doi: 10.21823/2311-2905-2020-26-1-62-71

Mid-Term Results of Simultaneous Reconstruction of Anterior Cruciate and Anterolateral Ligaments in Athletes

E.N. Goncharov[1,2], O.A. Koval[2], V.E. Dubrov[3], E.N. Bezuglov[4], A.A. Alekhin[5], N.G. Goncharov[1,2]

[1] *Russian Medical Academy of Continuous Professional Education, Moscow, Russian Federation*

[2] *Central Clinical Hospital of the Russian Academy of Sciences, Moscow, Russian Federation*

[3] *Lomonosov Moscow State University, Moscow, Russian Federation*

[4] *Sechenov First Moscow State Medical University, Moscow, Russian Federation*

[5] *Peoples' Friendship University of Russia, Moscow, Russian Federation*

Abstract

Relevance. Today, there exist a large number of methods for arthroscopic reconstruction of the anterior cruciate ligament, however, the return to the competitive level among athletes remains quite low. It is believed that the functional state depends on the restoration of the rotational and anteroposterior stability of the knee. Such data facilitate the search of techniques for additional stabilization of the knee, one of which is the reconstruction of the anterolateral ligament of the knee. ***The purpose goal of the study*** was to assess the medium-term results of combined one-stage arthroscopic reconstruction of the anterior cruciate and anterolateral ligaments of the knee in athletes and the probability of their return to the competitive level. ***Material and Methods.*** In the period from 2014 to 2015, 50 patients underwent surgery. They were divided into 2 groups. Group 1 (main) consisted of 20 patients, including 10 professional athletes, who underwent the arthroscopic reconstruction of the anterior cruciate ligament, supplemented by reconstruction of the anterolateral ligament. Group 2 (control) included 30 patients (of which 10 were the professional athletes) who underwent the arthroscopic reconstruction only of the anterior cruciate ligament. ***Results.*** Group 1. 2 years after surgical treatment, 100% of patients were able to return to the preoperative competitive levels of activity. The average Tegner Lysholm score before the operation was 72.60±6.45 points, after the operation — 97.40±1.18 points. The average value on the IKDC scale before surgery was 63.1±4.8%, after surgery — 96.3±1.8%. Group 2. Of 30 patients, 2 years after surgery, 20 patients returned to the preoperative and competitive levels (66.7%). Of the professional athletes, 5 out of 10 patients (50%) returned to the competitive level, among amateur athletes — 15 out of 20 patients (75%). The average Tegner Lysholm score before surgery was 69.6±3.5 points, after — 92.1±3.9 points. The average value on the IKDC scale before surgery was 73.4±3.2%, after — 90.3±3.7%. ***Conclusion.*** Medium-term results of the study showed that the one-stage restoration of the anterior cruciate and anterolateral ligaments, compared with arthroscopic reconstruction of only the anterior cruciate ligament, increased the probability that the patients with high functional requirements and professional athletes would return to sports.

Keywords: anterior cruciate ligament, anterolateral ligament, knee instability, knee arthroscopy.

Cite as: Goncharov E.N., Koval O.A., Dubrov V.E., Bezuglov E.N., Alekhin A.A., Goncharov N.G. [Mid-Term Results of Simultaneous Reconstruction of Anterior Cruciate and Anterolateral Ligaments in Athletes]. *Travmatologiya i ortopediya Rossii* [Traumatology and Orthopedics of Russia]. 2020;26(1):62-71. doi: 10.21823/2311-2905-2020-26-1-62-71. (In Russian).

Evgeniy N. Goncharov; e-mail: goncharoven@gmail.com

Received: 23.06.2019. Accepted for publication: 17.01.2020.

Rupture of the anterior cruciate ligament (ACL) is one of the most frequent sports injury of the knee joint which annually constitutes 68.6 cases per 100 thousand people [1]. According to some authors the number of patients with isolated and combined ACL injuries is 0.3-1.0% of total population of the Russian Federation [2, 3]. Arthroscopic ACL repair constantly improves since 1980s: new surgical techniques, equipment and materials are being introduced [4]. Today there are many procedures for arthroscopic ACL reconstruction providing successful outcomes allowing patients to return to a certain activity level postoperatively [5, 6]. Non the less the probability for athletes to return to competitive sport remains rather low with average 55% (44–72%) [7, 8, 9]. Such a low rate is due to many factors and in the list of all reasons residual rotational instability holds not the last place, while this phenomenon is observed in 25–30% of cases after ACL repair [10, 11]. Functional status is considered to be dependent on recovery of rotational and anteroposterior stability of the knee [12, 13]. Above data facilitates search for methods of additional knee stabilization, and one of those is extracapsular tenodesis or restoration of anterolateral ligament (ALL) of the knee.

ALL is involved in the rotational knee stability which was proved by multiple anatomical and biomechanical studies [14, 15, 16]. It's known that ACL rupture in accompanied by ALL injury in many cases [17]. Today there are various methods for ALL repair [18, 19, 20].

The purpose of the study — to evaluate mid-term outcomes of combined one stage arthroscopic repair of anterior cruciate and anterolateral ligaments in athletes and the probability of their return to competitive sports.

Material and Methods

Study design: single center prospective prolonged comparative controlled study.

Inclusion criteria

– Playing sports at least 3 times per week (at least three workouts per week).

– Participation in competitions.

– Professional athletics.

– Age from 16 to 40 years.

– Absence of previous surgeries on the affected knee joint.

– Consent for MRI examination of the knee joint prior to surgery.

– Absence of neurological and mental disorders.

– Consent for filling out questionnaires and participation in the study.

All patients gave their informed voluntary consent for participation in the study.

50 patients were operated in the period from 2014 to 2015 who corresponded to inclusion criteria:

– 20 patients (out of those 10 being professional athletes) underwent arthroscopic ACL repair supplemented by ALL repair — group I (main);

– 30 patients (out of those 10 being professional athletes) underwent arthroscopic ACL repair — group II (control).

Surgeries were performed using a single technique, the same instruments and implants. Patients of group I were operated by one and the same surgeon; patients of group II — by three surgeons from department (including the first author) equal in education and skills.

Technique of anatomical ALL repair was used for the present study. No exoarticular tenodesis was used.

Knee function assessment was based on clinical examination, collection of medical history of the patient and disease, results of functional tests, MRI scans, patients' responses when filling questionnaires prior and 2 years after surgery.

Surgical technique

Surgical technique of ACL repair presented by the authors is in some aspects similar

to procedure suggested by Chahla et al. [20] but with certain differences:

1. Additional incision of about 5 cm in projection of lateral femoral condyle. Graft harvesting for ALL and formation of distal tunnel for graft fixation was made through approach for graft harvesting from patella ligament for ACL repair.

2. For formation of ALL tunnels the authors did not use the guiding sleeve used for formation of tibial tunnel for ACL repair. Tunnel formation is made directly on the guiding pin.

3. During formation of proximal (femur) tunnel the authors used technique allowing to identify center of rotation, meaning such tunnel positioning which will ensure equal tightening of ALL during various flexion-extension angles in the knee.

4. Suturing of proximal and distal margins of the graft was done by bioresorbable thread.

5. Use of interference screws of various diameters.

6. Femoral screw is inserted with fully extended knee joint.

In all cases the authors used ACL autograft from patella ligament with two bone blocks. Femoral tunnel was formed through anteromedial portal. Bone tunnels were 10 mm in diameter. Graft was fixed according to classical method using bioresorbable interference screws (composite material — "polylactic acid — hydroxyapatite") of different length: 8×25 mm — femoral tunnel, 8×30 mm — tibial tunnel. The authors observed no cases of bone blocks protrusion from tunnels in both groups which otherwise might have required changing the surgical technique or graft fixation method.

Upon completion of the first stage (ACL repair) in group I the ALL repair was undertaken as the second stage. Incision initially used for ACL graft harvesting was again used for grafting of gracillis or semitendinous tendons for preparing ALL graft. Then a pin was inserted in the point on lateral tibial condyle 1 cm below the joint line in the middle of the line drawn from Gerdy's tubercle to fibular head, this pin was used to form a 8×25 mm tunnel. Distal end of the ALL graft was placed into the tunnel, then graft was fixed by a interference bioresorbable screw (8×25 mm, "polylactic acid — hydroxyapatite") (Fig. 1 a).

An incision of about 5 cm was made in projection of lateral femoral condyle, reached fascia lata in layers dissecting it longitudinally for 4–5 cm and going through to lateral condyle of femoral epicondyle (Fig. 1 b).

Forceps were introduced from lateral femoral condyle under iliotibial tract so that forceps jaws come out at the site of formed tibial tunnel. Forceps were used to pass proximal end of the graft to the area of lateral femoral condyle (Fig. 1 c).

Pin with eye was inserted 1 cm below and proximally to the center of the lateral epicondyle, this pin was used for winding proximal end of the graft. This procedure was followed by flexion-extension of the joint to check correct placement in rotation center (rotation center — such positioning of the graft ensuring equal tightening at various flexion-extension angles of the joint) (Fig.1 d).

After insertion through the rotation center the pin was pushed through medial femoral condyle to pass its middle. Then pin was used to form 8×25 mm tunnel, proximal end of the graft was sutured by a bioresorbable thread for 30 mm, and then threads of the sutured graft were passed into eye of the pin, and pin was removed on the opposite side. Thus, proximal end of the graft was loaded into femoral tunnel and graft tightening was made by sutures led out from the opposite side, afterwards the graft was fixed by an interference bioresorbable screw at fully extended knee. Positioning and tightening of the graft were checked prior to wound closure (Fig. 1 e).

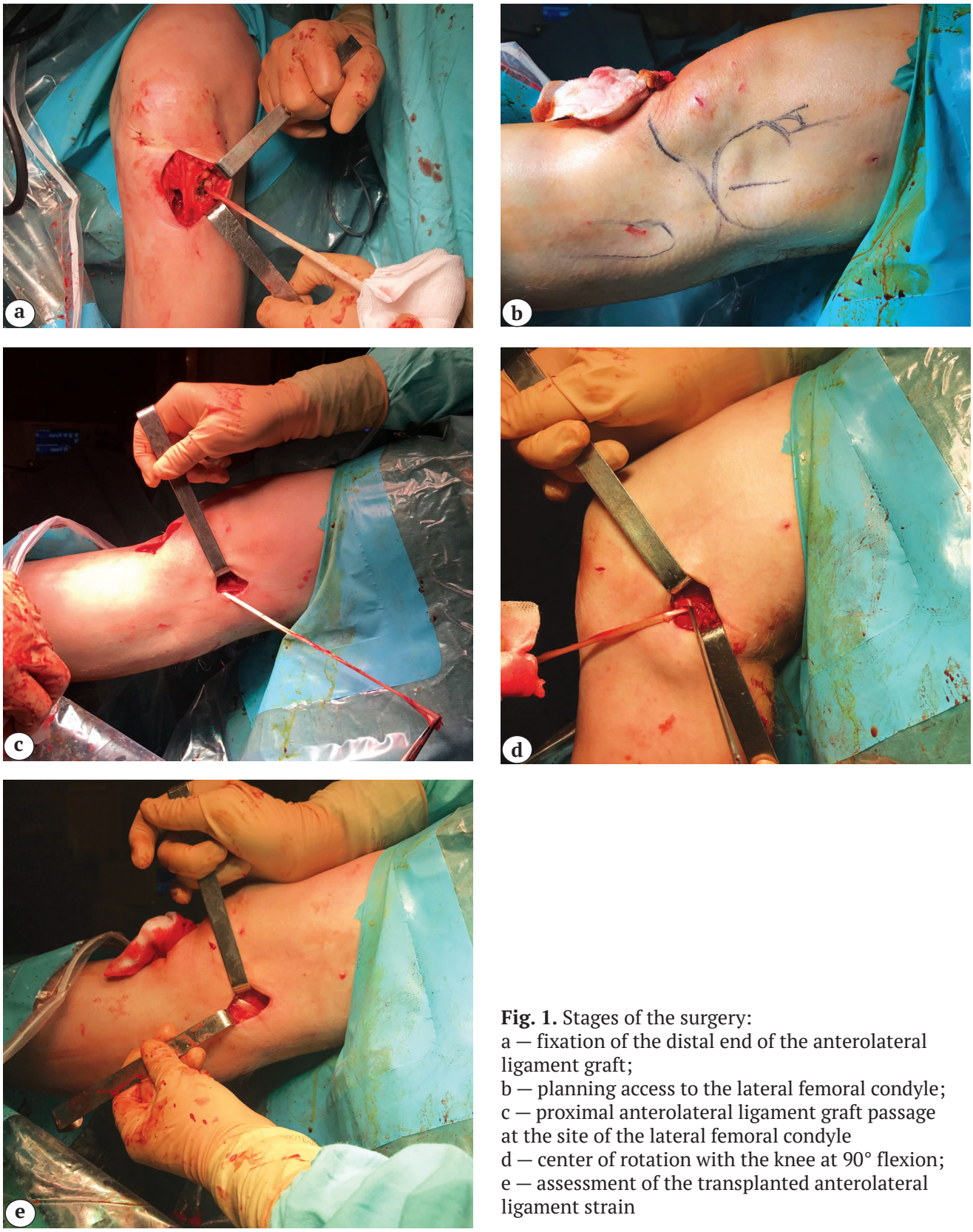

Fig. 1. Stages of the surgery:
a — fixation of the distal end of the anterolateral ligament graft;
b — planning access to the lateral femoral condyle;
c — proximal anterolateral ligament graft passage at the site of the lateral femoral condyle
d — center of rotation with the knee at 90° flexion;
e — assessment of the transplanted anterolateral ligament strain

Postoperative management

The same postoperative management protocol was used for both groups. No braces were used in postoperative period. Patients were allowed movements with full load on the operated leg next day after surgery. Bed rest was recommended for 3 weeks, then — passive restoration of joint ROM. By week 6 after surgery patients in both groups demonstrated knee flexion no less than 90°. Running on flat surface was allowed from 3rd month as well as gym exercises. Return to sports was recommended no earlier than in 8 months. Patients came for control examination in 12, 30 days and then after 3, 6, 12 and 24 months after surgery.

Evaluation of outcomes. Evaluation by objective scales (Tegner Lysholm Knee Scoring Scale and IKDC scale) was made prior to surgery and in 24 months after surgery.

Statistical analysis

Shapiro-Wilk test was used to check hypothesis that evaluated parameters in two samples correspond to normal distribution (approximating dependencies were used in calculating the required coefficients).

Confidence interval for mean values were calculated based on assumption that sample mean complies to the Students distribution.

Single factor dispersion analysis for each sample on two analyzed parameters was used to confirm significance of changes in status of patients prior and after the surgery.

Non-parametric Mann–Whitney test was used to confirm statistical significance of mean variances in parameters by Tegner Lysholm Knee Scoring Scale and IKDC scale for independent samples where different treatment options were applied (group I — arthroscopic ACL repair supplemented by ALL repair; group II — arthroscopic ALC repair). Data analysis was performed in SPSS software.

Validation was performed for p = 0,01% significance level.

Results

Group I

18 out of 20 patients of this group were available for early and late postoperative control examination. One patient was unavailable after removal of sutures for further follow up. Another patient was excluded from the study due to septic complication following non-compliance of the patient to recommendations. 2 out of 18 patients felt minor pain and discomfort (1–3 scores by pain VAS) in anterior part of the knee during physical load in 24 months after the surgery. In all patients of the study group the pivot-shift test was grade 0, Lachman test — <3 mm.

Thus, in two years after surgery 100% of patients from group I available for follow up were able to return to preoperative competitive activities.

Evaluation of parameters by Tegner Lysholm and IKDC scales was done prior and after surgical procedures. Average Tegner-Lysholm score before surgery was 73±6 and after surgery — 97±1. Mean IKDC value prior to surgery was 63.1±4.8% and after surgery — 96.3±1.8%.

Group II

All 30 patients from group II were available for follow up and control examinations in early and late postoperative period. 5 out of 30 patients reported minor pain and discomfort (1–3 scores on pain VAS) in anterior part of the knee during physical load. 4 out of 30 patients felt “lack of confidence” in the joint. Pivot-shift was grade 0 in 19 patients, grade 1 — in 10 patients, grade 2 — in 1 patient. Lachman test was less than 3 mm in 17 patients, 3–5 mm — in 11 patients, over 5 mm — in 2 patients.

20 out of 30 patients (66.7%) returned to preoperative and competitive level of activities (for professional athletes) in one year after surgery. 5 out of 10 (50%) professional athletes and 15 out of 20 (75%) amateur sportsmen returned to competitive level of sports. “Lack of confidence” in patients from

group II can be caused by positive pivot-shift and Lachman tests of various severity in 24 months after surgery. Average Tegner Lysholm score prior to surgery was 70±4 and after surgery - 92±4. Average IKDC value prior to surgery was 73.4±3.2% and after surgery — 90.3±3.7% (Table).

Single factor dispersion analysis for each sample on two analyzed parameters — Tegner Lysholm and IKDC scales — was used to confirm significance of changes in status of patients prior and after the surgery. Analysis demonstrated significant variances in mean sample values before and after surgery in both samples. Measuring parameters in dynamics in form of time series was not purpose of the study.

No statistically significant variances were reported for general population of patients with injury (ACL rupture) for Tegner Lysholm and IKDC scores.

Analysis demonstrated minor variances between Tegner Lysholm and IKDC parameters before surgeries in groups I and II which can be interpreted as similarity of patients' status in both groups before surgery.

Variances between Tegner Lysholm scale values after the surgery in groups I and II were also insignificant, meaning that patients' status by Tegner Lysholm scale were similar in both groups. With that the variances between IKDC scale values after surgery in groups I and II were statistically significant, moreover return to competitive sport level in group I was 100% for amateur and professional athletes, and in group II 66.7% of amateur sportsmen and 50% professional athletes returned to competitive sports.

Discussion

Basing on the results of the present study we can suppose that single stage ACL and ALL repair increases rotational knee stability allowing patients to return to physical activity corresponding to pre-injury level.

Isolated arthroscopic ACL repair allows the patients to return to pre-injury level of everyday activities [21, 22] and play sports on amateur level. Meta-analyses provide the data that return rate to amateur sports after arthroscopic ACL repair was 81–85%, but the situation in respect of professional athletes is different and only 53.4–65.0% of such patients return to pre-injury sports and no more than 44.0–55.0% of patients return to competitive sports level [9, 22]. Naturally, active patients and athletes can't be satisfied by such results. Certainly, such results are related to multiple factors including concomitant trauma of extra- and intraarticular structures affecting recovery, compliance to rehabilitation protocols and mental causes. However, residual instability after ACL repair plays not the least role [12, 13, 23] and the risk of graft rupture in patients below 20 years reaches 16.4% [24]. It should be noted that the probability of secondary rupture constitutes from 1.8 to 14.0% after isolated ACL repair [25, 26]. It's also known that positive pivot-shift test affects the knee function [12, 23]. There is still an open question on posttraumatic knee arthrosis development

Table

Assessment of patients status in both groups before and after surgery

Parameters	Group I				Group II			
	Prior to surgery		After surgery		Prior to surgery		After surgery	
	TL	IKDC	TL	IKDC	TL	IKDC	TL	IKDC
Mean value	73	63.1	97	96.3	70	73.4	92	90.3
Standard deviation	13	9.6	2	3.6	9	8.6	11	10.0

TL — Tegner Lysholm Knee Scoring Scale.

after ACL repair as compared to non-injured leg which can be due to some micro-instability which over time results in damage of articular cartilage [27]. Monaco et al. demonstrated in the experiment that ACL absence insignificantly increases values of pivot-shift test and additional ALL dissection increases pivot-shift test up to grade 2–3 [28]. So, it's possible to improve outcomes of ACL repair by supplementary ALL repair or exoarticular tenodesis.

ALL repair allows to improve postoperative outcomes. Results of one of the studies demonstrated that return of 83 patients to sports on the pre-injury level in two years after surgery was 71%, values of anterior drawer test reduced from 8.0±1.9 mm before surgery to 0.7±0.8 mm after surgery. Pivot-shift test in postoperative period was grade 0 in 76 patients and grade 1 — in remaining 7 patients [30].

S.A. Ibrahim et al. made a research using two patients' groups: group I (study) of 53 patients who underwent single stage ACL repair together with ALL repair, and group II (control) of 50 patients who underwent isolated ACL repair. Study reported reduction of values of anterior drawer tests in group I — up to 1,3±0,2 mm as compared to group II — 1.8±0.8 mm [31].

Mogos et al. reported the outcomes of surgical treatment of 32 patients who underwent single stage ACL repair in combination with ALL repair. Patients demonstrated significant positive dynamics in postoperative period (12 weeks) by IKDC, Tegner Lysholm scores, clinical pivot-shift test, Lachman test and reduced values of anterior drawer test from 7.19±1.96 mm (before surgery) to 0.13±0.34 mm [32].

Sonnery-Cottet et al. compared outcomes of arthroscopic ACL repair with patella ligament graft (group I), gracillis and semitendinous tendons graft (group II) and ACL graft from gracillis and semitendinous tendons supplemented by ALL repair (group III). Total number of patients was 502, mean follow up term was 38.4 months. 39 professional athletes were included into the study. Study demonstrated no statistically significant variances between the groups by IKDC, Tegner Lysholm scales, 93% of patients were able to return to sports, 64.6% returned to the pre-injury level of sports. Five patients out of 39 professional athletes suffered secondary joint injury which caused graft tear (3 patients from group I, one patient from group II, one patient from group III). Another 6 patients suffered injuries causing contralateral ACL rupture, 28 remaining patients returned to competitive level of sports. However, the rate of secondary graft tears in above groups was as follows: group I — 16.77%, group II — 10.77%, group III — 4.13%. So, ALL repair help to reduce risk of ACL graft tear [33].

Going back to the outcomes of the present study the authors would like to mention that lack of confidence in patients of group II can be due to positive pivot-shift and Lachman tests of various grades in 24 months after surgery.

Basing on the results of the present study we can suppose that single stage ACL and ALL repair enhances rotational knee stability which is especially important for sports with high torsional load. It's considered that early operative treatment after injury, compliance to recommendations and algorithm of postoperative rehabilitation, recovery spirit allow to completely restore the function of the operated joint, reduce mental discomfort of the patient and risk of graft tear [34]. Furthermore, it's necessary to restore the full function of the operated joint which equally distributes the load and reduce the risk of contralateral ACL rupture.

Study limitations

Non-homogenous patient groups were used that were different in age, number, men and women ratio, types of sports. The authors did not consider accompanying injuries

of knee structures; patients after meniscus repair were not included. Surgical treatment of group I was performed by one surgeon, treatment of patients in group II were performed by three surgeons (including the first author) comparable by experience and skills. Control MRI scans of the operated knee joint and correlation of surgery with accompanying pathologies of operated knee joint were not evaluated. All those aspects certainly influence the postoperative follow up, protocol and rehabilitation terms. Thus, the unambiguous assessment of study results was impossible.

Judging by mid-term outcomes of the study the authors consider ACL repair in combination of ALL repair a promising treatment option for patients with high functional demands. There is a need for further multi-center studies with selection of homogenous groups of patients to evaluate outcomes of ALL repair using single surgical technique.

Publication ethics

Patients gave voluntary informed consent to participate in the research study.

Conflict of interests: The authors declare that there are no competing interests.

Funding: State budgetary funding.

Authors' contributions

E.N. Goncharov — study concept and design; collection, analysis and interpretation of the data; editing of the paper; approval of the final paper version for publication; consent to bear responsibility for all aspects of the paper by ensuring investigation and solving the issues related to precision or integrity of any part of the work.

O.A. Koval — study design; collection, analysis and interpretation of the data; approval of the final version of the paper for publication.

V.E. Dubrov — writing and editing of the paper; approval of the final version of the paper for publication.

E.N. Bezuglov — collection, analysis and interpretation of the data; text of the paper; approval of the final version of the paper for publication.

A.A. Alekhin — collection and processing of the data.

N.G. Goncharov — study concept and design; writing and editing of the paper; approval of the final version of the paper for publication.

References

1. Sanders T.L., Maradit Kremers H., Bryan A.J., Larson D.R., Dahm D.L., Levy B.A. [et al.]. Incidence of Anterior Cruciate Ligament Tears and Reconstruction: A 21-Year Population-Based Study. *Am J Sports Med.* 2016;44(6):1502-1507. doi: 10.1177/0363546516629944.
2. Lazishvili G.D., Kuzmenko V.V., Girshin V.E. [Arthroscopic reconstruction of the anterior cruciate ligament of the knee]. *Vestnik travmotologii and opthopedii im. N.N. Priorova* [N.N. Priorov Journal of Traumatology and Orthopedics]. 1997;(1):23-27. (In Russian).
3. Fedoruk G.V., Goleva A.V., Brovkin S.S., Nevzorov A.M. [Modern technologies in arthroplasty of the anterior cruciate ligament]. *Zemsky vrach.* 2012; (2): 21–23. (In Russian).
4. Davarinos N., O'Neill B.J., Curtin W. A Brief History of Anterior Cruciate Ligament Reconstruction. *Adv Orthop Surg.* 2014;2014:1-6. doi: 10.1155/2014/706042.
5. Xie X., Liu X., Chen Z., Yu Y., Peng S., Li Q. A meta-analysis of bone-patellar tendon-bone autograft versus four-strand hamstring tendon autograft for anterior cruciate ligament reconstruction. *Knee.* 2015;22(2):100-110. doi: 10.1016/j.knee.2014.11.014.
6. Gudas R., Jurkonis R., Smailys A. Comparison of Return to Pre-Injury Sport After 10 mm Size Bone-Patellar Tendon-Bone (BPTB) versus 8 mm Hamstring Anterior Cruciate Ligament Reconstruction: A Retrospective Study with a Two-Year Follow-Up. *Med Sci Monit.* 2018;24:987-996.
7. Brophy R.H., Schmitz L., Wright R.W., Dunn W.R., Parker R.D., Andrish J.T. et al. Return to play and future ACL injury risk after ACL reconstruction in soccer athletes from the multicenter orthopaedic outcomes network (MOON) group. *Am J Sports Med.* 2012;40(11):2517-2522. doi: 10.1177/0363546512459476.
8. Mascarenhas R., Tranovich M.J., Kropf E.J., Fu F.H., Harner C.D. Bone-patellar tendon-bone autograft versus hamstring autograft anterior cruciate ligament reconstruction in the young athlete: a retrospective matched analysis with 2-10 year follow-up. *Knee Surg Sports Traumatol Arthrosc.* 2012;20(8):1520-1527. doi: 10.1007/s00167-011-1735-2.
9. Ardern C.L. Anterior Cruciate Ligament Reconstruction-Not Exactly a One-Way Ticket Back to the Preinjury Level: A Review of Contextual Factors Affecting Return to Sport After Surgery. *Sports Health.* 2015;7(3):224-230. doi: 10.1177/1941738115578131.

10. Chambat P., Guier C., Sonnery-Cottet B., Fayard J.M., Thaunat M. The evolution of ACL reconstruction over the last fifty years. *Int Orthop*. 2013;37(2):181-186. doi: 10.1007/s00264-012-1759-3.
11. Nedeff D.D., Bach B.R. Jr. Arthroscopic anterior cruciate ligament reconstruction using patellar tendon autografts. *Orthopedics*. 2002;25(3):343-357; quiz 358-359.
12. Kocher M.S., Steadman J.R., Briggs K.K., Sterett W.I., Hawkins R.J. Relationships between objective assessment of ligament stability and subjective assessment of symptoms and function after anterior cruciate ligament reconstruction. *Am J Sports Med*. 2004;32(3):629-634. doi: 10.1177/0363546503261722.
13. Ayeni O.R., Chahal M., Tran M.N., Sprague S. Pivot shift as an outcome measure for ACL reconstruction: a systematic review. *Knee Surg Sports Traumatol Arthrosc*. 2012;20(4):767-777. doi: 10.1007/s00167-011-1860-y.
14. Goncharov E.N., Koval O.A., Krasnov H.O., Mironov A.N., Goncharov N.G. [Topography-anatomycal characteristics of anterolateral ligament in knee joint]. *Travmatologiya i orthopediya Rossii* [Traumatology and Orthopedics of Russia]. 2018;24(2):88-95. doi: 10.21823/2311-2905-2018-24-1-88-95. (In Russian).
15. Caterine S., Litchfield R., Johnson M., Chronik B., Getgood A. A cadaveric study of the anterolateral ligament: re-introducing the lateral capsular ligament. *Knee Surg Sports Traumatol Arthrosc*. 2015;23(11):3186-3195. doi: 10.1007/s00167-014-3117-z.
16. Sonnery-Cottet B., Lutz C., Daggett M., Dalmay F., Freychet B., Niglis L., Imbert P. The involvement of the anterolateral ligament in rotational control of the knee. *Am J Sports Med*. 2016;44(5):1209-1214. doi: 10.1177/0363546515625282.
17. Claes S., Luyckx T., Vereecke E., Bellemans J. The Segond fracture: a bony injury of the anterolateral ligament of the knee. *Arthroscopy*. 2014;30(11):1475-1482. doi: 10.1016/j.arthro.2014.05.039.
18. Smith J.O., Yasen S.K., Lord B., Wilson A.J. Combined anterolateral ligament and anatomic anterior cruciate ligament reconstruction of the knee. *Knee Surg Sports Traumatol Arthrosc*. 2015;23(11):3151-3156. doi: 10.1007/s00167-015-3783-5.
19. Wagih A.M., Elguindy A.M. Percutaneous Reconstruction of the Anterolateral Ligament of the Knee With a Polyester Tape. *Arthrosc Tech*. 2016;5(4):e691-e697. doi: 10.1016/j.eats.2016.02.028.
20. Chahla J., Menge T.J., Mitchell J.J., Dean C.S., LaPrade R.F. Anterolateral Ligament Reconstruction Technique: An Anatomic-Based Approach. *Arthrosc Tech*. 2016;5(3):e453-e457. doi: 10.1016/j.eats.2016.01.032.
21. Leiter J.R., Gourlay R., McRae S., de Korompay N., MacDonald P.B. Long-term follow-up of ACL reconstruction with hamstring autograft. *Knee Surg Sports Traumatol Arthrosc*. 2014;22(5):1061-1069. doi: 10.1007/s00167-013-2466-3.
22. Ardern C.L., Webster K.E., Taylor N.F., Feller J.A. Return to sport following anterior cruciate ligament reconstruction surgery: a systematic review and meta-analysis of the state of play. *Br J Sports Med*. 2011;45(7):596-606. doi: 10.1136/bjsm.2010.076364.
23. Kocher M.S., Steadman J.R., Briggs K., Zurakowski D., Sterett W.I., Hawkins R.J. Determinants of patient satisfaction with outcome after anterior cruciate ligament reconstruction. *J Bone Joint Surg Am*. 2002;84-A(9):1560-1572. doi: 10.2106/00004623-200209000-00008.
24. Magnussen R.A., Lawrence J.T., West R.L., Toth A.P., Taylor D.C., Garrett W.E. Graft size and patient age are predictors of early revision after anterior cruciate ligament reconstruction with hamstring autograft. *Arthroscopy*. 2012;28(4):526-531. doi: 10.1016/j.arthro.2011.11.024.
25. Mariscalco M.W., Flanigan D.C., Mitchell J., Pedroza A.D., Jones M.H., Andrish J.T. et al. The influence of hamstring autograft size on patient-reported outcomes and risk of revision after anterior cruciate ligament reconstruction: a Multicenter Orthopaedic Outcomes Network (MOON) Cohort Study. *Arthroscopy*. 2013;29(12):1948-1953. doi: 10.1016/j.arthro.2013.08.025.
26. Van Eck C.F., Schkrohowsky J.G., Working Z.M., Irrgang J.J., Fu F.H. Prospective analysis of failure rate and predictors of failure after anatomic anterior cruciate ligament reconstruction with allograft. *Am J Sports Med*. 2012;40(4):800-807. doi: 10.1177/0363546511432545.
27. Jonsson H., Riklund-Ahlström K., Lind J. Positive pivot shift after ACL reconstruction predicts later osteoarthrosis: 63 patients followed 5-9 years after surgery. *Acta Orthop Scand*. 2004;75(5):594-599. doi: 10.1080/00016470410001484.
28. Monaco E., Maestri B., Conteduca F., Mazza D., Iorio C., Ferretti A. Extra-articular ACL Reconstruction and Pivot Shift: In Vivo Dynamic Evaluation With Navigation. *Am J Sports Med*. 2014;42(7):1669-1674. doi: 10.1177/0363546514532336.
29. Helito C.P., Bonadio M.B., Gobbi R.G., da Mota E Albuquerque R.F., Pécora J.R., Camanho G.L., Demange M.K. Combined Intra- and Extra-articular Reconstruction of the Anterior Cruciate Ligament: The Reconstruction of the Knee Anterolateral Ligament. *Arthrosc Tech*. 2015;4(3):e239-244. doi: 10.1016/j.eats.2015.02.006.
30. Sonnery-Cottet B., Thaunat M., Freychet B., Pupim B.H., Murphy C.G., Claes S. Outcome of a Combined Anterior Cruciate Ligament and Anterolateral Ligament Reconstruction Technique With a Minimum 2-Year Follow-up. *Am J Sports Med*. 2015;43(7):1598-1605. doi: 10.1177/0363546515571571.
31. Ibrahim S.A., Shohdy E.M., Marwan Y., Ramadan S.A., Almisfer A.K., Mohammad M.W. et al. Anatomic Reconstruction of the Anterior Cruciate Ligament of the Knee With or Without Reconstruction of the Anterolateral Ligament: A Randomized Clinical Trial. *Am J Sports Med*. 2017;45(7):1558-1566. doi: 10.1177/0363546517691517.
32. Mogos S., Sendrea B., Stoica I.C. Combined Anatomic Anterior Cruciate Ligament and Anterolateral Ligament Reconstruction. *Maedica (Buchar)*. 2017;12(1):30-35.
33. Sonnery-Cottet B., Saithna A., Cavalier M., Kajetanek C., Temponi E.F. Daggett M. et al. Anterolateral Ligament Reconstruction Is Associated with Significantly Reduced ACL Graft Rupture Rates at a Minimum Follow-up of 2 Years: A Prospective Comparative Study of 502 Patients From the SANTI Study Group. *Am J Sports Med*. 2017;45(7):1547-1557. doi: 10.1177/0363546516686057.
34. Ardern C.L., Taylor N.F., Feller J.A., Webster K.E. A systematic review of the psychological factors associated with returning to sport following injury. *Br J Sports Med*. 2013;47(17):1120-1126. doi: 10.1136/bjsports-2012-091203.

AUTHORS' INFORMATION:

Evgeny N. Goncharov — Cand. Sci. (Med.), Assistant Lecturer, Traumatology and Orthopedics Department, Russian Medical Academy of Continuous Professional Education; Orthopaedic Surgeon, Traumatology and Orthopedics Center, Central Clinical Hospital of the Russian Academy of Sciences, Moscow, Russian Federation

Oleg A. Koval — Orthopaedic Surgeon, Traumatology and Orthopedics Center, Central Clinical Hospital of the Russian Academy of Sciences, Moscow, Russian Federation

Vadim E. Dubrov — Dr. Sci. (Med.), Head of General and Specific Surgery Department, Fundamental Medicine Faculty, Lomonosov Moscow State University, Moscow, Russian Federation

Eduard N. Bezuglov — Assistant Lecturer, Department of Sport Medicine, I.M. Sechenov First Moscow State Medical University, Moscow, Russian Federation

Anton A. Alekhin — Student, Peoples' Friendship University of Russia, Moscow, Russian Federation

Nikolay G. Goncharov — Dr. Sci. (Med.), Head of Department, Traumatology and Orthopedics Department, Russian Medical Academy of Continuous Professional Education; Head of Department, Traumatology and Orthopedics Center, Central Clinical Hospital of the Russian Academy of Sciences, Moscow, Russian Federation