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The influence of thickness of ACL tendon graft on long-term results of treatment

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ABSTRACT:

1. Introduction: Operative treatment is the treatment of choice for the most severe, third-degree ACL sprain. Many operational techniques exist, including technique using a quadruple-folded semitendinosus tendon and the technique of double-folded semitendinosus and gracilis tendons. Depending on the technique chosen, we can obtain different thicknesses of the grafts used.

2. Aim of the study: To find a relationship between the type of surgical technique used and the thickness of the graft, as well as to assess the effect of the thickness of the applied autograft on the long-term outcome of the treatment.

3. Materials and methods: A retrospective study included a group of 43 patients operated on due to ACL injury. In 21 patients, the procedure was performed using the quadruple-folded semitendinosus tendon, whereas in 22 patients the procedure was performed using double-folded semitendinosus and gracilis tendons. The patients were divided into groups based on the thickness of the transplant. A special questionnaire prepared on the basis of the KOOS scale was used to assess the subjective performance of the knee. The type and thickness of the graft was determined based on the analysis of operational protocols. The statistical analysis of the results of the study was performed. The Chi-square compatibility test or chi-square compatibility test in the Yates modification were used to assess the relationship.

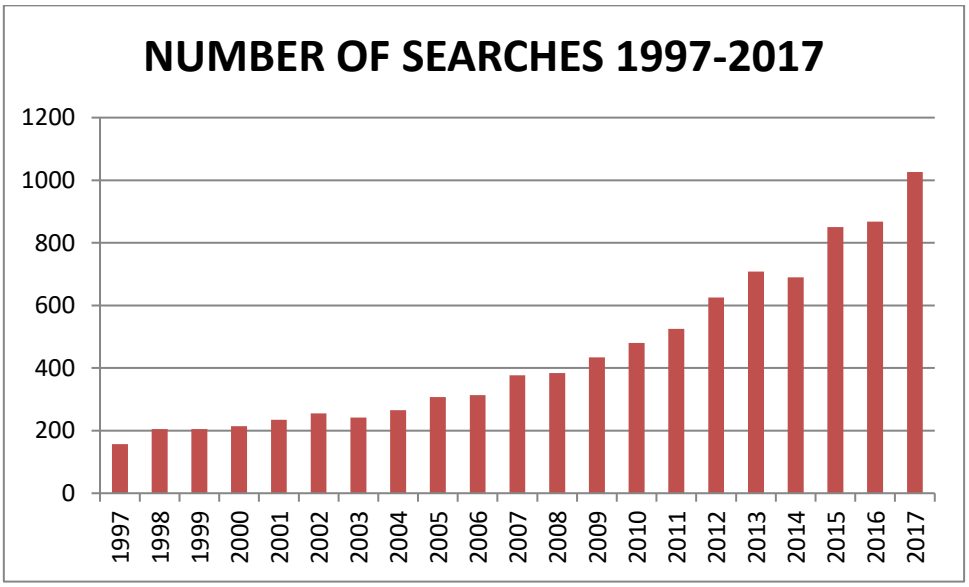
4. Results: A relationship was found between the parameters: "general quality of life" ($p = 0.01$), "pain" ($p = 0.005$), "sports activity" ($p = 0.05$), "everyday activities" ($p = 0, 01$). There is no dependence for the "other symptoms" parameter ($p = 0.1$). There is no relationship between the technique used and the graft thickness ($p = 0.2$).

5. Conclusions: The choice of the surgical technique does not affect the final thickness of the autograft. Overall quality of life, pain, sports activity; everyday activities are the parameters of the KOOS scale, which are affected by the thickness of the transplant.

6. Keywords: ACL; anterior cruciate ligament; reconstruction; graft

1. INTRODUCTION:

Various types of damage to the anterior cruciate ligament (ACL) are still a serious diagnostic and therapeutic problem. Despite the continuous development of imaging techniques, research and operational methods, this subject arouses interest and provokes discussion not only for orthopedics and traumatology specialists, but also for doctors in other fields of medicine or physiotherapists. The number of publications and scientific reports related to this topic is constantly growing each year [1], which confirms the validity of the analyzed topic. Over the last 25 years, over a few thousand scientific works have been created - among which there are at least a few breakthroughs and those deserving special attention [2,3] and a dozen or so full text textbooks [4,5]. This publication is based on our own test results and observations of a group of patients after ACL injuries undergoing surgical treatment. It complements the series of articles [6, 7] created on the basis of the research of a group of patients operated on due to damage anterior cruciate ligament and other accompanying injuries in the knee joint.



Graph 1. The number of results for searches for "ACL reconstruction" in the database ncbi.nlm.nih.gov in years 1997-2017 [1].

Proper, quick diagnosis and the selection of the optimal treatment method are crucial for the patient's future activity. Omission of treatment or leading it improperly directly causes a significant reduction in the quality of patient's life, or even disability. The type of treatment should depend on the degree of structural damage. This work will focus only on the treatment of grade III damage, that is, surgical treatment techniques. ALC injuries often result in damage to other parts of the knee [6]. Omission or significant delay in the treatment of the ligament

leads to progressive damage to these components - already after 12 months in 40% of patients and after 10 years even in 80% of patients, the meniscus injury occurs. In addition, the development of osteoarthritis is accelerated and chronic knee instability progresses.

The choice of a particular method of surgical treatment may pose problems for novice surgeons, as so for those with more experience. The most important goal of the procedure is to reconstruct the ligament and restore its attachments so that the return of the function is as fast as possible. Various surgical procedures may be used, depending on number of factors: type of damage, surgeon preferences, financial possibilities or individual patient preferences. The Internal Bracing method, allogenic implants, artificial implants, ALC reconstruction by means of a patellar ligament graft or ACL reconstruction with semitendinosus and gracilis muscle tendons are some of the methods available. There are also many techniques and instruments available for these procedures [9]. This work will focus exclusively on the analysis of the results of the treatment of anterior cruciate ligament injury with the last of the mentioned methods - the quadruple-folded semitendinosus tendon (ST) and the double-folded semitendinosus and gracilis tendons (ST + GR).

2. OBJECTIVE:

The aim of the study is to find a relationship between the type of surgical technique used (double-folded semitendinosus and gracilis tendons and the quadruple-folded semitendinosus tendon) and the thickness of the transplant, as well as the effect of the thickness of the applied autograft on the long-term outcome of the treatment.

3. MATERIALS AND METHODS:

The study was carried out in two stages. The first stage consisted of creating and delivering a specific subjective assessment of knee function according to the KOOS scale to the patients. Parameters of knee function such as: presence and severity of pain, specific symptoms, influence on everyday activities, possibilities of sport activity and general quality of life of patients were assessed. In each of the above-mentioned elements, a maximum of 100 points was to be obtained, which meant the most beneficial result from the patient's point of view. The respondents were giving answers in the scale from 0 to 4. The final result was obtained by the researchers after converting the patients' responses according to the appropriate method for the chosen scale [10]. In the second stage, the records from the operational protocols were analyzed, which made it possible to determine the operating method and the types of implants used.

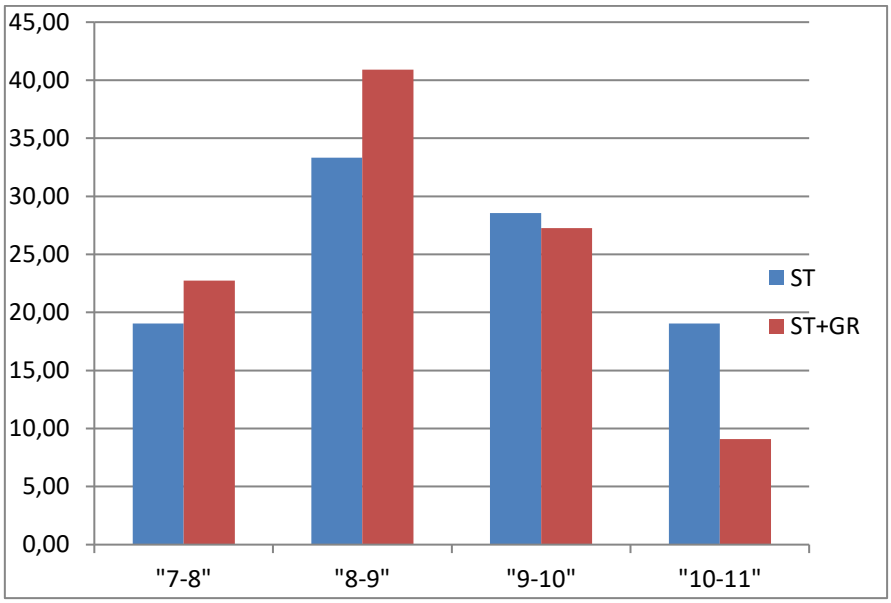
All patients underwent obligatory perioperative antibiotic and antithrombotic prophylaxis. Patients were operated under general or subarachnoid anesthesia. The operated limb supported under the femur, so that the knee joint was bent to an angle of 90 degrees. The period between the operation and the assessment ranged from several to several dozen months. The longest follow-up time was over 24 months. The patients were predominantly male.

The statistical analysis of the results of the study was performed. The Chi-square compatibility test or chi-square compatibility test in the Yates modification were used to assess the relationships.

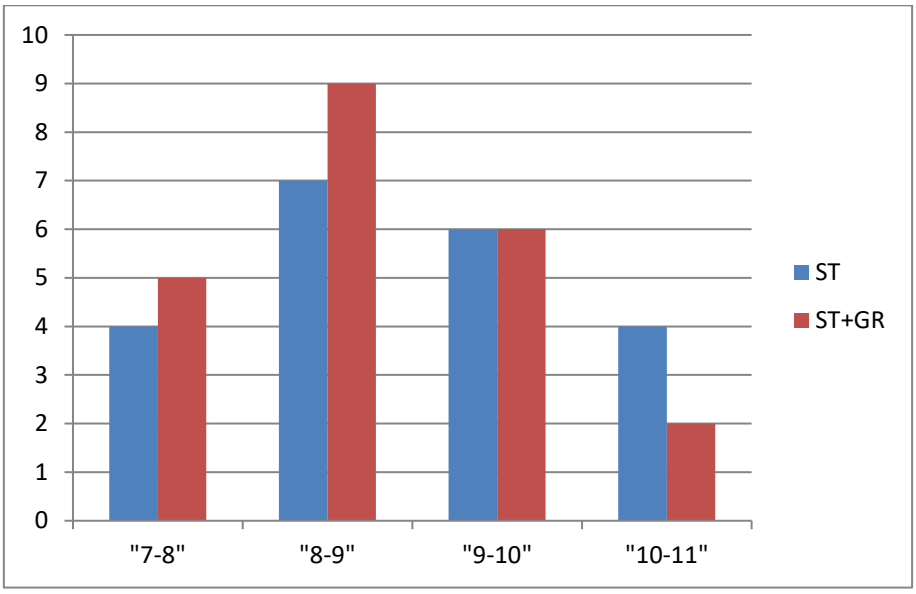
4. RESULTS:

First stage:

This part of the study presents and discusses the results of the analysis of the impact of the choice of surgical technique on the graft's thickness. As presented earlier in the study, two types of surgical technique were considered - quadruple-folded semitendinosus tendon (ST) and double-folded semitendinosus and gracilis tendons (ST + GR). The average thickness of the anterior cruciate ligament (ACL) is 11mm. The thickness of the transplants used is from 7 to 11mm. It is obvious that the thickness of the tendon of semitendinosus and gracilis muscles is variable individually and the thickness of autografts after their preparation varies depending on the operational capabilities and the technique of the surgeon. Is the choice of the surgical technique influencing the final thickness of the graft? A group of 43 patients was divided into four subgroups depending on the thickness of the transplant used.



Graph 2. Division of patients into four subgroups depending on the thickness of the transplant used - percentage graph.



Graph 3. Division of patients into four subgroups depending on the thickness of the transplant used - numerical chart.

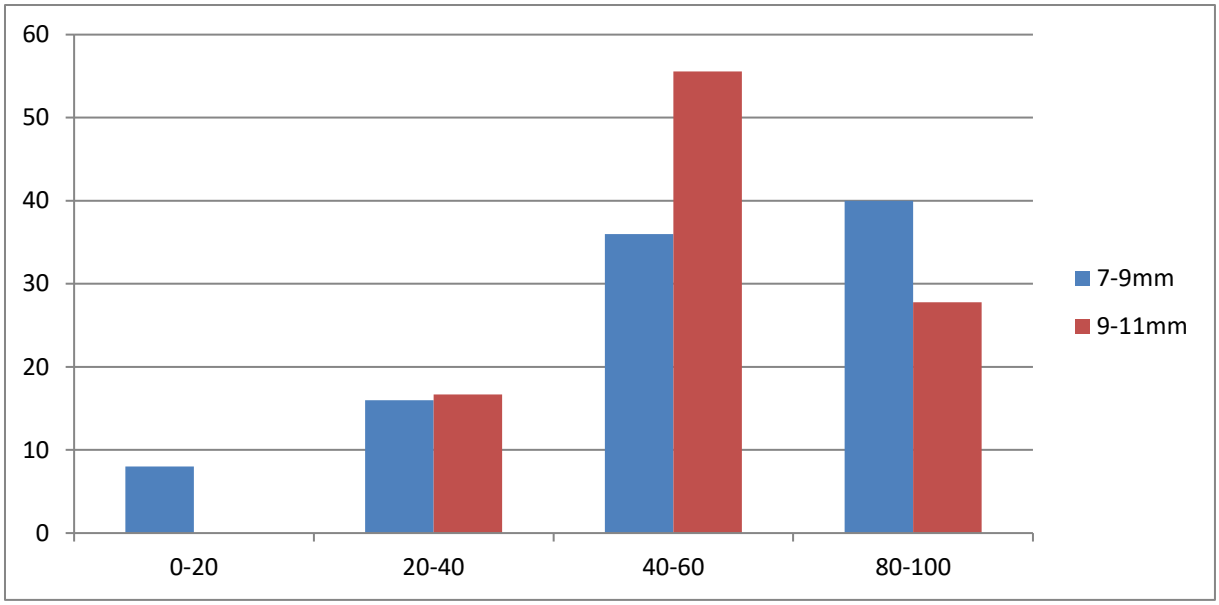
The analysis of the above graphs and statistical calculations of the presented data indicate the lack of statistical significance between the surgical technique and the final thickness of the autograft used. The significance level (p) is 0.2 for a chi-square test of 4.65. On the basis of the tested sample, the relationship between the examined parameters cannot be determined.

Second stage:

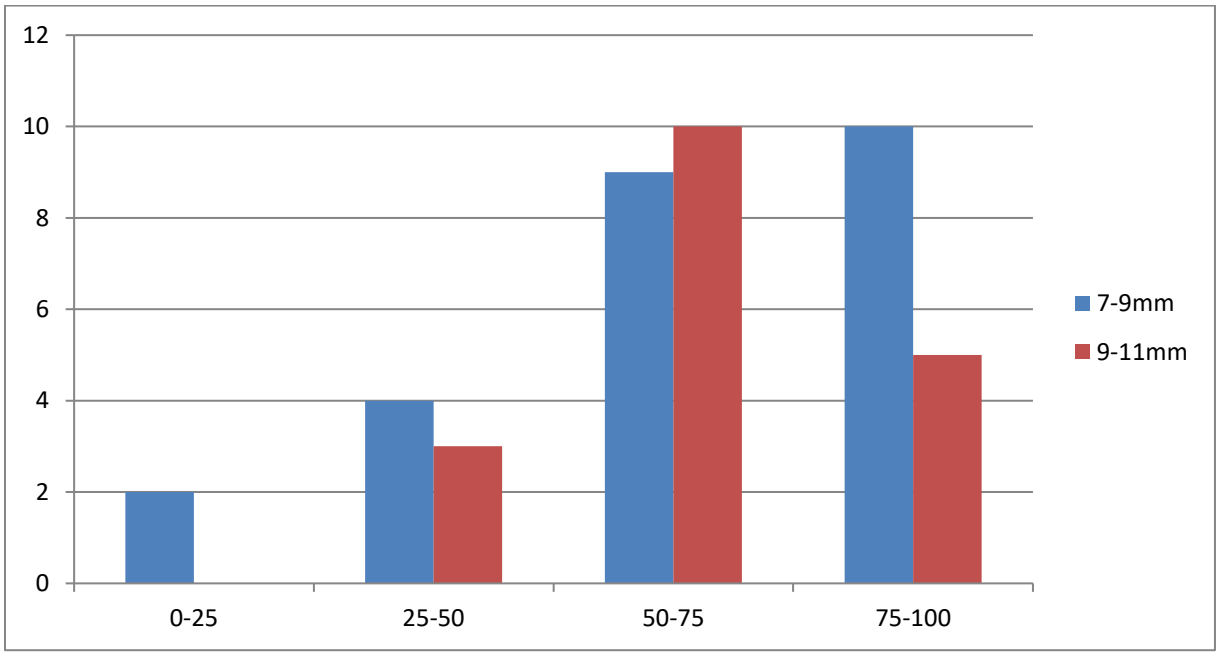
A group of 43 patients was divided into two subgroups depending on the thickness of the transplant used. 25 patients were qualified to the first group, in which the graft thickness ranged from 7mm to 9mm. The second group consisted of 18 patients with the graft thickness of 9 to 11mm. The division into two groups, depending on the surgical technique, remained unchanged - 21 patients underwent the procedure using the technique of quadruple-folded semitendinosus tendon (ST), while 22 patients were operated on using double-folded semitendinosus and gracilis tendons (ST + GR).

The individual parameters, assessed with accordance to the KOOS scale: general quality of life, occurrence and severity of pain, possible sports activity, performing everyday activities, and other symptoms were analyzed. The results are presented on charts according to the KOOS scale, with values from 0 to 100; 100 is the most favorable result.

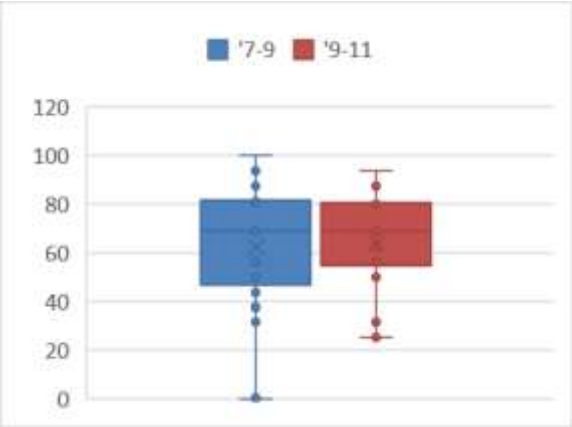
a) Assessment of the impact of the thickness of the transplant used on the overall quality of life of patients.



Graph 4. Division of patients into two subgroups. The effect of graft thickness on the parameter: general quality of life. Percentage graph. Statistically significant results (p = 0.01).



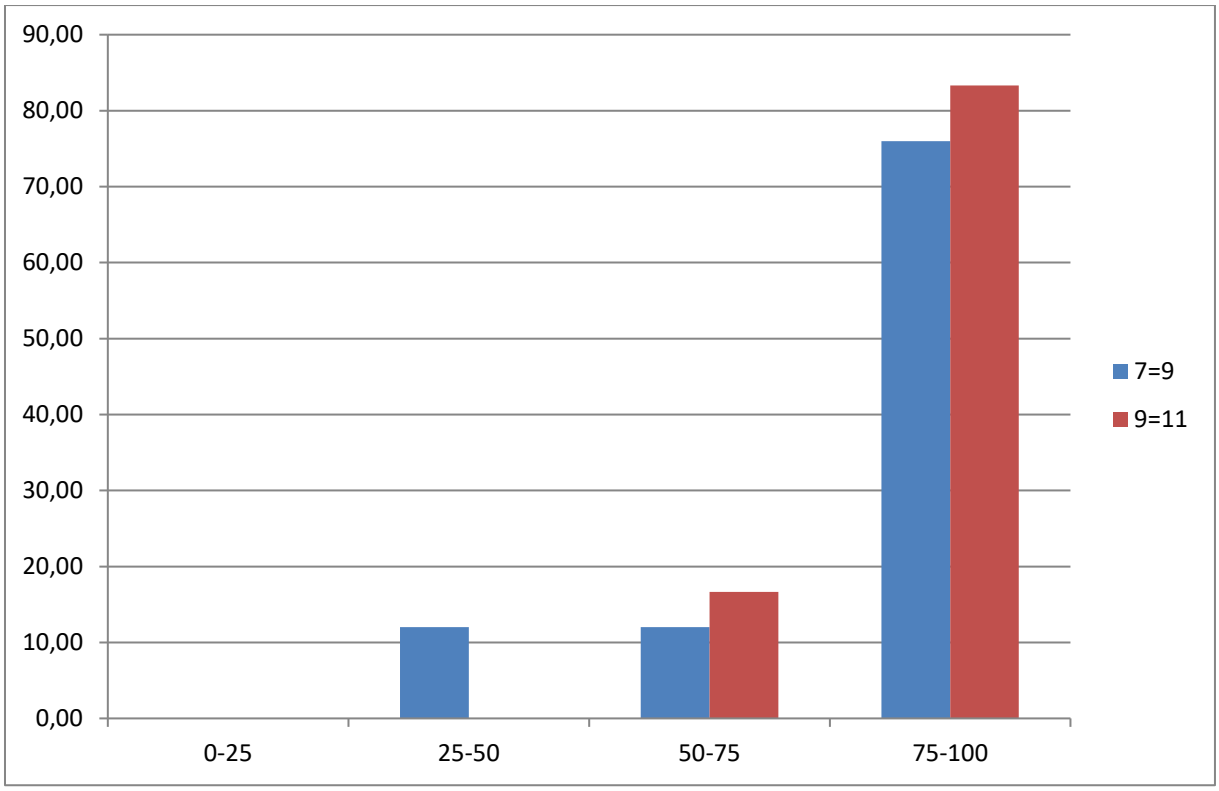
Graph 5. Division of patients into two subgroups. The effect of graft thickness on the parameter: general quality of life. Numerical graph. Statistically significant results (p = 0.01).



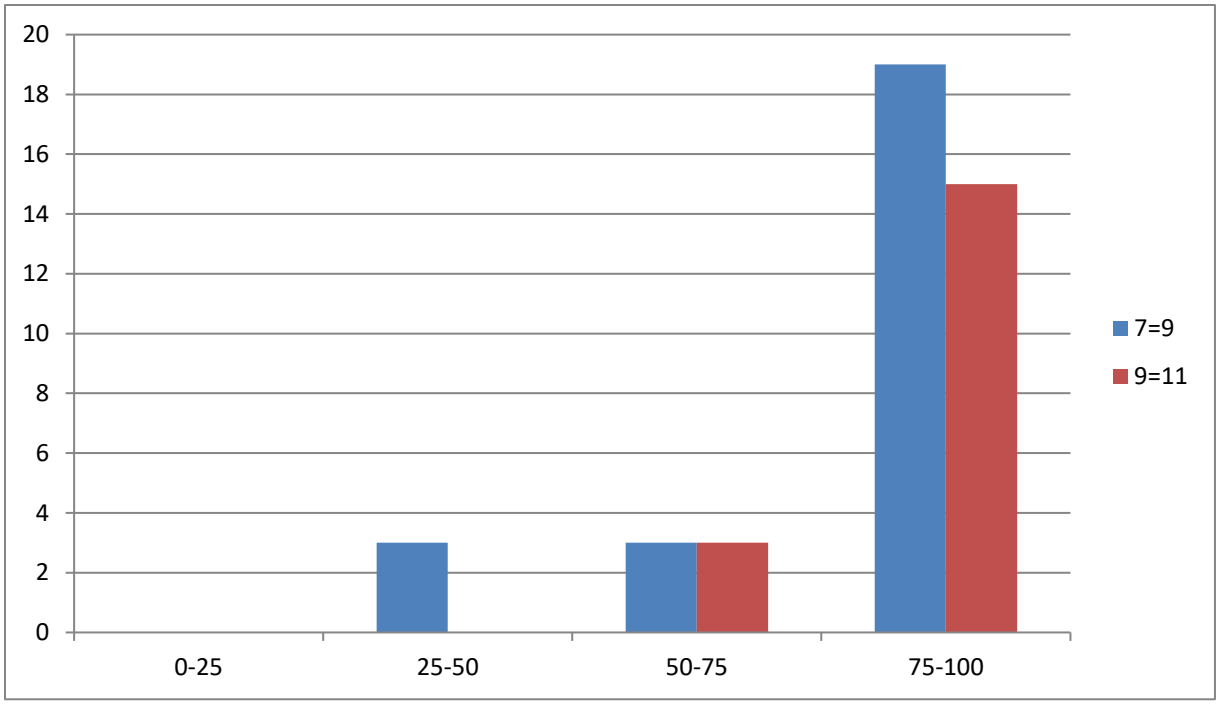
Graph 6. The effect of graft thickness on the parameter: general quality of life.

Statistical analysis indicates the presence of statistical significance between the examined parameters. The significance level (p) is 0.01 for the Chi2 independence test of 11.75. The evaluation of these data and graphs suggests a better overall quality of life in patients after thigh graft implantation, closer to the size of the primary thickness of the ligament.

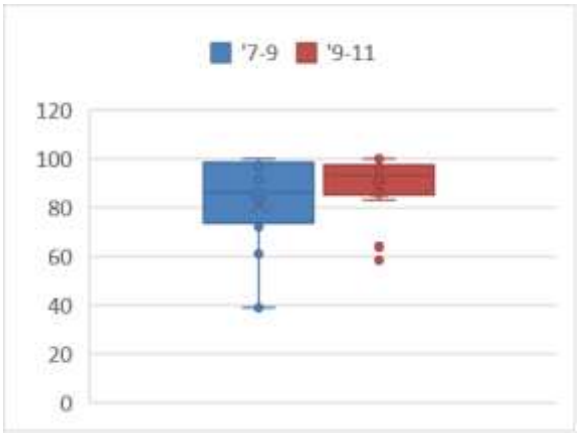
b) Assessment of the impact of the thickness of the graft used on pain.



Graph 7. Division of patients into two subgroups. The effect of graft thickness on the parameter: pain. Percentage graph. Statistically significant results (p = 0.005).



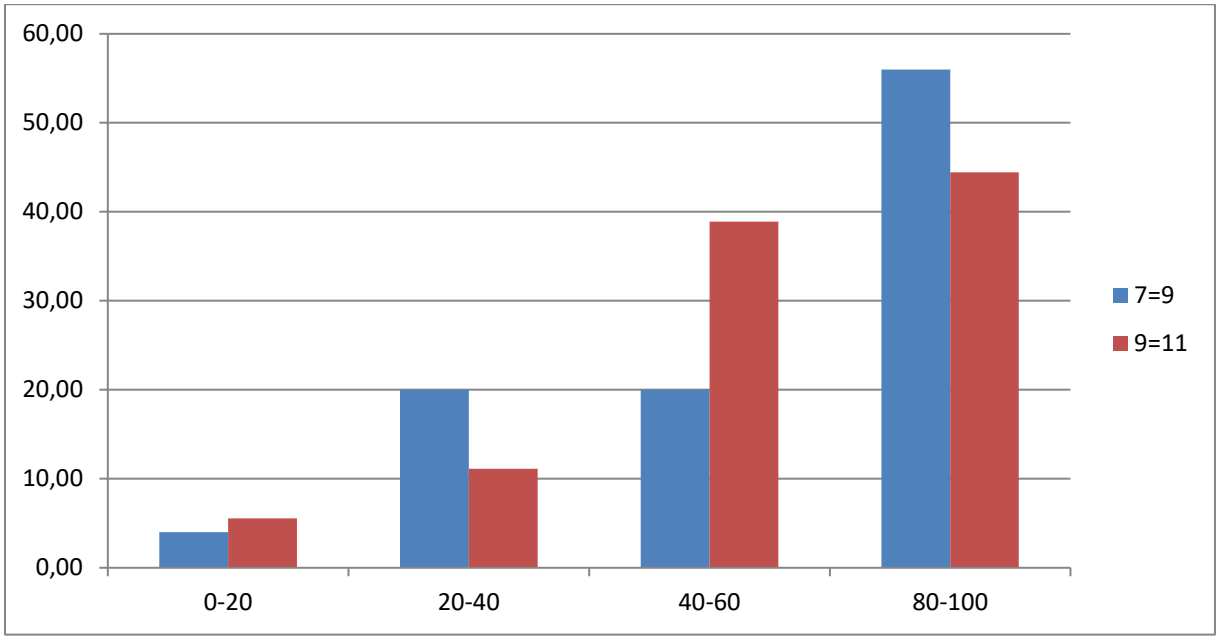
Graph 8. Division of patients into two subgroups. The effect of graft thickness on the parameter: pain. Numerical graph. Statistically significant results (p = 0.005).



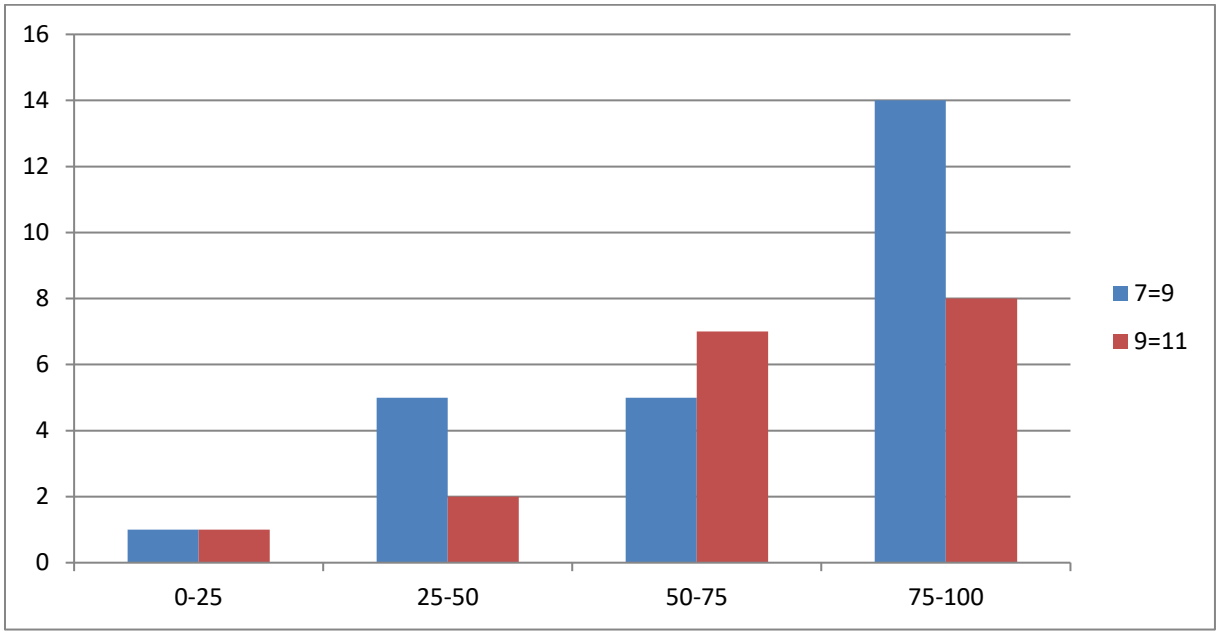
Graph 9. Division of patients into two subgroups. The effect of graft thickness on the parameter: pain.

Significant reduction of pain after an ACL repair operation using both surgical techniques is a perfect confirmation of the correctness of this procedure. Only three patients scored below 50 points on the KOOS scale, and the vast majority (34 patients) assessed their pain symptoms between 75 and 100 points, which is a positive result. Data analysis shows slightly better results obtained by patients with thicker grafts (9-11mm). There is a strong statistical relationship between the parameters studied. The level of significance for these parameters is p = 0.005.

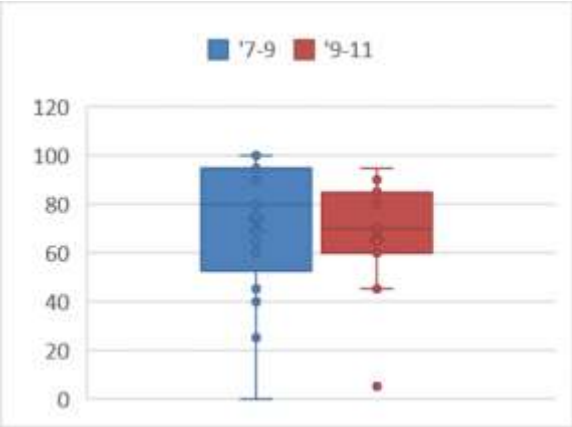
c) Assessment of the impact of the thickness of the graft used on sport activity.



Graph 10. Division of patients into two subgroups. Influence of graft thickness on the parameter: sport activity. Percentage chart. Statistically significant results (p = 0.05).



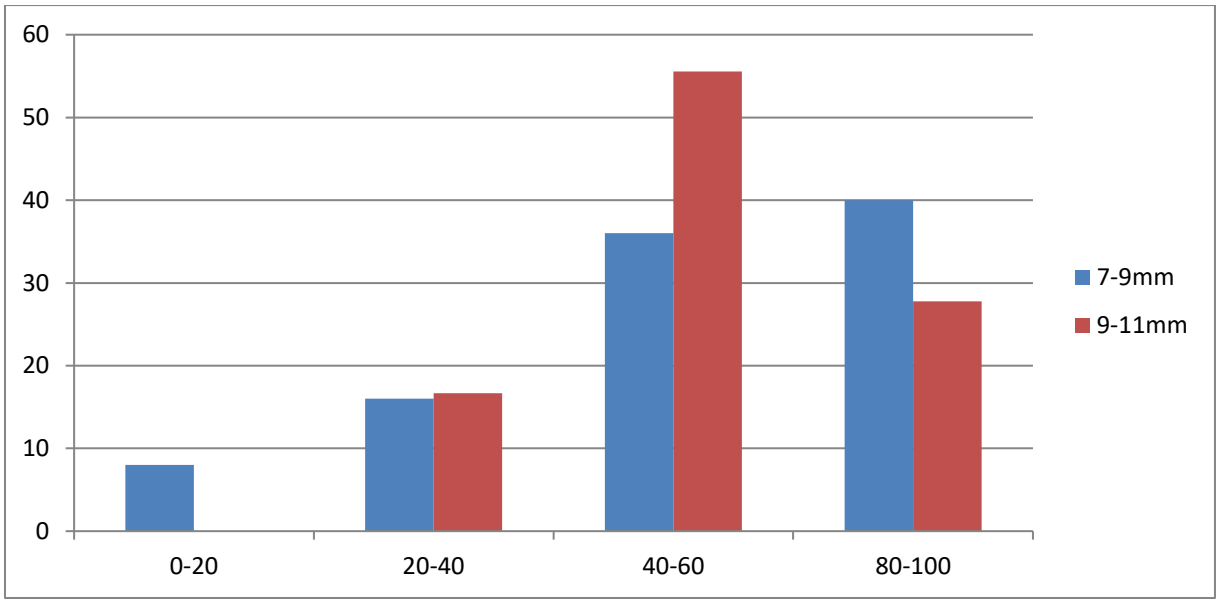
Graph 11. Division of patients into two subgroups. Influence of graft thickness on the parameter: sport activity. Numerical chart. Statistically significant results (p = 0.05).



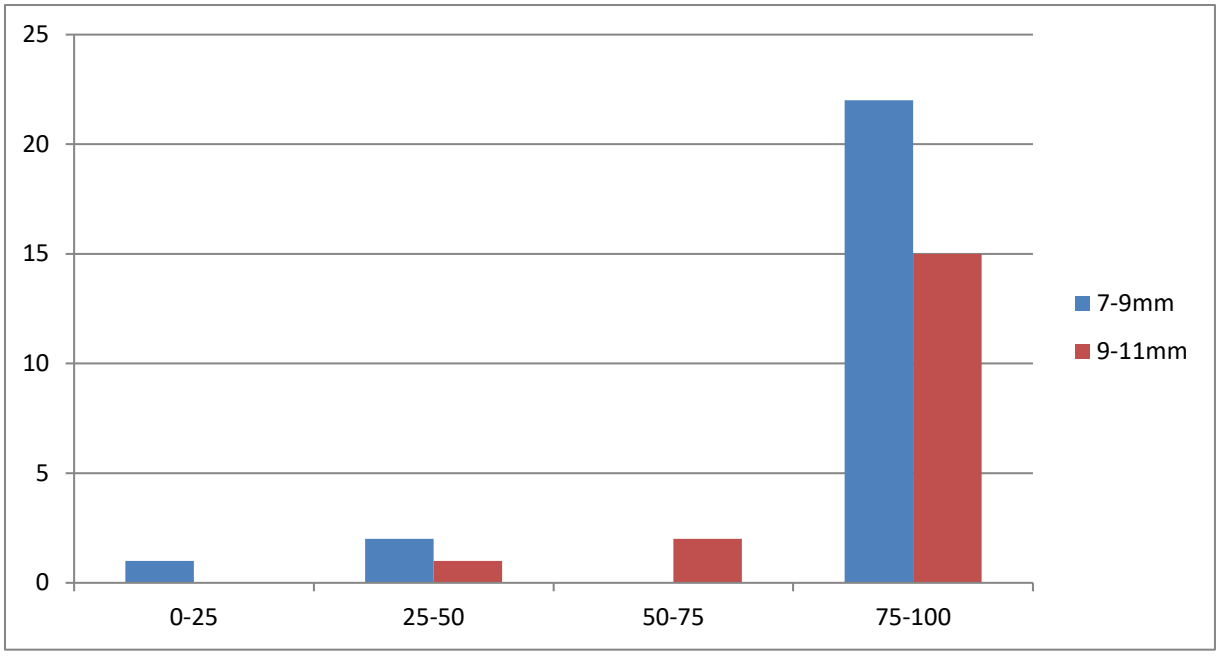
Graph 12. Effect of graft thickness on the parameter: sport activity.

Statistical analysis using the Chi2 compatibility test in the Yates modification shows the existence of a relationship between the parameters studied. The result of the calculation for the parameter of the KOOS scale "sport activity" is 10.8 and the significance level p = 0.05. There is a relationship between the thickness of the graft used and the possibility of practicing sports in patients after reconstructing the anterior cruciate ligament.

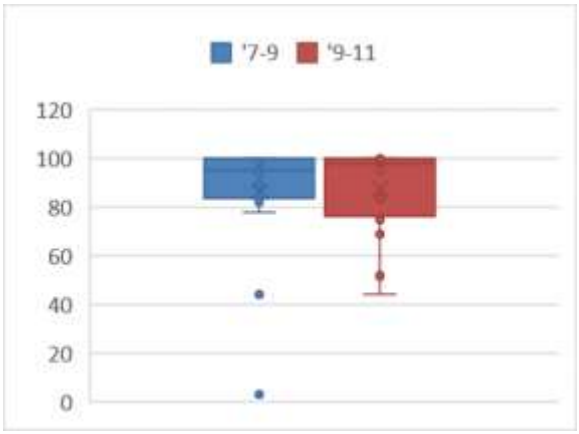
d) Assessment of the influence of the graft thickness on everyday activities.



Graph 13. Division of patients into two subgroups. The effect of graft thickness on the parameter: daily activities. Percentage chart. Statistically significant results (p = 0.01).



Graph 14. Division of patients into two subgroups. The effect of graft thickness on the parameter: daily activities. Numerical chart. Statistically significant results (p = 0.01).



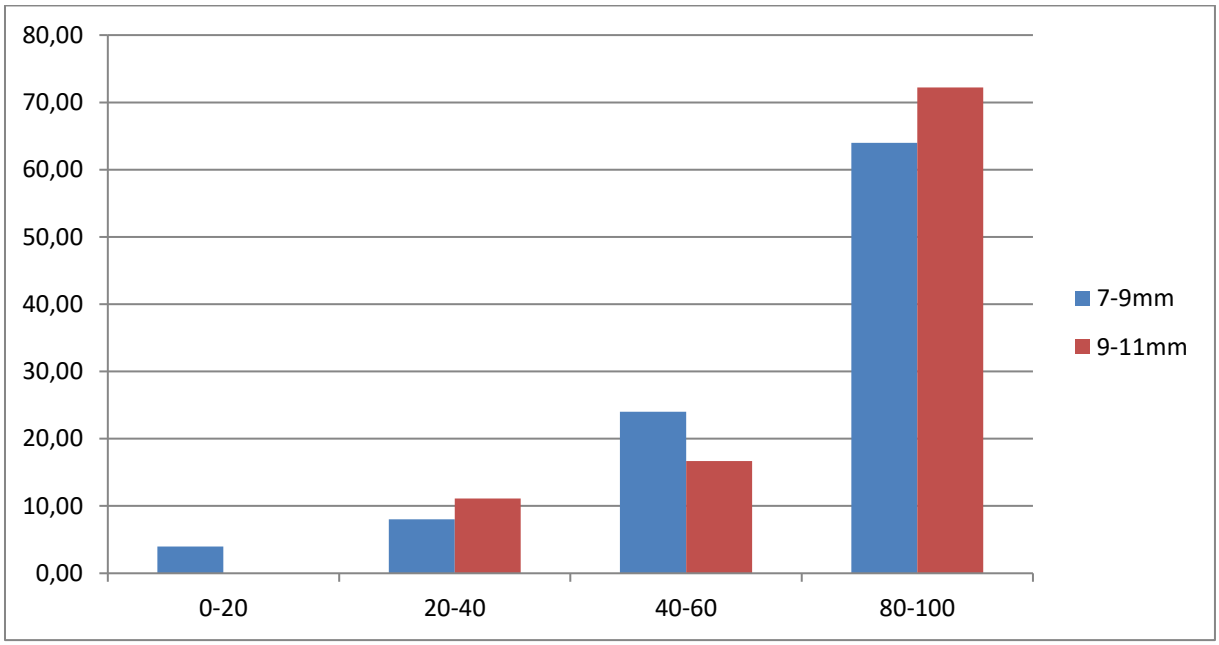
Graph 15. The effect of graft thickness on the parameter: daily activities.

There is a statistical relationship between the parameters analyzed. The significance level is p <0.01 for Chi2 equal to 11.68. Observation and analysis of the results allows to state first of all that the reconstruction of the ligament with the use of any graft thickness improves the performance of daily activities. The vast majority of patients evaluate their results very well in this category. It seems that generally better results were obtained in patients with 7-9mm transplantation. It is a statically significant relationship.

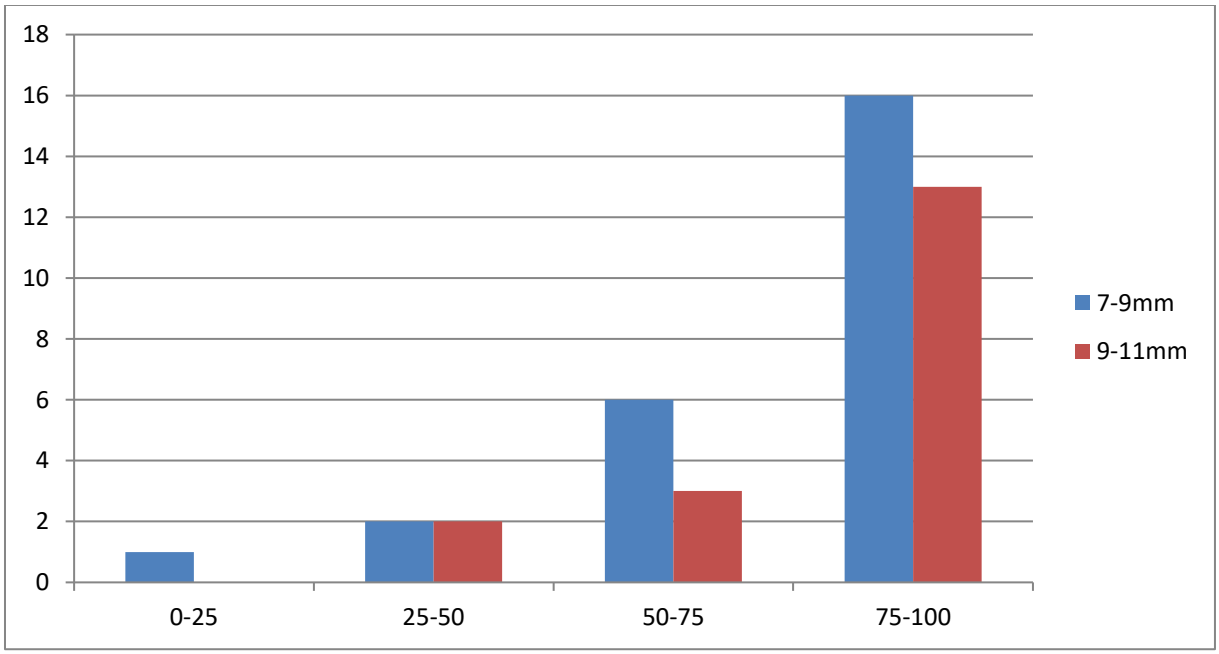
e) Assessment of the influence of the graft thickness on the appearance of other symptoms.

Other symptoms included in the survey prepared according to the KOOS scale included ailments such as the frequency of swelling, the occurrence of friction, the appearance of blocks during bending or straightening the knee. The subjective assessment of the possibility of complete flexion and extension in the joint was also assessed here. Analysis of the results and

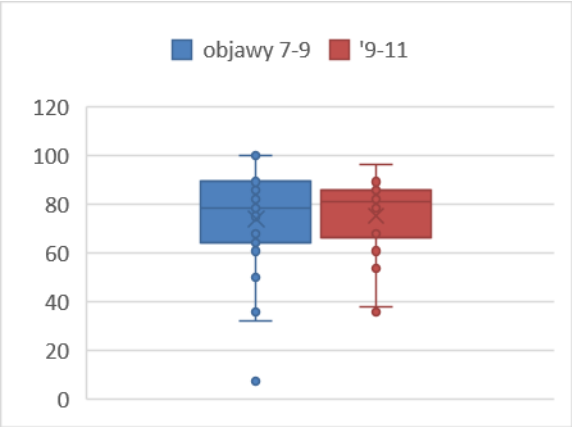
statistical calculations did not show any relationship between the thickness of the transplant used and the occurrence of the described "other symptoms". The level of significance for the tested parameters in this case was p = 0.1. Result statistically insignificant.



Graph16. Division of patients into two subgroups. The effect of graft thickness on the parameter: other symptoms. Numeric chart. Non-statistically significant results (p = 0.1).



Graph 17. Division of patients into two subgroups. The effect of graft thickness on the parameter: other symptoms. Numerical chart. Non-statistically significant results (p = 0.1).



Graph 18. Effect of graft thickness on the parameter: other symptoms.

5. DISCUSSION AND CONCLUSIONS:

Third degree damage to anterior cruciate ligament (ACL) is an absolute indication for surgical treatment. Injuries of the discussed ligament are a problem so frequent that its reconstructions are one of the most common arthroscopic procedures. It is naturally associated with complications that may lead to serious limitation of knee function [9] [11] [12]. However, it cannot limit these procedures in any way, because it is the lack of treatment that results in the creation of a truly large number of complications. Even 70% of patients get poor treatment results due to a lack of qualification for surgery. Damage of the menisci or cartilage - as mentioned earlier - is progressing very rapidly in the unstable knee [13]. The tendency is completely opposite in the case of surgical treatment. Despite the many complications mentioned above, up to 95% of patients achieve a satisfactory long-term treatment outcome [14].

There are many publications and studies comparing the results of treatment and quality of life in patients after ACL reconstruction. Most of them show similar, satisfactory results regardless of the method used [15]. A number of analyzes and descriptions of the strategy of conduct were performed, attempting to systematize surgical operations in case of damage to the discussed ligament [16] [17]. An in-depth review of the available literature and the authors' own experience allow to conclude that the correct patient qualification and implementation of surgical treatment are of the utmost importance. The choice of the surgical technique is just another factor affecting the distant outcome of treatment.

Information on the impact of graft thickness on a long-term treatment may be extremely important not only for surgeons, who for various reasons in their daily practice choose ACL reconstruction techniques using tendons of semitendinosus and semimembranosus muscles, but also for enthusiasts of other methods. As it has been proved in this publication, there are

dependencies confirmed by statistical analyzes between the thickness of the transplant used and the majority of the parameters tested.

The relationship between the thickness of the graft and the parameters such as: general quality of life, pain, sports activity, everyday activities has been demonstrated. In the vast majority of the cases discussed, slightly better results in subjective assessment were obtained by patients with a "thicker" graft, i.e. 9-11mm, that is, similar in thickness to the original ACL. No relationship was found between the broad parameter "other symptoms" and the thickness of the graft. The presented results encourage to continue research on a larger group of patients in this area, in order to better understand the problem and establish more detailed relationships between the thickness of the transplant used and the long-term treatment result. The study did not find a relationship between the choice of the surgical technique and the thickness of the graft. Regardless of whether the surgeon decided to use the double-folded semitendinosus and gracilis tendons or quadruple-folded semitendinosus tendon, it did not affect the transplant. In other studies, however, the influence of the selected type of surgical technique on the long, subjective outcome of treatment was noticed [7].

BIBLIOGRAPHY

[1] https://www.ncbi.nlm.nih.gov/pubmed/?term=acl+reconstruction.

[2] Butler DL: Anterior cruciate ligament: its normal response and replacement. J. Orthop. Res. 1989 7:910 – 921.

[3] Johnson RJ, Beynnon BD, Nichols CE and Renstrom PAFH: Current concepts review. The treatment of injuries of the anterior cruciate ligament. J. Bone and Joint Surg. Jan. 1992 74-A: 140 – 151.

[4] Feagin JA Jr. [editor]: The Crucial Ligaments: Diagnosis and Treatment of Ligamentous Injuries about the Knee. New York, Churchill Livingstone, 1988.

[5] Daniel DM, Akeson WH and O'Connor JJ [editors]: Knee Ligaments: Structure, Function, Injury, and Repair. New York, Raven Press, 1990.

[6] Piech P, Polak P, Kozioł M et al.: Comparision of treatment outcomes in isolated injuries of anterior cruciate ligament (ACL) and injuries of ACL connected with damages of menisci, conducted with use of KOOS scale. Journal of Education, Health and Sport 2017 vol. 7 nr 4, s. 29-37.

[7] Piech P, Polak P, Rasoul K: The comparison between the results of treatment of patients after ACL reconstruction using double-folded semitendinosus and gracilis tendons and quadruple-folded semitendinosus tendon. Journal of Education, Health and Sport 2017 vol. 7 nr 6, s. 107-119.

[8] Levy AS, Meier SW: Approach to cartilage injury in the Anterior cruciate ligament-deficient knee. Orthop Clin North Am. 2003;34:149-167.

[9] Sharp JW, Kani KK, Gee A et al.: Anterior cruciate ligament fixation devices: Expected imaging appearance and common complications. Eur J Radiol. 2018 Feb;99:17-27.

[10] http://www.koos.nu/

[11] Matava MJ: Complications of anterior cruciate ligament reconstruction: graft issues. Instr Course Lect, 2006; 55: 489–96.

[12] Sekiya JK, Ong BC, Bradley JP: Complications in anterior cruciate ligament surgery. Orthop Clin North Am, 2003; 34(1): 99–105.

[13] Sommerlath K: The importance of meniscus in unstable knee: a comparative study. Am Sports Med, 1989; 17: 173–77.

[14] Wolf RS, Lemak LJ: Revision anterior cruciate ligament reconstruction surgery. J South Orthop Assoc, 2002; 11(1): 25–32.

[15] Stolarczyk A, Nagraba Ł, Mitek T et al.: The comparison of two methods of arthroscopic anterior cruciate ligament reconstruction. Artroskopia i Chirurgia Stawów, 2006; 2(3): 22–29.

[16] Stolarczyk A, Kalińska J, Nagbara Ł et AT al.: Management of anterior cruciate ligament injuries. Artroskopia i Chirurgia Stawów, 2007; 3(2): 18-29.

[17] Mioduszewski A: The cruciate ligaments treatment strategy; Acta Clinica, 2002;2(1): 17-25.