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## The knee joint deformities in rheumatoid arthritis patients

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*Knee joints injury in rheumatoid arthritis patients appear in 70 % cases. This is the most common cause of loss of work capacity, the ability to self-care. Patients become severely disabled, in that the disease is accompanied by deformations with the development of discordant positions of the lower limbs, which lead to a partial or complete loss of the function of support and walking, so this problem needs to be studied. Objective. To make an analysis of orthopedic treatment of secondary arthrosis of knee joints in RA patients, complicated by deformities depending on the age and gender of the patient, stage, duration of the disease and activity of the inflammatory process. Methods. In this work we have analyzed the orthopedic treatment of 66 RA patients with secondary arthrosis with axial deformities, who underwent 75 total endoprosthetics between 2013 and 2020. Anamnestic data, clinical, biomechanical and statistical research methods were used. The obtained data were evaluated using the scale of Joseph J., Kaufman E. E. Results. The analysis of the results of knee joint replacement was followed in the period from 6 months to 5 years. The results were carried out according to the 100-point scale Joseph J., Kaufman E. E. (1990). Thus, the analysis of the results of total knee arthroplasty in patients with RA according to the scale of Joseph J., Kaufman E. E. showed that good results were obtained in 46 (79.31 %) patients, satisfactory results in 11 (18.97 %) and unsatisfactory results obtained in 1 (1.72 %) patients. The reliable relationship of the level of joint deformation with the level of disease activity and with the scale of Joseph J., Kaufman E. E. was researched. Other indicators are not reliably correlated with the level of joint deformation. As a result of pairwise comparisons of groups with each other using the Duncan test, a significant increase in the degree of joint deformation was found in the group with activity 3 compared to the group with activity 1. The use of basic or complex therapy does not reliably affect the degree of joint deformation. Conclusions. Total knee joint replacement need patients with II stage of the 2<sup>nd</sup> phase of the disease and higher. In our opinion, this is the most optimal time for surgical treatment, which allows patients with RA to fully use the possibilities of an implanted endoprosthesis.*

*Ураження колінних суглобів за ревматоїдного артриту (РА) відмічають у 70 % випадках. Це найпоширеніша причина втрати працездатності, можливості самообслуговування. Пацієнти стають тяжкими інвалідами, оскільки захворювання супроводжується деформаціями та контрактурами з розвитком дискордантних положень нижніх кінцівок, що призводять до часткової або повної втрати функції опори та ходьби. Мета. Розглянуто аналіз результатів лікування вторинного артрозу колінних суглобів, ускладненого фронтальними деформаціями, у хворих на РА. Методи. Проаналізовано результати ортопедичного лікування, спрямованого на відновлення функції колінного суглоба у 66 хворих на РА з фронтальними деформаціями, яким проведено 75 операцій тотального ендопротезування у період з 2013 по 2020 рр. Вивчено анамнез, активність і стадію РА, фронтальні деформації колінного суглоба, рентгенологічну динаміку змін у ньому, лабораторні показники. Результати ендопротезування оцінювали за шкалою Кауфмана. Виконано кореляційний аналіз за Спірманом, однофакторний дисперсійний аналіз. Результати. Термін спостереження за пацієнтами після ендопротезування колінного суглоба становив від 6 міс. до 5 років. За шкалою Кауфмана добрі результати отримано в 46 (79,31 %) хворих, задовільні — 11 (18,97 %), незадовільні — 1 (1,72 %). Виявлено суттєвий зв'язок між рівнем фронтальної деформації суглобів і рівнем активності РА ( $r = 0,30$ ;  $p < 0,05$ ) та показником шкали Кауфмана ( $r = -0,46$ ;  $p < 0,001$ ). Визначено, що стадія захворювання, стать і вік пацієнта, медикаментозна терапія значуще не впливають на формування фронтальної деформації. Для розрахунку її ступеня отримано формулу залежно від рівня активності й тривалості РА, шкали Кауфмана до та після операції. Висновки. Тотальне ендопротезування колінного суглоба слід виконувати хворим на РА, починаючи з II стадії 2 фази. Це дозволить пацієнтові повною мірою використати можливості ендопротеза, оскільки ураження суміжних сегментів, зазвичай, ще мінімальні. Ключові слова. Ревматоїдний артрит, колінний суглоб, фронтальні деформації, вальгус, варус, тотальне ендопротезування.*

**Key words.** Rheumatoid arthritis, knee joint, frontal deformities, valgus deformity, varus deformity, total knee arthroplasty

## Introduction

Rheumatoid arthritis (RA) is one of the most common chronic inflammatory joint diseases. Among the adult population in different countries of the world, its incidence is from 0.6 to 5 % [1, 2]. RA affects able-bodied people more often: the peak of the disease falls on the age period of 40–50 years. At the same time, women suffer 2–4 times more often than men. The incidence among women increases after the age of 30, reaching the highest rates at the age of 45–75. In men, this indicator gradually increases, decreasing after 70 years [3].

In our study, we used the clinical, X-ray, and morphological classification of RA according to E. T. Sklyarenko and V. I. Stetsula [1]:

- stage I — synovitis (acute, subacute, chronic);
- stage II — productive-destructive panarthrititis:
  - 1<sup>st</sup> phase — exudative-proliferative;
  - 2<sup>nd</sup> phase — proliferative-destructive;
  - 3<sup>rd</sup> phase — destructive-sclerotic;
- stage III — ankylosing:
  - 1<sup>st</sup> phase — fibrous ankylosis;
  - 2<sup>nd</sup> phase — bone ankylosis.

Damage to the knee joints due to RA is observed in 70 % of cases. This is the most common cause of loss of work capacity, self-care capabilities. Patients become severely disabled, as the disease is accompanied by deformities with the development of discordant positions of the lower limbs, which leads to a partial or complete loss of the function of support and walking [4]. Damage to the knee joints in such patients in the late stages occurs according to the type of secondary gonarthrosis with the development of deformations in the frontal and horizontal planes.

The mechanism of development of lower limb deformations can be caused by direct pathological changes in the joints resulting from the underlying disease or secondary reactions of the entire locomotor system. Accordingly, there are two types of compensatory reactions and mechanisms of deformation development [5].

The development of axial deformations of knee joints is also closely related to changes in periarticular tissues, which, like bones, are affected by the pathological process. In particular, in the joint capsule, a specific role is played by a decrease in the level of fluid in the tissues, intra-articular pressure, adhesion and contraction of the synovial membrane, as well as weakening, ruptures and failure of the ligament apparatus, which leads to further deformation of the knee joint. Many scientists direct their attention to the study of fibrotization of the joint capsule due to the deposition of collagen as a key fac-

tor in reducing its elasticity. Soft tissue balance is one of the most critical issues during knee replacement and is somewhat different in non-RA patients [6]. For the majority of RA patients, minor interventions on soft tissues can be sufficient and effective [7], however, the balance of the latter is difficult to ensure in some individuals, therefore the question of the need to use knee joint endoprosthesis structures of the connected type becomes relevant for them [8].

Patients with RA are characterized by the formation of valgus deformity in the frontal plane and flexion contracture in the sagittal plane.

Valgus deformity is classified into three degrees:

- I (80 % of cases) — axial deviation of 6°–10°, amenable to passive correction, lateral soft tissues contracted, without overstretching of the medial bypass ligament;
- II (15 %) — axial deviation from 10° to 20°, lateral soft tissues are contracted and compacted, stretching of the medial bypass ligament without violation of the stabilizing function;
- III (5 %) — axial deviation of more than 20°, lateral soft tissues are contracted and compacted, overstretching of the medial bypass ligament with impaired stabilizing function.

Numerous studies by domestic and foreign authors show that the development of functionally disadvantageous joint deformations increases the importance of surgical assistance. Operative interventions are primarily aimed at restoring the lost function of the limb, improving self-care, increasing the functional activity of patients [9]. In recent years, joint replacement has become the method of choice for orthopedic treatment of patients with arthrosis. Assessment of scientific information indicates certain problems developing after such operations. Despite the constant improvement of prostheses and extensive clinical experience of orthopedists, to this day 3–12 % of patients have complications in the early and late postoperative periods.

During endoprosthetic repair of knee joints, complications are usually due to careless planning of the surgical intervention, fracture of the femoral and tibial condyles [10]. It should be taken into account that the density of bone tissue is lower in patients with RA due to the immunosuppressive effect of long-term use of steroids, the level of prostaglandins in the synovial fluid or the presence of rheumatoid granulation tissues among the cancellous bone tissue [11], which has a significant impact on the risk of complications after total knee arthroplasty. They can include such undesirable conditions as infection (early or late, superficial or deep), migration of the structure, peri-articular fractures, hematomas, neuritis, thromboembolism, wear and tear of polyethylene.

The main factors in the development of complications, according to the majority of orthopedists, are complex techniques of interventions, previous operations on the knee joint, insufficient management of patients in the postoperative period [11].

The formation of valgus deformity with damage to the soft tissue structures of the outer part of the knee joint determines lateral release and mandatory resection of osteophytes during endoprosthetic repair [12].

*The purpose of the study:* to assess the results of orthopedic treatment of secondary arthrosis of the knee joints, complicated by frontal deformities, in patients with rheumatoid arthritis.

### Material and methods

The materials of the article were reviewed at the meeting of the Bioethics Committee of the State Institution Institute of Traumatology and Orthopedics of the National Academy of Sciences of Ukraine and recognized as meeting the requirements of the Helsinki Convention of the Council of Europe on Human Rights and Biomedicine, the relevant laws of Ukraine and recommended for publication (Protocol No. 4 of 19.10.2022).

The study is based on the assessment of the results of orthopedic treatment aimed at restoring the function of the knee joint in 66 RA patients with frontal deformities, who underwent 75 total arthroplasty operations between 2013 and 2020. Surgical treatment was carried out in the conditions of the adult joint disease clinic of the State Institution Institute of Traumatology and Orthopedics of the National Academy of Sciences of Ukraine.

The study of the features of the lesion and the state of the knee joints in patients with RA involved an assessment of the history, medical documentation from the previous stages of treatment, radiological time course of changes in the affected knee joints, and laboratory findings.

During history taking, the patient's presentation, various factors that preceded the manifestation of RA (combined disorders, stressful conditions, pregnancy for women, etc.), duration of the disease, term of observation by a rheumatologist, and basic and hormonal therapy at the stage of conservative treatment were investigated. At the same time, the effectiveness of conservative treatment, the type of drugs taken by the patient, their dosage, and side effects from drug therapy on the blood and adrenal glands were determined.

The appearance of RA patients with axial deformations of the knee joints is shown in Fig. 1.

The clinical checkup of patients began with an examination. For complete information, it was comparative and segment-by-segment. First, gross changes that disturb the structure of the entire limb were determined, then the damaged area was evaluated, and the examination was completed by studying the changes in the upper and lower parts, taking into account the condition of the muscles and the nature of compensatory changes. The axes of the lower limbs were determined with the help of auxiliary lines drawn in the frontal plane under the correct (physiological) position of the patient and limbs. Then the movements in the knee joints were assessed in the lying position.

*The axis of the lower limb* (clinical) passes through the front upper spine of the iliac bone (*spina iliaca anterior superior*), the outer edge or middle of the kneecap and the first interdigital space (Fig. 2, a). In the absence of lateral distortions, all these three points are on the same straight line. The displacement of the point(s) from the straight line indicates deformation of the axis. Changes in the normal axis of the limb occur in lateral curvatures, displacement of the limb segments outward from the axis and an open inward angle of deformation — varus deformation (O-shaped) (Fig. 2, b). Valgus deformity (X-shaped) occurs in displacement of the segment inward from the axis of the limb and the open angle between the segments to the outside (Fig. 2, c).

There are no lateral movements (abduction and adduction) in the extended knee. When it is flexed and the lateral ligaments are relaxed, slight lateral movements are possible. Rotation is similar to lateral movements.

The obtained results were evaluated using the scale of J. Joseph, E. E. Kaufman. In the absence of pathological changes, the condition of the knee



**Fig. 1.** Appearance of the lower limbs of a patient with RA and secondary osteoarthritis of the knee joints, complicated by multi-plane deformations: anterior view (a); lateral view (b)



joint is classified as 100 points, if they are present, the number of points decreases. In particular, the result is considered good if the number of points ranges from 100 to 80, satisfactory from 79 to 60, and unsatisfactory 59 and less. The specified scale can be compared with the generally accepted system of evaluation of results [13]:

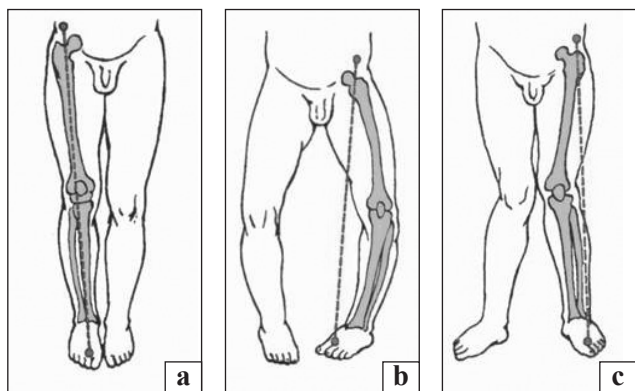
– good — the patient does not feel pain both at rest and during exercise, there may be slight pain during long walking; the limb is stable, it is possible to walk without additional support, or with the support of a stick during long walks, there is no limping, the axis of the limb is correct, the joint is stable, the range of motion in it is 100° and more (extension 180°, bending to an angle of 80° and more), which corresponds to 100-80 points;

– satisfactory — periodic pain at rest and during moderate walking for a short distance, use of an additional support (stick) outside the apartment, the limb is stable, the violation of its axis does not exceed 10° in the frontal plane, the range of motion in the knee joint is limited from 100° to 70° (extension — 180°–170°, flexion — 100°–80°), which corresponds to 79–60 points;

– unsatisfactory — constant pain at rest, increasing under load conditions, the patient constantly uses additional support while walking, especially stairs; deviation of the axis in the frontal plane is more than 10°, flexion contracture is more than 10°, range of motion in the knee joint is less than 70°, which corresponds to 59 points and less.

## Results and their discussion

Evaluation of treatment outcomes (knee joint replacement) was monitored over a period of 6 months up to 5 years and good results have been determined in most patients.



**Fig. 2.** Diagram of the location of the axis of the limb in the norm (a), in varus (b) and valgus (c) deformations

The main reason for satisfactory results was contractures in the knee joints. They were mostly in individuals with various types of ankylosis and immobility in the preoperative period, so the patients could not fully develop movements after the operation. In particular, in 4 operated patients, the satisfactory result was due to preservation of the flexion (within 5°) contracture in the knee joint. Two subjects had pain in the knee joint while walking; two had valgus up to 10°. However, we believe that we have succeeded, because maintaining movement in each joint is of great importance for RA patients.

Unsatisfactory results were associated with supuration of soft tissues in the area of the endoprosthesis in the early and late postoperative periods, which led to its instability, as well as aseptic instability of the endoprosthesis components.

Thus, evaluation of the results of total knee replacement in patients with rheumatoid arthritis according to the scale of J. Joseph, E. E. Kaufman showed that good results were obtained in 46 (79.31 %) patients, satisfactory results in 11 (18.97 %), unsatisfactory results in 1 (1.72%).

Since RA is a multifactorial disease, in our opinion, evaluation of the results of knee arthroplasty in this category of patients requires taking into account such influencing factors as the activity and duration of the inflammatory process, the type of anti-inflammatory therapy, the patient's condition, and pain syndrome.

Grade II functional insufficiency of the affected joints (FIJ II) was observed in 8 (9 %) patients, grade III (FIJ III) in 56 (91 %).

The activity of the process was determined according to the criteria of Academician M. D. Strazhesko Institute of Cardiology, taking into account clinical (morning stiffness, pain syndrome, local signs of inflammation) and general laboratory (ESR, C-reactive protein, content and ratio of albumins and globulins in blood serum) data.

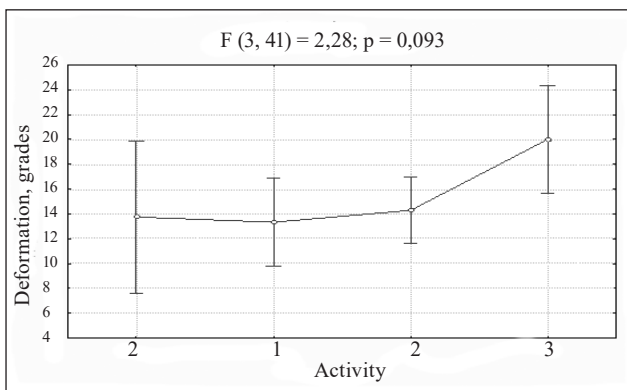
Spearman's rank correlation analysis was conducted to study the influence of disease activity on the level of deformation (grades), (see Table).

A significant relationship between the level of frontal joint deformation and the level of activity ( $r = 0.30$ ;  $p < 0.05$ ) and the Kaufman scale indicator ( $r = -0.46$ ;  $p < 0.001$ ) was revealed. Other indicators did not correlate with the level of frontal deformation of the joint.

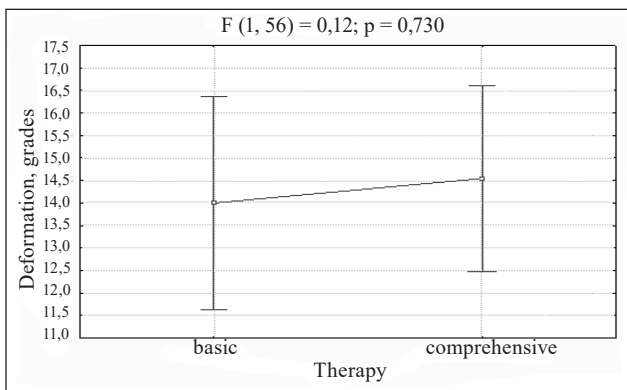
One-factor variance analysis was conducted to study the influence of the disease activity factor on the degree of frontal joint deformation (Fig. 3). As a result of pairwise comparisons of groups with

each other using the Duncan test, a significant increase in the degree of joint deformation was found in the group with activity 3 compared to the group with activity 1 ( $p < 0.05$ ). Therefore, the third level of disease activity causes a significantly higher deformation of the joints.

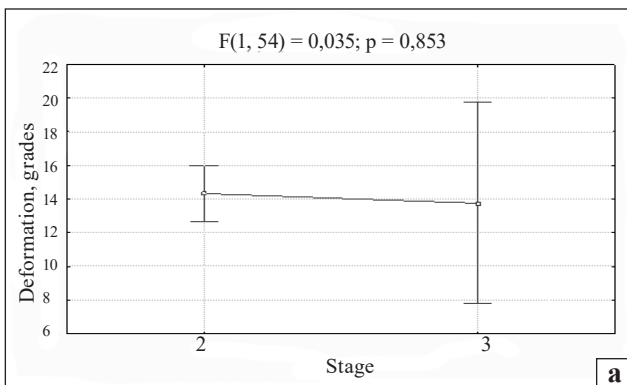
Also, a univariate variance analysis was conducted to investigate the effect of the used medical treatment on the degree of joint deformation (Fig. 4) and no significant difference was found in the application



**Fig. 3.** Graph of the influence of activity on the grade of joint deformation



**Fig. 4.** Graph of the influence of drug therapy on the development of anterior deformation of the knee joint due to RA



of basic or complex therapy (basic and hormonal) on the degree of joint deformation.

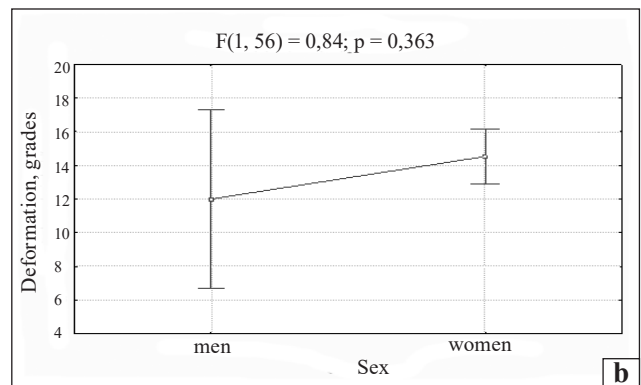
The study showed that neither the stage of the disease (Fig. 5, a) nor the gender (Fig. 5, b) significantly affected the development of frontal deformation.

Regression analysis showed no relationship between the level of joint deformation and the age of patients at the time of surgery ( $R = 0.16$ ;  $R^2 = 0.0278$ ;  $F(1.56) = 1.60$ ;  $p < 0.21$ ), degree of deformity and duration of the disease ( $R = 0.02$ ;  $R^2 = 0.0004$ ;  $F(1.56) = 0.02$ ;  $p < 0.89$ ).

Thus, it was established that total knee arthroplasty should be performed in patients with RA, starting from stage II of the 2nd phase. In our opinion, this is the most optimal time for surgical treatment,

**Table**  
**Correlation of the grade of joint deformation with various indicators**

Determination of the correlation of the grade of deformation with the indicator	Number	Spearman	t(N-2)	p-level
Age	58	0,14	1,05	0,300
Sex	58	0,14	1,03	0,305
Stage	56	0,04	0,27	0,789
<b>Activity</b>	<b>45</b>	<b>0,30</b>	<b>2,06</b>	<b>0,045</b>
Duration of disease (years)	58	-0,05	-0,41	0,686
Range of motion before extension	58	0,11	0,81	0,422
Range of motion before bending	58	0,11	0,04	0,970
Range of motion after extension	58			
Range of motion after bending	58	-0,07	-0,52	0,605
<b>Results according to J. Joseph, E. E. Kaufman score (points) before surgery</b>	<b>58</b>	<b>-0,46</b>	<b>-3,57</b>	<b>0,000</b>
Results according to J. Joseph, E. E. Kaufman score (points) after surgery	58	0,03	0,23	0,818



**Fig. 5.** Graph of influence of RA stage (a) and gender (b) on the development of anterior deformation of the knee joint

since the involvement of the adjacent segments, for the most part, is still minimal. At stage II, phase 3 of RA, the hip, contralateral knee, and supracalcaneal joints, hypotrophy of the thigh muscles, and gluteal muscles are usually already affected. The first and second phases of stage III of RA are a condition when the optimal terms for total knee arthroplasty have already been missed.

To evaluate the complex effect of indicators on the degree of joint deformation, a multiple regression was performed, which resulted in the formula for calculating the degree of deformation depending on the level of disease activity, duration of the disease, and the Kaufman scale before and after surgery:

Level of deformity (grades) =  $2.85 \times \text{Activity} + 0.086 \times \text{Disease duration} - 0.91 \times \text{Kaufman scale before surgery} + 2.07 \times \text{Kaufman scale after surgery} - 121.3$ .

$R = 0.67$ ;  $R^2 = 0.45$ ;  $F(4.40) = 8.28$ ;  $p < 0.00006$ .

The correlation coefficient of the model is high and is 0.67; the coefficient of determination is 0.45 (the model can explain the variance of indicators by 45 %), has a reliable significance level of  $p < 0.00006$ . The activity of the disease and the index on the Kaufman scale have a greater influence on the degree of frontal deformation of the joint, and the duration of the disease has an insignificant effect.

## Conclusions

Total knee arthroplasty should be performed in patients with RA, starting from stage II of the 2<sup>nd</sup> phase. This will allow the patient to make full use of the possibilities of the implanted endoprosthesis, since the lesions of adjacent segments are usually still minimal.

The level of frontal deformity of the knee joint is significantly related to the level of disease activity ( $r = 0.30$ ;  $p < 0.05$ ) and the Kaufman score ( $r = -0.46$ ;  $p < 0.001$ ).

As a result of pairwise comparisons of groups with each other using the Duncan test, a significant increase in the grade of joint deformation was found in the group with activity 3 compared to the group with activity 1 ( $p < 0.05$ ). Therefore, the third level of disease activity causes a significantly higher deformation of the joints.

The use of basic or complex medical therapy does not significantly affect the grade of frontal deformation of the joint ( $p = 0.730$ ).

**Conflict of interest.** The authors declare no conflict of interest.

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## THE KNEE JOINT DEFORMITIES IN RHEUMATOID ARTHRITIS PATIENTS

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