

Z.A. Arutyunyan, D.V. Morozenko, V.O. Tulyakov
Sytenko Institute of Spine and Joint Pathology Ukrainian National Academy
of Medical Sciences, Kharkiv

**LABORATORY BLOOD MARKERS DYNAMICS IN PATIENTS WITH GONARTHROSIS
AND KNEE JOINT CONTRACTURE BEFORE AND AFTER TOTAL KNEE REPLACEMENT
AND THEIR FURTHER REHABILITATION**

e-mail: zorik.dr@gmail.com

The article is devoted to the change of blood laboratory indexes in patients with knee osteoarthritis with knee contractures before and after total knee replacement with further rehabilitation. In patients with knee osteoarthritis stage IV, 2 months after knee replacement without development of flexed contracture of knee a decline of activity of inflammatory-destructive processes was observed in bone and cartilaginous tissues, registered on the reliable decreasing of maintenance of glycoproteins, chondroitinsulphates, activity of alkaline phosphatase in blood serum and ESR of patients testifies to efficiency of knee replacement. Patients with knee osteoarthritis IV stage, 2 months after total replacement with development of flexed contracture of knee was fixed resistant reliable change of maintenance of glycoproteins, chondroitinsulphates, activity of alkaline, acid phosphatases in blood serum and ESR, which are adjective for increasing of activity of inflammatory-destructive processes in an organism of patients, that rehabilitation is required. Rehabilitation 14 days after Knee replacement improved the clinical state of patients and diminished activity of inflammatory-destructive processes in an organism, what was reflected partial normalization of researched parameters.

Key words: knee osteoarthritis, replacement, biochemistry, dynamics, rehabilitation.

З.А. Арутюнян, Д.В. Морозенко, В.О. Туляков
ДИНАМІКА ЛАБОРАТОРНИХ МАРКЕРІВ КРОВІ У ХВОРИХ НА ГОНАРТРОЗ
З КОНТРАКТУРАМИ КОЛІННИХ СУГЛОБІВ ДО ТА ПІСЛЯ ТОТАЛЬНОГО
ЕНДОПРОТЕЗУВАННЯ З ПОДАЛЬШОЮ РЕАБІЛІТАЦІЄЮ

Стаття присвячена зміні лабораторних показників крові у хворих на гонартроз з контрактурами колінних суглобів до і після тотального ендопротезування з подальшою реабілітацією. У хворих на гонартроз IV стадії через 2 місяці після тотального ендопротезування без розвитку згинальних контрактур колінних суглобів спостерігалось зниження активності запально-деструктивних процесів у кістковій та хрящовій тканині зареєстроване за достовірним зниженням вмісту глікопротеїнів, хондроїтинсульфатів, активності лужної фосфатази у сироватці крові та швидкості осідання еритроцитів пацієнтів, що свідчить про ефективність ендопротезування. У хворих на гонартроз IV стадії через 2 місяці після тотального ендопротезування із розвитком згинальних контрактур колінних суглобів спостерігалися стійкі достовірні зміни вмісту глікопротеїнів, хондроїтинсульфатів, активності лужної, кислої фосфатаз у сироватці крові та швидкості осідання еритроцитів, характерні для підвищення активності запально-деструктивних в організмі пацієнтів, що потребувало проведення реабілітаційних заходів. Проведення реабілітації упродовж 14 днів покращувало клінічний стан пацієнтів та зменшувало активність запально-деструктивних процесів в організмі, що відображалось у частковій нормалізації досліджуваних показників.

Ключові слова: гонартроз, ендопротезування, біохімія, динаміка, реабілітація.

The study is a fragment of the research project "Investigation of the causes of development and improvement of methods for prevention and treatment of knee contractures in patients with knee osteoarthritis, the consequences of injuries and after knee replacement", state registration No. 0118U003214.

Currently, the incidence of knee osteoarthritis reaches up to 99.6 cases per 10,000 adults. In 86 % of cases, this disease occurs in people of working age, and in 6.5-14.6 % of patients it leads to disability. Among all dystrophic diseases of the large joints of the lower extremity, knee osteoarthritis ranges from 50.6 to 54.5 % [2]. A study by Y. Okamoto, S. Otsuki, M. Nakajima et al. (2019) out of 120 examined knee joints revealed flexion contracture more than 10 after knee replacement in 33 people, which is 28 %. The same authors indicate an increased incidence of this complication in people with short stature with relatively short lower extremities [11]. At the same time, the presence of varus deformity of the knee joint before surgery, although it increases the risk of flexion contracture in the postoperative period, but does not always lead to the formation of the latter, as previously thought [15]. The presence of preoperative flexion contracture increases the risk of permanent postoperative flexion deformity, the presence of which often leads to unsatisfactory treatment results in general [7]. Hyperextension deformity by more than 10° is associated with an increased risk of excessive pain and movement disorders in the knee joint [13]. The authors conclude that the flexion contours of the knee joint play a leading role, which determines the role

in the functionality of the results of primary total knee replacement [6, 12]. At the same time, other authors believe that only flexion contracture more than 20° increases the risk of patients perceiving the results of treatment as negative [10]. Z. Li, F. Lan, Y. Shen et al. (2019) indicate the need for postoperative development of the knee joint after its total knee replacement with anesthesia, which significantly improves the results of surgery, especially in elderly patients [9]. The formation of flexion contracture may be associated with damage to the cyclops, i.e. soft tissue mass, which can usually be formed after the reconstruction of the anterior cruciate ligament or in the case of total knee arthroplasty with preservation of both cruciate ligaments [12]. The presence of bone defects, capsular adhesion, cicatricial-adhesive process of the anterior thigh muscles, extra-articular deformities, post-traumatic changes in bone structure leads to unsatisfactory results in more than 17 % of cases [3]. A number of studies have proposed to use a mathematical model to predict the results of total knee arthroplasty [4]. The parameters that determine the outcome of treatment, the authors included age, sex, race, level of education, the presence of diabetes, preoperative use of support while walking, pain in the contralateral joint and physiological distress [8, 11]. It is proposed to prevent the development of postoperative flexion contractures of the knee joint with the use of nonsteroidal anti-inflammatory drugs. The authors indicate that inhibition of the cascade of inflammatory reactions potentially reduces the degree of activation of myofibroblasts, which reduces the formation of scar tissue. A multimodal pharmacological study has shown the effectiveness of the impact on the cellular component [14]. Thus, it is possible to consider the study of biochemical markers of inflammatory and destructive processes in the joints with knee osteoarthritis after total knee replacement to predict the need for further rehabilitation of patients with postoperative contractures.

The purpose was to study the dynamics of laboratory blood markers in patients with knee osteoarthritis with knee contractures before and after total knee replacement to predict the need for further rehabilitation of patients with postoperative contractures.

Materials and methods. The retrospective study was performed on the basis of the departments of joint pathology and laboratory diagnosis and immunology of the State Institution “Sytenko Institute of Spine and Joint Pathology Ukrainian National Academy of Medical Sciences” (License of the Ministry of Health of Ukraine for medical practice dated 16 August 2012 No. 02012214) in 2017–2019. The results of a standard biochemical examination of 28 patients (18 women and 10 men aged 56 to 73 years) for stage IV knee osteoarthritis with knee contractures before and after total knee replacement with subsequent rehabilitation were used. Of them, 14 patients had an uneventful postoperative period (study group I), while the other 14 patients developed contractures of the knee joints in the postoperative period (study group II). The diagnosis was established based on the results of history taking and comprehensive examination of patients using clinical and instrumental methods, namely clinical examination, radiography of the affected joints, resulting in a diagnosis of “stage IV knee osteoarthritis” according to Kelgren-Lawrence. The criteria for inclusion of patients in the study were primary knee osteoarthritis and dysplastic knee osteoarthritis. The exclusion criterion was posttraumatic knee osteoarthritis.

Patients of group II underwent the following rehabilitation measures: restorative measures after knee replacement of the knee and special measures for knee contractures according to the method developed by us.

All patients were informed about the possibility of using the results of their examination for the study; they provided informed consent of the appropriate sample. The study was discussed and approved at a meeting of the Bioethics Committee, Minutes No. 164 of 18 April 2017. In parallel, blood samples were taken from 30 healthy individuals (donors) of the same age, who made up the control group, namely 15 men and 15 women. Blood sampling was performed before surgery, 60 days after surgery, as well as in 74 days, of which the last 14 with the implementation of a typical rehabilitation program to restore movement. Laboratory tests were performed in the department of laboratory diagnosis and immunology of the State Institution “Sytenko Institute of Spine and Joint Pathology Ukrainian National Academy of Medical Sciences“, certificate of conformity of measuring instruments No. 01-0018 / 2019 of 08 February 2019, valid until 08 February 2022, accreditation certificate of the Main Accreditation Commission at the Ministry of Health of Ukraine of the highest category No.468 of 13.03.2018, valid until 12.03.2021, certificate for the quality management system of State Enterprise “Kharkivstandartmetrologiya” № UA 80072.02012214.1-2019 of 26.02.2019, valid until 25.02.2022.

Blood for the study was sampled from patients in fasting state from the ulnar vein. After centrifugation at 3000 rpm for 15 minutes the blood serum was selected and assessed for the content of glycoproteins using a modified method developed by O.P. Steinberg and Ya.N. Dotsenko, chondroitin sulfate by reaction with rivanol, the activity of alkaline and acid phosphatases by kinetic methods, total calcium by potentiometry [1, 5]. The erythrocyte sedimentation rate was determined by Panchenkov method [1]. Semi-automatic biochemical analyzers “GBG STAT FAX 1904 plus” and Stardust FC were

used to perform biochemical studies. Statistical data analysis was performed using software packages Microsoft Excel XP and Statsoft Statistica 10.0 (license No. 00218-04981-27336-AA152) using non-parametric Wilcoxon test with calculations of median (Me) and percentiles (25 % and 75 %).

Results of the study and their discussion. Group 1 of patients with stage IV knee osteoarthritis after knee replacement without complications at the starting point of the study before treatment was found to have a 57.9 % higher level of serum glycoproteins than that in the control group, which was characteristic of chronic inflammation. This is confirmed by a 3-fold increase in the sedimentation rate of erythrocytes (table 1).

At the same time, 127.0 % higher levels of chondroitin sulfates in their serum were predictably detected in this group of patients before the start of treatment, which indicated an active dystrophic process with destruction of cartilage tissue, in particular, in the affected knee joint. Accordingly, there was an increase of 80.2 % in the serum activity of alkaline phosphatase in patients of this group, which was characteristic of the intensive restructuring of the subchondral bone tissue of the affected knee joints. The content of total calcium and the activity of acid phosphatase in the blood serum did not have significant differences with such indicators in the control group.

Two months after surgery in persons without postoperative complications, the dynamics of serum glycoprotein levels indicated a decrease in the activity of the inflammatory process 2 months after surgery, but this figure did not reach that in the control group. This was characterized by a significant decrease in the content of glycoproteins in the serum by 22.2 % compared with pre-treatment (table 1).

The content of glycoproteins in the serum is a universal marker of inflammation in the diagnosis of diseases, in particular the disorder that is accompanied by destruction of connective tissue, so in this case there might have been a reduction in inflammatory and destructive processes in patients without postoperative contractures after total knee replacement. At the same time, the content of chondroitin sulfates in their blood serum decreased by 16.7 %, which indicated a slowdown in the catabolism of connective tissue proteoglycans, namely, the affected knee joints. Disorders of proteoglycan metabolism were also probably due to inflammatory and regenerative processes in bone tissue after surgery. It should be noted that taking into account the decrease in the content of chondroitin sulfates in the serum of patients, the intensity of catabolic processes in the body of patients with knee osteoarthritis decreased 2 months after surgery if they did not have postoperative contractures.

Table 1

Dynamics of laboratory blood parameters in patients with stage IV knee osteoarthritis after arthroplasty without complications

Indices	Patients with stage IV knee osteoarthritis, n=14			Control group, n = 30
	Before treatment	2 months after surgery	14 days after rehabilitation	
Glycoproteins, g/l	0.90# 0.86–0.91	0.77#* 0.75–0.79	0.75#* 0.73–0.77	0.57 0.40–0.72
Chondroitin sulfate, g/l	0.168# 0.163–0.170	0.140#* 0.137–0.142	0.115#*◇ 0.100–0.129	0.074 0.055–0.098
Alkaline phosphatase, U/L	337.0# 330.5–344.3	283.5#* 278.0–306.5	310.0# 299.6–320.4	187.0 110.0–285.0
Acid phosphatase, U/L	3.75 3.10–3.98	3.35 3.05–3.88	3.21 3.02–3.40	3.20 2.70–3.85
Total calcium, mmol/l	2.50 2.40–2.50	2.40 2.33–2.50	2.35 2.27–2.43	2.45 2.35–2.60
Erythrocyte sedimentation rate, mm/h	15.0# 13.0–15.0	9.0#* 7.0–10.0	8.0#◇ 6.0–10.0	5.0 3.0–7.0

Notes: # – statistically significant $p < 0.05$ compared with the control group; * – statistically significant $p < 0.05$ compared to pre-treatment; ◇ – statistically significant $p < 0.05$ compared with the postoperative rate

It is the content of chondroitin sulfates which can be used as a diagnostic test to assess the intensity of inflammatory and destructive processes in orthopedic diseases, in particular, the destruction of cartilage in the knee joints [3]. The specified group of patients was found to have changes in bone metabolism, which were reflected in a decrease in the activity of alkaline phosphatase due to its bone isoenzyme, contained in bone tissue. Acid phosphatase activity and total calcium content in serum did not change significantly. These parameters indicate a decrease in the activity of bone remodeling, probably due to the area of the underlying bone of the operated knee joint. Reduction of erythrocyte sedimentation rate by 40 % in individuals of this group 2 months after surgery confirmed a decrease in the activity of the inflammatory process, in particular, at the site of surgery.

After 14 days of rehabilitation in persons with knee osteoarthritis, who after surgery did not have complications in the form of contractures, the level of glycoproteins in the serum was 31.6 % higher than in the control group, but 16.76 % lower than before treatment. In the process of implementation of

rehabilitation measures, this indicator did not show significant changes (Table 1). The content of chondroitin sulfates in the serum of patients of the study group after rehabilitation continued to decrease, although it did not reach this in the control group. Thus, in comparison with the data of patients before treatment, it was significantly lower by 31.5 %, compared with that before rehabilitation measures – by 17.9 %, but significantly exceeded the level of this indicator in the control group by 55.4 % (table 1). These indicators confirm the assumption of a longer course of the inflammatory process in people with knee osteoarthritis, who after total knee replacement developed flexion contractures. This assumption is confirmed by the continuation of the presence of increased by 60.0 % compared with the control group level of erythrocyte sedimentation rate (table 1). The activity of alkaline phosphatase did not change significantly for this period and continued to remain significantly higher than that of the control group by 65.8 % (table 1). Under conditions of constant acid phosphatase activity and total calcium content, this may indicate the continuation of reactive bone remodeling with primary inflammatory origin. In the second group of patients with stage IV knee osteoarthritis, who after treatment developed flexion contractures, in the postoperative period the content of glycoproteins and chondroitin sulfates in the serum remained elevated at the level of such indicators before treatment. The activity of alkaline phosphatase decreased by 30.1 %, acid phosphatase – by 23.5 % compared with the corresponding data before treatment (table 2). The content of total calcium in the blood of this group 2 months after surgery did not change significantly.

Table 2

Dynamics of laboratory blood parameters in patients with stage IV knee osteoarthritis after knee replacement with complications in the form of contracture

Indices	Patients with stage IV knee osteoarthritis, n=14			Control group, n = 30
	Before treatment	2 months after surgery	14 days after rehabilitation	
Glycoproteins, g/l	1.22# 1.16–1.26	1.28# 1.07–1.37	0.78#*◇ 0.75–0.81	0.57 0.40–0.72
Chondroitin sulfates, g/l	0.219# 0.213–0.229	0.193#* 0.188–0.202	0.128#*◇ 0.123–0.133	0.074 0.055–0.098
Alkaline phosphatase, U/L	452.0# 434.0–467.5	316.1#* 303.5–327.0	319.7#* 306.9–330.6	187.0 110.0–285.0
Acid phosphatase, U/L	8.10# 7.30–8.60	6.20#* 5.50–6.60	4.80#*◇ 4.30–5.20	3.20 2.70–3.85
Total calcium, mmol/l	2.40 2.30–2.50	2.40 2.40–2.50	2.52 2.42–2.53	2.45 2.35–2.60
Erythrocyte sedimentation rate, mm/h	14.0# 12.0–16.0	25.0# 19.0–32.0	9.0◇ 6.0–16.0	5.0 3.0–7.0

Notes: # – statistically significant $p < 0.05$ compared with the control group; * – statistically significant $p < 0.05$ compared to pre-treatment; ◇ – statistically significant $p < 0.05$ compared with the postoperative rate

The erythrocyte sedimentation rate increased by 78.6 % (table 2). These data indicate that the inflammatory process in patients of this group continued without significant signs of its attenuation, at the same time, the restructuring of bone tissue, according to this indicator, probably decreased in intensity. After 14 days of rehabilitation, the content of glycoproteins in the blood decreased by 39.1 %, chondroitin sulfate by 33.4 %, compared with the level of the corresponding indicators in 2 months after surgery. Alkaline phosphatase activity did not change compared with the severity of this indicator in 2 months after total knee replacement, acid phosphatase activity decreased by 29.0 %, erythrocyte sedimentation rate decreased by 2.8 times. The content of total calcium remained unchanged both 2 months after treatment and 14 days after rehabilitation (table 2).

Thus, the dynamics of the studied laboratory parameters in groups of patients with stage IV knee osteoarthritis, who underwent total knee arthroplasty, differed significantly depending on the further development of postoperative contractures, and this difference could be analyzed using the proposed biochemical and general laboratory methods before surgery, which can give the practitioner in the field of practical orthopedics the ability to predict the course of events after surgery and properly prepare the patient for surgery to improve treatment outcomes and reduce its duration and cost. Rehabilitation measures increased the degree of normalization of the studied biochemical and clinical and laboratory parameters, which corresponds to the data presented in A. Anania, M. P. Abdel, Y.-Y. Lee et al. (2013) [6].

The above confirms the effectiveness of the rehabilitation measures used. In our opinion, this system is more accurate and objective than the mathematical modeling proposed in the works of Y. Okamoto S. Otsuki, M. Nakajima et al. (2019), Z. Chen, Z. Deng, Q. Li, et al. (2010) [8, 11]. Also, our study provides the biochemical base of the use of non-steroidal antiinflammatory drugs to prevent the formation of postoperative contractures, in particular, as noted in M. T. Murphy, T. L. Skinner, A. G. Cresswell et al (2013) [10]. It is possible to count on improvement of functional results of operative

treatment and reduction of probability of development of a pain syndrome correlating with data A. Anania, M. P. Abdel, Y.-Y. Lee et al. (2013), Y. Okamoto, S. Otsuki, M. Nakajima et al. (2019) [6, 12].

Prospects for further research lie in the study continuation to develop an algorithmic system for predicting possible complications in patients before surgery.

Conclusion

1. In patients with stage IV knee osteoarthritis 2 months after total knee replacement of the knee joint without the development of postoperative flexion contractures of the knee joints there was a decrease in the activity of inflammatory and destructive processes in bone and cartilage tissue, which was reflected in a significant decrease in glycoprotein serum and erythrocyte sedimentation rate, which indicates the effectiveness of knee replacement and confirms the absence of postoperative complications.

2. In patients with stage IV knee osteoarthritis 2 months after total knee replacement of the knee joint with the development of postoperative flexion contractures of the knee joints, there were persistent significant changes in glycoproteins, chondroitin sulfates, alkaline, acid phosphatase activity in blood serum and erythrocyte sedimentation rates, characteristic of increased inflammatory and destructive activity in patients, which required additional rehabilitation measures.

3. Additional rehabilitation measures for 14 days in patients with stage IV knee osteoarthritis 2 months after total knee replacement of the knee joint improved the clinical condition of patients and reduced the activity of inflammatory and destructive processes in the body, which was reflected in the partial normalization of glycoprotein protein, chondroitin, chondroitin in blood serum and erythrocyte sedimentation rate.

References

1. Kamyshnikov VS. Metody klinicheskikh laboratornykh issledovaniy. Uchebnoye posobiye. M.: Medpress-inform; 2018. 736 p. [in Russian]
2. Kariakin NN, Malyshev YY, Horbatov RO, Rotich DK. Endoprotezirovaniye kolennogo sustava s primieneniem individualnykh napravitieliev, sozdannykh s pomoshchyu tekhnologii 3D pechati. *Travmatologiya i ortopediya Rossii*. 2017; 23(3): 110-8. DOI.org/10.21823/2311-2905-2017-23-3-110-118. [in Russian]
3. Makolinet KV, Makolinet VI, Morozenko DV, Hlebova KV. Biokhimichni ta imunolohichni markery syrovatky krovi u khvorykh na rannikh stadiyakh. Aktualni problemy suchasnoyi medytsyny. 2017; 17(4): 140-3. Available from: [http://nbuv.gov.ua/UJRN/apsm_2017_17_4\(1\)_33](http://nbuv.gov.ua/UJRN/apsm_2017_17_4(1)_33). [in Ukrainian]
4. Malyshev YY, Zykin AA, Horbatov PO, Kuvshynov SG, Pavlov DV. Matematicheskoye modelirovaniye izmieniyni nagruzok na kolennyi sustav pri osyevykh deformatsiyakh nizhney konechnosti i rezultate yego klinicheskogo primieneniya. *Sovremennyye problemy nauki i obrazovaniya*. 2016; 2: 162. Available from: <http://www.science-education.ru/ru/article/view?id=24430>. [in Russian]
5. Morozenko DV, Leontieva FS. Metody doslidzhennia markeriv metabolizmu spoluchnoyi tkanyny u klinichniy ta eksperymentalniy medytsyni. *Molodyi vchenyi*. 2016; 2(29): 168-72. Available from: http://nbuv.gov.ua/UJRN/molv_2016_2_43. [in Ukrainian]
6. Anania A, Abdel MP, Lee Y-Y, Lyman S, Valle AGD. The natural history of a newly developed flexion contracture following primary total knee arthroplasty. *Int. Orthop*. 2013; 37: 1917-20. DOI: 10.1007/s00264-013-1993-3.
7. Chen JY, Loh B, Woo YL, Chia S-L, Lo NN, Yeo SJ. Fixed flexion deformity after unicompartmental knee arthroplasty: how much is too much. *J Arthroplasty*. 2016; 31(6): 1313-16. DOI: 10.1016/j.arth.2015.12.003
8. Chen Z, Deng Z, Li Q, Chen J, Ma Y, Zheng Q. How to predict early clinical outcomes and evaluate the quality of primary total knee arthroplasty: a new scoring system based on lower-extremity angles of alignment. *Musculoskelet Disord*. 2020; 21: 518. DOI: org/10.1186/s12891-020-03528-3.
9. Li Z, Lan F, Shen Y, An S, Xu N, Yin C et al. Prediction of the need for manipulation under anesthesia for flexion contracture after total knee arthroplasty in patients of advanced age. *J. Int Med Res*. 2019; 47(7): 3061-9. DOI: 10.1177/0300060519851328.
10. Murphy MT, Skinner TL, Cresswell AG, Crawford RW, Journeaux SF, Russell TG. The effect of knee flexion contracture following total knee arthroplasty on the energy cost of walking. *J Arthroplasty*. 2014; 29(1): 85-9. DOI: org/10.1016/j.arth.2013.04.039.
11. Okamoto Y, Otsuki S, Nakajima M, Jotoku T, Wakama H., Neo M. Sagittal alignment of the femoral component and patient height are associated with persisting flexion contracture after primary total knee arthroplasty. *J Arthroplasty*. 2019; 34(7): 1476-82. DOI: 10.1016/j.arth.2019.02.051.
12. Okamoto Y, Otsuki S, Nakajima M. Sagittal Alignment of the Femoral Component and Patient Height Are Associated With Persisting Flexion Contracture After Primary Total Knee Arthroplasty. 2019. Vol. 34, № 7. 1476–1482. DOI: 10.1016/j.arth.2019.02.051.
13. Pua Y-H, Poon CL-L, Seah FJ-T, Thumboo J, Clark RA, Tan M-H, et al. Predicting individual knee range of motion, knee pain, and walking limitation outcomes following total knee arthroplasty. *Acta Orthop*. 2019; 90(2): 179-86. DOI: 10.1080/17453674.2018.1560647.
14. Salib CG, Reina N, Trousdale WH, Limberg AK, Tibbo ME, Jay AG, et al. Inhibition of COX-2 pathway as a potential prophylaxis against arthrofibrogenesis in a rabbit model of joint contracture. *J. Orthop. Res*. 2019; 37(12): 2609-20. DOI: 10.1002/jor.24441.
15. Ushio T, Mizuuchi H, Okazaki K, Miyama K, Akasaki Y, Ma Y et al. Medial soft tissue contracture does not always exist in varus osteoarthritis knees in total knee arthroplasty. *Knee Surg Sports Traumatol. Arthrosc*. 2019; 27: 1642-50. DOI: 10.1007/s00167-018-5276-9.

Стаття надійшла 28.12.2019 р.