Original Article

Pre-operation rehabilitation of patients with a relapse of anteromedial instability of knee joint

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Abstract

Introduction. Study of the effectively of preoperative rehabilitation of patients with anteromedial instability.

Methods. The study included 51 randomly selected individuals with anteromedial instability release with different knee joint compensation, aged 25–50 years, both males and females. All participants underwent rehabilitation treatment in the Institute of Traumatology and Orthopaedics, National Academy of Medical Sciences of Ukraine, and had surgeries in the Institute's clinics. **Results and conclusions.** Treatment results of patients with compensated form of instability are not affected by the fact whether the patients undergone the pre-surgery rehabilitation treatment or not due to the fact that in 6 months period after the knee joint revision surgery main group $85,60 \pm 10,01$ ($\bar{x} \pm SD$) and control group $84,57 \pm 9,22$ ($\bar{x} \pm SD$) showed same functional results ($p > 0.05$). Treatment results of patients with sub-compensated form of instability that undergone rehabilitation treatment in 3 months after the knee joint revision surgery in connection with the anteromedial instability are slightly better $65,33 \pm 12,71$ ($\bar{x} \pm SD$) than the results of patients $55,00 \pm 8,32$ ($\bar{x} \pm SD$) who did not undergo rehabilitation treatment course ($p < 0.05$), but in 6 months period after the surgery the results are almost the same ($p > 0.05$). Treatment results of patients with decompensated form of instability that undergo pre-surgery rehabilitation course in 3 months term after the knee joint revision surgery in connection with the anteromedial instability are much better $58,20 \pm 12,43$ ($\bar{x} \pm SD$) that results of the patients $49,87 \pm 9,30$ ($\bar{x} \pm SD$) that did not undergo the rehabilitation treatment course ($p < 0.05$). Treatment results of patients with decompensated form of instability that undergone rehabilitation treatment course in 6 months after the knee joint revision surgery in connection with the anteromedial instability are much better $69,80 \pm 13,64$ ($\bar{x} \pm SD$) than those with patients $53,33 \pm 6,95$ ($\bar{x} \pm SD$) who did not undergo the rehabilitation treatment ($p < 0.05$). The best results of the treatment were received in patients with compensated and sub-compensated knee joint instability, worse ones being in a decompensated form. Patients with decompensated form of instability had the most effective use of the preoperative rehabilitation program.

Key words: physical rehabilitation, trauma, anteromedial instability, knee joint, recovery treatment

Introduction.

Technology of anterior crucial ligament restoration has changed significantly. Although post operational results have improved, substantial number of anteromedial instability relapse post operation cases require not only improvement of existing surgery techniques and diagnosing causes of unsuccessful results, but also development of rehabilitation approaches [Roy I. at al., 2019; Rusanov A. at al., 2018, 2019].

After initial plastic reconstruction of anterior crucial ligament 80-90% patients showed positive results and 10% showing negative results accordingly. According to the statistics, 8% of patients had unacceptable result and required recurrent operation on renewal of anterior crucial ligament. Results of recurrent operations were much worse, than the initial plastic surgery, which is why it is very important to take individual approach in each case of anteromedial instability relapse [Wolf R.S., 2002].

It should be noted that while there are different surgery techniques for treatment of anteromedial instability it is still hard to define the optimal post-surgery treatment tactic [Stanescu M. at al., 2019; Kostrub, A. at al., 2020]. Pre-surgery rehabilitation is a separate issue. Often the anteromedial instability relapse is caused by the absence of an active stabilizer chain (sartorius), which results in overload of PAL graft and frustration of the "ligamentization" process [Mironov S.P., 1999]. That is why there is a necessity to conduct a pre-surgery treatment, which would be primarily aimed at strengthening of active stabilizers. We believe, that pre-surgery rehabilitation of patients with anteromedial instability relapse will be as important as post-surgery rehabilitation.

Aim of the research. Study of the effectively of preoperative rehabilitation of patients with anteromedial instability.

Methodology of research.**Participants.**

The study included 51 randomly selected individuals with anteromedial instability release with different knee joint compensation, aged 25–50 years, both males and females.

Randomization or random selection are used to create simple accidental sampling. Pairwise selection was used – a strategy for compiling selection groups, which provided for such groups to include subjects that are equivalent in accordance with the material side parameters that are important for the experiment (character of injury, medical condition and age). Such strategy is efficient for experiments with the use of experimental and control groups. Stratometric selection was used – randomization with separation of groups.

When such approach towards formation of selection is used the total amount of participants is split into patient groups that have certain characteristics of the knee instability forms and patients with respective characteristics of knee instability forms are chosen for the experiment.

Procedure.

To achieve the set target in this work the following methods were used: theoretical analysis of data from the scientific and methodological literature, pedagogical, clinical (examination, anamnesis collection), instrumental methods of research and methods of mathematical data processing. All the materials for this work were obtained during studies based on the State Enterprise “Institute of Traumatology and Orthopedics of the National Academy of Medical Sciences in Ukraine (ITO NAMS)”.

The algorithm of the complex diagnostics for acute ACL injuries, created in ITO NAMS of Ukraine, was applied to the patients having corresponding claims; this algorithm implied clinic-functional and X-ray examination, ultrasound examination and MRT.

During clinical examination and anamnesis collection all patients were asked about the reason of turning to the rehabilitation department, about the intensity of pain syndrome; their claims on pain syndrome while active movements, passive movements and stasis; instability of KJ, which was measured by the following tests: Lachman test, drawer test.

The patients were also diagnosed for the activity (by scale of Tegner), and for the indicator of movement function of KJ, which was obtained with the help of scale IKDC-2000 (International Knee Documentation Committee).

Statistical analysis.

The empirical material was processed with mathematical statistics methods. Descriptive data are presented as mean, and standard deviation. The sample data for normality were tested with the normal distribution formula, Shapiro-Wilk test. Nonparametric statistic were used to compare whether these parameters significantly changed in the preoperative and follow-up periods at the 3th and 6th month after surgery, the Wilcoxon’s test was used. The level of statistical significance was considered as $p < 0.05$. Statistical analyses were performed with the Statistical Package for the Social Sciences (SPSS) 10.0.

Ethical approval.

The research related to human use has complied with all the relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki, and has been approved by the Ethics Committee Board of the Institute of Traumatology and Orthopaedics, National Academy of Medical Sciences of Ukraine.

Informed consent. Informed consent has been obtained from all individuals included in this study

Results.

In order to study the effect of the pre-surgery rehabilitation of patients with anteromedial instability release with different knee joint compensation ratio homogenous groups of 51 with anteromedial instability release with different knee joint compensation, aged 25–50 years, both males and females. The patients (51 people) without temporary contraindications for arthroscopic operative intervention were examined using instrumental methods of research. The examination was made within different periods of recovery treatment. In the first group (21 patients- main group) pre-surgery rehabilitation was performed; in the second group (30 patients- control group) pre-surgery rehabilitation was not performed. The results, registered on the preliminary stage of research, showed no statistically meaningful discrepancies between the examined indicators and the age of the patients among the control group and the main group.

All patients were divided into three groups in accordance with the form of knee joint instability as suggested by the classification of Kotelnikov [Kotelnikov G.P., 1991]. First group included patients with compensated form, second – with sub-compensated form of instability, and third – with decompensated form of instability (table 1).

Table 1

Division of patients in accordance with the instability form and pre-surgery preparation

Instability form	main group		control group		Total	
	n	%	n	%	n	%
Compensated	5	9,8	7	13,7	12	23,5
Sub compensated	6	11,8	8	15,7	14	27,5
Decompensated	10	19,6	15	29,4	25	49

Pre-surgery rehabilitation was aimed at improvement of lower extremity muscles, i.e. improvement of active stabilizers function. All patients performed rehabilitation exercises (with and without apparatus – stationary bicycle and stair stepper) (10-20 minutes, every day), undergone electrical myostimulation using “Stymul-1”, “Miorythm-040” in accordance with standard techniques, undergone massage therapy (relaxing, aimed at decrease of limb swelling and improvement of blood circulation, raising tone of quadriceps muscle of thigh, mainly), patients exercised in swimming pool (10-25 minutes, every day).

Electrical Myostimulation of damaged limb with the view to increase its strength was performed by means of use of an 8-channel machine for electrical myostimulation “Miorythm 040” and “Stimul-1” (Russia), with the change of the frequency and time of the procedure on a case by case basis taking into account the responses of muscles to stimulation. Electrical myostimulation was used for annular flow of thigh muscles (anterior and back) and lower leg sciatic muscle of the operated limb in the following order: anterior group of thigh muscles (4 s), posterior (4 s), lower leg muscles: flexor group (4 s) and extensor group (4 s). The pulse shape was asymmetrical bipolar without steady component, pulse duration 0,3 ms. Stimulation regime – 60 Hz, duration of cycle – “stimulation – relaxation” 4 s with increase to 8 s starting from the 5th -6th procedure, subject to positive dynamics and the procedures are well tolerated, duration of 5-10-30 minutes, each day, No. 12. Duration of the 1st procedure was 5-10 minutes, the 2nd-3rd – 10 minutes, the 4th -5th – 15 minutes, the 6th-8th 20 minutes, until the end of the myostimulation – 25-30 minutes). During the 1st-8th procedures the duration of “Stimulation – Relaxation” cycle was 4 s; the 8th-12th – 8 s. The intensity of current strength was fixed before the feeling of vibration and painless muscle contractions appeared.

Use of therapeutic massage with elements of passive development to increase the movement range of the damaged joint and postisometric relaxation. Duration of the procedure at the beginning of the rehabilitation treatment equalled 15-20 minutes and subsequently gradually increased.

Rehabilitation treatment was carried out in compliance with the following methodological rules:

- early appointment and use of the massage depending on the speed of recovery processes and patients’ conditions;
- sequence of body massage in accordance with the pumping out method;
- combination of massage with physiotherapeutic procedures, which, depending on the recommendations, were used prior to or after the massage;
- combination of massage with therapeutic exercise;
- part of passive exercises was used during the massage to increase the movement range of the operated limb;
- combination of massage with postisometric relaxation.
- Combination of massage with liniment, gel and liquids by medical prescription.

Massage procedure consisted of preparatory, main and final parts.

In the course of preparatory part, a patient is being prepared during 1-2 minutes with sensitive stretch (frottage and frolement) for the main part of the procedure.

The moves are made at a quick rate until the feeling of pleasant warmth appears.

During the main part a differentiate massage is made, which depends on the condition of the patient.

In the course of the final part, massage moves are being slowed down during 1-3 minutes, and at the end of the procedure frottage of the all massage area is being done. Duration of the massage procedure depended on the individual peculiarities, age, height, weight, mass of subcutaneous tissue and muscle system development, age, condition of the patient. Massage was scheduled quotidian (on a day to day basis) or quaque altera die (on each alternate day). Time allocation among different massage practices depended on the purpose of differentiated procedure of massage, patient’s condition and his reactions to massage manipulation.

The course of massage was divided into preparatory, main and final periods.

During preparatory period (1-3 procedures) massage areas, patient’s reactions and tolerance of different manipulations and muscle conjunctions occurrence, occurrence of hyperalgesia, extended or limited hypertension and myogelosis were studied. During the main period specific differentiated massage method was used with considerations of the functional condition of the patient. The strength of manipulations was increased through the use of 8-16 procedures. In the course of final period the patient was taught self-massage techniques, if necessary, and procedures used during the main period were continued.

Patients had massage of knee joint, which included massage of upper third of a leg, knee joint and lower third of a thigh.

Massage of the knee joint of the intact limb and thigh muscles of the intact limb was performed in accordance with the classical method and included:

- Massage of the posterior surface of thigh with the use of manipulations in the following order: frottage, frolement, fulling, tapping, vibrating manipulations, use of passive movements;
- Massage of the anterior surface of thigh with the use of manipulations in the following order: frottage, frolement, fulling, tapping, vibrating manipulations, use of passive movements;
- Massage of the knee cap area with the use of the manipulations in the following order: frottage, frolement, fulling (only of an intact limb).

Massage of a knee joint of a damaged limb and thigh muscles of the intact limb was performed in accordance with the analogic method with special attention to passive movements: hemicyclic relocation to the sides and up and down. Performance of therapeutic massage was combined with elements of passive development to increase the movement amplitude of the damaged joint, increase of toning and trophic effect of massage, development of compensation and resetting functions of the operated joint. Movements were made in compliance with natural axis of the knee joint, slowly, gently, with increase of amplitude to maximum possible (4-5 moves), without painful feelings. Table 2 shows function of knee joint in accordance with IKDC scale in patients main and control group with anteromedial instability of knee joint relapse (prior to surgery, in 3 and 6 months period after surgery). In three months after the surgery the average results of patients in the main group verifiably overgrew results of patients from the control group and equalled $62,62 \pm 11,87$ ($\bar{x} \pm SD$) and $56,17 \pm 12,12$ ($\bar{x} \pm SD$) respectively. The effectiveness of the pre-surgery programme that was applied confirms that in 6 month after the surgery the average results of patients in the main group verifiably overgrew results of patients from the control group and equalled $77,05 \pm 14,00$ ($\bar{x} \pm SD$) and $68,87 \pm 17,97$ ($\bar{x} \pm SD$) respectively. Difference between the results of patients from the main group and the control group is statistically correct on condition that $p < 0,05$.

Table 2

Function of knee joint in accordance with IKDC scale in patients main and control group with anteromedial instability of knee joint relapse (prior to surgery, in 3 and 6 months period after surgery), $p < 0.05$

Instability form	prior to surgery ($\bar{x} \pm SD$)		P	in 3 months period after surgery ($\bar{x} \pm SD$)		P	in 6 months period after surgery ($\bar{x} \pm SD$)		P
	main group	control group		main group	control group		main group	control group	
Compensated	44,00 $\pm 3,16$	43,86 $\pm 4,18$	$p > 0.05$	68,20 $\pm 7,50$	71,00 $\pm 8,33$	$p > 0.05$	85,60 $\pm 10,01$	84,57 $\pm 9,22$	$p > 0.05$
Sub compensated	39,67 $\pm 3,08$	40,63 $\pm 4,93$	$p > 0.05$	65,33 $\pm 12,71$	55,00 $\pm 8,32$	$p < 0.05$	82,00 $\pm 12,71$	84,25 $\pm 11,60$	$p > 0.05$
Decompensated	28,50 $\pm 4,81$	29,93 $\pm 4,23$	$p > 0.05$	58,20 $\pm 12,43$	49,87 $\pm 9,30$	$p < 0.05$	69,80 $\pm 13,64$	53,33 $\pm 6,95$	$p < 0.05$
Total	35,38 $\pm 7,91$	36,03 $\pm 7,54$	$p > 0.05$	62,62 $\pm 11,87$	56,17 $\pm 12,12$	$p < 0.05$	77,05 $\pm 14,00$	68,87 $\pm 17,97$	$p < 0.05$

Treatment results of patients of main group and control group according to IKDC scale in 3 and 6 months periods are shown in pic. 1.

Pic.1 – Diagram of treatment results of patients of main group and control group in accordance with IKDC Scale in 3 and 6 months:

- Var1- main group prior to surgery
- Var2- control group prior to surgery
- Var3 - main group in 3 months period after surgery
- Var4- control group in 3 months period after surgery
- Var5- main group in 6 months period after surgery
- Var6- control group in 6 months period after surgery

Similar data was received during the evaluation of patients applying the Tegner Activity Scale: the pre-surgery activity level of all patients ranged from 0 to 2, which evidenced inability of these patients to remain in upright position and urged them to lead inactive life. Average activity level patients in accordance with the Tegner Scale gradually increased after the surgery, however depended on the initial activity level and the knee

joint compensation ratio (in patients with compensated instability of KJ: prior to surgery – approximately 2 points, in 3 months – approximately 3.5 points, in 6 months after the surgery – almost 5.5 points, in patients with sub-compensated instability of KJ: prior to surgery – almost 1.5 points, in 3 months - 2.5 points, in 6 months – slightly over 3 points; in patients with decompensated instability of KJ: prior to surgery – approximately 0, in 3 months – more than 1 point, in 6 months – 2 points). The results, registered on the stages of research, showed no statistically meaningful discrepancies between the examined indicators of the patients among the control group and the main group.

Treatment results of patients with compensated instability form of main group and control group according to IKDC scale in 3 and 6 months periods are shown in pic. 2.

Pic.2 – Diagram of treatment results of patients with compensated form of instability of main group and control group in accordance with IKDC Scale in 3 and 6 months:

Var1- main group prior to surgery

Var2- control group prior to surgery

Var3 - main group in 3 months period after surgery

Var4- control group in 3 months period after surgery

Var5- main group in 6 months period after surgery

Var6- control group in 6 months period after surgery

Prior to the treatment in accordance with the subjective scale the condition of knee joint of all the patients with compensated form of instability evidencing showed no statistically meaningful discrepancies between the examined indicators of the patients among the control group and the main group, and in 3 and 6 months after revision surgery of ACL treatment results of patients with compensated form of instability significantly improved in both groups irrespective of the fact whether the pre-surgery rehabilitation was performed or not.

Treatment results of patients with sub-compensated form of instability in main group and control group in accordance with IKDC scale in 3 and 6 months are shown in pic. 3.

Pic. 3 – Diagram of treatment results of patients with sub-compensated form of instability of main group and control group in accordance with IKDC Scale in 3 and 6 months:

Var1- main group prior to surgery

Var2- control group prior to surgery

Var3 - main group in 3 months period after surgery
 Var4- control group in 3 months period after surgery
 Var5- main group in 6 months period after surgery
 Var6- control group in 6 months period after surgery

As we can see from pic. 3, in 3 months after ACL revision surgery patients that undergone pre-surgery rehabilitation (main group) received more positive results in comparison to control group. Consequently, treatment results of patients with sub-compensated form of instability that undergone rehabilitation treatment course in 3 months period after a knee joint revision surgery in connection with the anteromedial instability slightly better than results of those patients who did not undergo the rehabilitation treatment, but in 6 months term after the surgery the results are practically the same.

Treatment results of patients with decompensated form of instability of main group and control group in accordance with IKDC scale in 3- and 6-months period are shown in pic.4.

Pic. 4 – Diagram of treatment results of patients with decompensated form of instability of main group and control group in accordance with IKDC scale in 3 and 6 months.

Var1- main group prior to surgery
 Var2- control group prior to surgery
 Var3 - main group in 3 months period after surgery
 Var4- control group in 3 months period after surgery
 Var5- main group in 6 months period after surgery
 Var6- control group in 6 months period after surgery

Positive effect of pre-surgery rehabilitation is registered in main group both in 3 months period and in 6 months period after the surgery. Treatment results of patients with decompensated form of instability that undergone rehabilitation treatment course in 3 and 6 months after the knee joint revision surgery in connection with the anteromedial instability are much better than those with patients who did not undergo the rehabilitation treatment.

Discussion.

Anterolateral instability is a common lesion of the knee which can result in significant disability. Without treatment, this problem can typically cause recurrent meniscal tearing, increased joint laxity, progressive giving way, joint surface deterioration and restrictions of functional activities. Although surgery can be performed to improve static stability, many patients elect a nonoperative approach based on a knee rehabilitation program [Engle R. at al., 1989].

Results of surgical treatment of 62 patients with a recurrence of anteromedial knee joint instability and the primary anterior cruciate ligament tear are presented. The patients were divided into three groups according to the compensation degree of their anteromedial knee joint instability. The results were evaluated with help of IKDC 2000 form and Tegner Lysholm knee scoring scale before surgery, 3 and 6 months after surgical treatment. It is shown that the initial degree of knee joint instability compensation influenced the treatment result. The best results of the treatment were received in patients with a compensated knee joint instability, worse ones being in a decompensated form [Strafun S. at al., 2012].

However, despite recent studies that show the benefits of exercises for people with osteoarthritis, the majority of people, especially with lower limb osteoarthritis, are insufficiently physically active. Patients with osteoarthritis have different levels of motivation to change their physical activity and a change in behaviour may take many months to become routine. Tele-rehabilitation, motivational interviewing and evidence-based

rehabilitation methods are used by health care professionals to help patients with osteoarthritis achieve mutually agreed physical activity goals [Mysuła I. at al., 2019].

Pain, muscle weakness and biomechanical dysfunction affect the progression of osteoarthritis, making muscle strengthen exercises of paramount importance in the prevention and rehabilitation of primary osteoarthritis of the knee. Physical rehabilitation strategies that actively change lower limb biomechanics are a promising strategy for the treatment of symptoms as well as for prevention of osteoarthritis progression. Different types and combinations of physical rehabilitation, depending on the biomechanical dysfunction, have the potential to improve the adaptive and compensatory function of joints, muscles and other periarticular tissues with minimal risk of adverse events [Mysuła I. at al., 2019].

On the basis of the performed analysis of indices that characterize the functional condition of the injured limb of patients with an injury of ACL of knee joint at the functional stage of rehabilitation treatment, it is possible to identify a high and medium level of loading asymmetry in the lower extremities, decrease of electrobiological activity and muscle resistance ability during bending, stretching, adduction, and abduction, as the main prognostic criterion of orthopaedic complications development [Rusanov A. at al., 2019].

Limitations.

Nevertheless, we recognize that our pilot study has limitations: it would be interesting to perform a prospective study with adults aged 35–40 years, or even 40–50 years olds patients to follow the course of joint laxity over time, and the number of the patients should be increased to confirm the correctness of the results.

Resume. Treatment results of patients with compensated form of instability are not affected by the fact whether the patients undergone the pre-surgery rehabilitation treatment or not due to the fact that in 6 months period after the knee joint revision surgery main group $85,60 \pm 10,01$ ($\bar{x} \pm SD$) and control group $84,57 \pm 9,22$ ($\bar{x} \pm SD$) showed same functional results ($p > 0.05$).

Treatment results of patients with sub-compensated form of instability that undergone rehabilitation treatment in 3 months after the knee joint revision surgery in connection with the anteromedial instability are slightly better $65,33 \pm 12,71$ ($\bar{x} \pm SD$) than the results of patients $55,00 \pm 8,32$ ($\bar{x} \pm SD$) who did not undergo rehabilitation treatment course ($p < 0.05$), but in 6 months period after the surgery the results are almost the same ($p > 0.05$).

Treatment results of patients with decompensated form of instability that undergo pre-surgery rehabilitation course in 3 months term after the knee joint revision surgery in connection with the anteromedial instability are much better $58,20 \pm 12,43$ ($\bar{x} \pm SD$) than results of the patients $49,87 \pm 9,30$ ($\bar{x} \pm SD$) that did not undergo the rehabilitation treatment course ($p < 0.05$).

Treatment results of patients with decompensated form of instability that undergone rehabilitation treatment course in 6 months after the knee joint revision surgery in connection with the anteromedial instability are much better $69,80 \pm 13,64$ ($\bar{x} \pm SD$) than those with patients $53,33 \pm 6,95$ ($\bar{x} \pm SD$) who did not undergo the rehabilitation treatment ($p < 0.05$).

The best results of the treatment were received in patients with compensated and sub-compensated knee joint instability, worse ones being in a decompensated form. Patients with decompensated form of instability had the most effective use of the preoperative rehabilitation program.

Disclosure statement. No author has any financial interest or received any financial benefit from this research.

Conflict of interest

The authors state no conflict of interest.

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