decrease in calcium content in the urine and belonging to the RG (reverse relationship, CA 0.12).

The sensitivity of phosphorus content in serum is 27.58 %, specificity - 66.67 %, accuracy - 36.84 %. No reliable relationship was found between the phosphorus content in the blood and belonging to the RG (reverse relationship, KA - 0.13).

A decrease in the content of phosphorus in urine is 1.30 times more common among patients with RG than among patients with ComparisonG.

No reliable relationship was found between the phosphorus content in the urine and belonging to the RG (direct relationship, CA 0.13).



A decrease in the content of vitamin D is 4.62 times more common among patients with RG than among patients with ComparisonG. Sensitivity – 97.36 %, specificity – 11.11 %, accuracy – 69.64 %. A reliable relationship was found between the content of vitamin D and belonging to the RG (direct relationship, KA 0.64).

The sensitivity of PTH content is 43.10 %, specificity – 38.89 %, accuracy – 42.10 %. No reliable relationship was found between the changed content of PTH and belonging to the DH (reverse relationship, CA 0.34).

Table 3

**The results of a comparison of the diagnostic value of indicators of calcium-phosphorus metabolism and markers of its regulation in the research and control groups (% sensitivity; % specificity; % accuracy, association coefficient, contingency coefficient)**

Index	Sensitivity, %	Specificity, %	Accuracy, %	CA	CC	The odds ratio
1 Ionized calcium (serum)	36.84	100.00	57.64	1.00	0.40 <sup>^</sup>	-
2 Total calcium (serum)	72.41	71.42	72.09	0.73 <sup>#</sup>	-	6.56
3 Calcium (urine)	49.12	67.85	55.29	0.34	-	2.03
4 Phosphorus (serum)	27.58	92.85	48.84	0.66 <sup>#</sup>	-	4.95
5 Phosphorus (urine)	33.33	100.00	55.29	1.00	0.37 <sup>^</sup>	-
6 25-(OH)D	97.36	25.00	66.67	0.85 <sup>#</sup>	-	12.33
7 PTH	43.10	75.00	53.48	0.38	-	2.27

**Notes:** # – statistically significant relationship between indicators of CG and RG (RG1+RG2) (CA 0.5 and more); <sup>^</sup> – statistically significant relationship between CG and RG indicators (RG1+RG2) (CC > 0.3).

The sensitivity of ionized calcium is 36.84 %, specificity – 100.00 %, accuracy – 57.64 %. A reliable relationship was found between the content of ionized calcium and belonging to the RG (direct relationship, CC 0.40).

Reduced content of total calcium in the serum of 6.56 was more often detected in RG than in CG. The sensitivity of the indicator of total calcium content is 72.41 %, specificity – 71.42 %, accuracy – 72.09 %. A reliable relationship was found between the content of total calcium and belonging to the RG (direct relationship, CA 0.73).

An increased level of calcium in urine was detected 2.03 times more often in patients with RG than in patients with CG. The sensitivity of the indicator as a marker of the presence of osteopenia or OP is 49.12 %, specificity – 67.85 %, accuracy – 55.29 %. A statistically unconfirmed relationship between the indicator and belonging to the DH was established (direct relationship, CA 0.34).

A reduced level of phosphorus in the serum was found 4.95 times more often in patients with RG compared to CG. Sensitivity – 27.58 %, specificity – 92.85 %, accu-

racy – 48.84 %. A statistically confirmed connection was established between the decrease in the content of the indicator and belonging to the RG (direct connection, CA 0.66).

The sensitivity of phosphorus content in urine as a marker of the presence of osteopenia or OP is 33.33 %, specificity – 100.00 %, accuracy – 55.29 %. A statistically confirmed connection between the indicator and belonging to the RG was established (direct connection, CC 0.37).

Decreased content of vitamin D in 12.33 times occurred in patients with RG compared to CG. Sensitivity – 97.36 %, specificity – 25.00 %, accuracy – 66.67 %. A statistically confirmed relationship between the reduced content of the indicator and belonging to the RG was established (direct relationship, CA 0.85).

Decreased content of PTH is 2.27 times more common in patients with RG than among individuals with CG. Sensitivity – 43.10 %, specificity – 75.00 %, accuracy – 53.48 %. A statistically unconfirmed connection was established between the reduced content of the indicator and belonging to the DH (direct connection, CA 0.38).

The analysis of the results of the second stage of the study allows us to state that in patients with RA and osteopenia or OP significantly more often than in patients with RA without BMD disorders, it was recorded that indicators of ionized calcium, total calcium, phosphorus in serum and urine, as well as vitamin D were outside the reference values. It was also proven that the reduced content of vitamin D is more often found in RA patients with osteopenia and OP compared to healthy people.

It is important to note that in the study by A. Triveni, it was found that patients with RA have significantly lower levels of calcium and significantly higher levels of phosphorus in blood serum compared to healthy individuals [18]. In our study, this was not confirmed, the level of calcium and phosphorus in the blood was higher in CG subjects compared to RA patients without BMD disorders.

H. L. Young in his study found that the level of vitamin D in RA patients was significantly lower than in healthy individuals, it was also proved by us that the level of vitamin D in RA patients with OP was significantly lower compared to RG1, ComparisonG and CG [19].

We found that PTH levels were significantly higher in healthy subjects compared to patients, but PTH levels in both groups were within the reference range, which is consistent with T. Jensen's results [12].

**Conclusions.** In patients with rheumatoid arthritis with osteopenia or osteoporosis, significantly more often than in patients with rheumatoid arthritis without a violation of bone mineral density, ionized and total calcium, phosphorus in serum and urine, as well as vitamin D indices have deviations from the reference values and are of diagnostic significance.

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#### Conflict of interest

The authors of this article argue that there is no conflict of interest.

## Calcium-Phosphorus Metabolism and Markers of its Regulation in Patients with Rheumatoid Arthritis with Violation of Bone Mineral Density: Character and Diagnostic Value

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**Introduction.** Patients with rheumatoid arthritis (RA) are twice as likely to have osteoporosis (OP) compared to the general population. The strength of bones depends on mineral substances, mainly represented by calcium phos-

phate microcrystals. The chief role in the regulation of calcium-phosphorus metabolism is played by vitamin D and parathormone (PTH).

**The aim of the study.** To investigate markers of calcium-phosphorus metabolism in patients with rheumatoid arthritis accompanied by bone mineral density (BMD) disorders and to find out their diagnostic value.

**Materials and methods.** 76 patients with RA (64 premenopausal women and 12 mature men) were included in the study. All patients with RA were subjected to ultrasound bone densitometry and according to its results, patients were divided into three groups: patients with RA and osteopenia, patients with RA and OP; RA patients without BMD disorders. The control group included 22 healthy individuals of both genders without BMD abnormalities. To evaluate calcium-phosphorus metabolism, ionized calcium, total calcium, phosphorus, PTH, and vitamin D in blood serum, and levels of calcium and phosphorus in urine were detected.

**Results.** It was revealed that concentration of total calcium in blood serum of patients with RA is lower compared to healthy individuals, while the same index in urine of patients with RA accompanied by osteopenia, OP or without BMD disorders is higher compared to healthy people. The concentration of vitamin D is significantly lower in patients with RA and OP compared to patients with RA with osteopenia, without BMD disorders, or healthy individuals. The concentration of PTH is higher in healthy individuals compared to patients with RA without BMD abnormalities or with osteopenia.

**Conclusions.** In patients with rheumatoid arthritis with osteopenia or osteoporosis, significantly more often than in patients with rheumatoid arthritis without a violation of bone mineral density, ionized and total calcium, phosphorus in serum and urine, as well as vitamin D indices have deviations from the reference values and are of diagnostic significance.

**Keywords:** rheumatoid arthritis, osteoporosis, bone mineral density, ionized calcium, total calcium, phosphorus, parathyroid hormone (PTH), vitamin D.

## Кальцієво-фосфорний обмін та маркери його регулювання у хворих на ревматоїдний артрит із порушенням мінеральної щільності кісткової тканини: стан і діагностична цінність

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**Вступ.** Ревматоїдний артрит (РА) – системна автоімунна хвороба нез’ясованої етіології із хронічним запальним процесом, яка зазвичай уражає суглоби, а з наростанням тяжкості провокує і позасуглобові ураження. Хронічне запалення у хворих на РА впливає на метаболізм кісткової тканини й порушує нормальний цикл резорбції, знижує мінеральну щільність кісткової тканини (МЩКТ). Одним із таких уражень є остеопороз (ОП). Як відомо, міцність кісток залежить від мінеральних речовин, які представлені переважно мікрокристалами кальцію. Основну роль у регулюванні кальцієво-фосфорного обміну відіграють вітамін D і паратгормон (ПТГ), які регулюють баланс кальцію та фосфору в організмі. Тому визначення показників кальцієво-фосфорного обміну та маркерів його регулювання є важливими показниками, що можуть свідчити про наявність ураження МЩКТ у хворих на РА.

**Мета.** Дослідити стан кальцієво-фосфорного обміну й маркерів його регулювання у хворих на ревматоїдний артрит із порушенням мінеральної щільності кісткової тканини та з’ясувати їхню діагностичну цінність.

**Матеріали й методи.** У дослідження в рандомізованій спосіб із попередньою стратифікацією за наявністю РА включено 76 хворих (64 жінки (84,21 %) і 12 чоловіків (15,78 %) віком від 38 до 60 років (середній вік на час обстеження жінок  $48,67 \pm 2,34$  року, чоловіків –  $45,42 \pm 2,78$  року)), які отримували метилпреднізолон (4,0–24,0 мг/добу) й не вживали лікарські засоби для лікування ОП, жінки були у пременопаузальному періоді, чоловіки зрілого віку. Усім хворим на РА проведено ультразвукову кісткову денситометрію п’яткової кістки та за її результатами хворих стратифікували на три групи: хворі на РА і з остеопенією – дослідна група 1 (ДГ 1); хворі на РА і ОП – дослідна група 2 (ДГ 2); хворі на РА і без порушення мінеральної щільності кісткової тканини (вікова норма) – група порівняння (ГП). Контрольну групу (КГ) створено із 22 здорових осіб (18 жінок (81,81 %) і 4 чоловіків (18,18 %)), середній вік жінок на час обстеження  $42,95 \pm 2,14$  року, чоловіків –  $38,69 \pm 2,11$  року) аналогічних статі й віку, у яких за результатами ультразвукової денситометрії п’яткової кістки не виявлено порушень МЩКТ. Для оцінки кальцієво-фосфорного обміну визначено вміст йонізованого кальцію, загального кальцію в сироватці крові, кальцію у сечі, фосфору в сироватці та в сечі, ПТГ та вітаміну D.

**Результати.** Концентрація загального кальцію в сироватці крові у здорових осіб вища, ніж у хворих ГП. Концентрація кальцію в сечі вища у хворих ДГ 1, ДГ 2, ГП порівняно зі здоровими (КГ). Концентрація вітаміну D достовірно нижча у хворих на ОП порівняно з хворими на РА без порушення МЩКТ і хворих із остеопенією, а також порівняно зі здоровими. Концентрація ПТГ вища у здорових осіб порівняно з хворими, у яких не виявлено порушень МЩКТ та з остеопенією.

У хворих на РА з остеопенією та ОП достовірно частіше, ніж у хворих на РА без порушення МЩКТ, фіксували, що показники йонізованого кальцію, загального кальцію, фосфору в сироватці крові та в сечі, а також вітаміну D виходили за межі референтних значень. Менший вміст вітаміну D частіше виявляли у хворих на РА з остеопенією та ОП порівняно зі здоровими.

**Висновки.** У хворих на ревматоїдний артрит із порушенням мінеральної щільності кісткової тканини або без неї вміст кальцію в сечі достовірно більший, ніж у здорових осіб. Уміст загального кальцію в сироватці крові достовірно більший у здорових осіб.

У хворих на ревматоїдний артрит із остеопорозом вміст вітаміну D є менший, ніж у хворих із остеопенією, хворих без порушення мінеральної щільності кісткової тканини та здорових.

У хворих на ревматоїдний артрит із остеопенією та остеопорозом достовірно частіше, ніж у хворих на ревматоїдний артрит без порушення мінеральної щільності кісткової тканини, фіксували відхилення від референтних значень таких показників, як вміст йонізованого кальцію, загального кальцію, фосфору в сироватці крові та в сечі, а також вітаміну D, що свідчить про те, що зміни цих показників характерні для порушень мінеральної щільності кісткової тканини у хворих на ревматоїдний артрит і їх потрібно застосовувати для діагностики.

**Ключові слова:** ревматоїдний артрит, остеопороз, йонізований кальцій, загальний кальцій, кальцій, фосфор, паратгормон, вітамін D.

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