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Original Article

The use of the stabilography method during physical rehabilitation among patients undergoing the reconstruction of anterior cruciate ligament with arthroscopic surgical interventions

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Abstract. *Purpose:*The article covers the issues of grounding, elaborating and studying the effectiveness of the physical rehabilitation complex program among patients undergoing the reconstruction of anterior cruciate ligament with arthroscopic surgical interventions. The reason for the program was the use of workout modules performed on stabilographic platform, remedial gymnastics, therapeutic massage with the passive workoutelements, aimed to increase the movements' amplitude in the injured joint and to achieve the postisometric relaxation, mechanotherapyon the joints workout machine and keeping to the orthopedic routine. The primary biomechanical characteristics of balance control, received during the balance test, show that the patients have problems with load distribution in lower limbs with the injury of anterior cruciate ligament *Materials:*According to the proposed program, 21 patients (the main group of patients) underwent rehabilitation after ACL reconstruction. 31 patients received the traditional program of physical rehabilitation. The results registered on the previous study stage showed the lack of statistically meaningful discrepancies in the studied indicators and the age among the patients of the control and the main groups. . All patients (52 people) underwent the rehabilitation treatment in the rehabilitation department of ITO NAMS of Ukraine and were operated in the hospitals of the institute. The femoral end of the transplant was fixed with the help of "Rigid-fix" or "Cross-pin" systems, and the tibial end – using "Biointrafix" or "Biosure-synk" systems. Medication were applied according to the prescriptions. *Results:*The results of stabilographic studies in the functional rehabilitation period show that 100% of patients in the control group have middle or high asymmetry level of load distribution in lower limbs (by indicators of load time difference (dominant) of intact and injured lower limb) – 38,53±6,74 % ($\bar{x}$ ±S), which proves that the patients continued to overload the intact lower limb. At the same time, in patients of the control group during the functional rehabilitation period, the load time indicators (dominant) (%) of intact and injured lower limb showed static distinctions ($p<0,05$), while indicators of the intact lower limb exceeded indicators of the injured one for 1,89-3,38 times. In the dynamic studies there were positive changes observed, which were manifested in decreased load time difference (dominant) of intact and injured lower limbs, thus, during the functional rehabilitation period patients of the control group achieved the preoperative level of the studied indicators – 38,53±6,74 % ($\bar{x}$ ±S) ($p<0,05$). At the same time, in patients of the control group the studied indicators of injured lower limb, comparing to the preoperative period, have increased in average to 0,28 times, for intact lower limb – have slightly decreased ($p>0,05$). *Conclusions:*Thus, the load distribution function in the vertical stance among the patients of the control group has left deficient, which allows concluding, that the middle or high asymmetry level of load distribution in lower limbscannot be overcome without the use of special tools of physical rehabilitation, such as combination of workout modules on Gamma Platform.
Key words: stabilography, knee joint, balance control, balance-training, rehabilitation.

Introduction.

The most appropriate method for treating decompensated anterior knee joint instability, caused by the tear of anterior cruciate ligament (ACL),today is the surgical stabilization of knee joint [Fedoruk G.V., Goleva A.V., Brovkin S.S., Nevzorov A.M., 2012]. The use of less invasive arthroscopic technique, which provides low

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traumatic risk during invasion and proper reconstruction of the injured ligaments, proved to be successful [Lazishvili G.D., 2005, Fedoruk G.V., Goleva A.V., Brovkin S.S., Nevzorov A.M. , 2012].

At the same time, the question of the optimal transplant for arthroscopic surgeryof ACL is still open for discussion [Zinchenko V.V., Rusanov A.P., Rusanova O. M., 2014, Fedoruk G.V., Goleva A.V., Brovkin S.S., Nevzorov A.M. , 2012].

Implementing the modern technology of transtibial arthroscopic reconstruction of ACL using the fixation systems Rigid Fix and Biointrafix and developing a system of the complex rehabilitation among patients in the postoperative period allowed to achieve good and satisfactory functional treatment results in 94,5% cases, which proves the technology to be the most effective and provide full rehabilitation [Karaseva T.Yu., Karasev E.A. , 2013]. Patients with pathology in movement and support organs are still the most difficult for the medical rehabilitation system. One of the possible ways to improve the treatment results among patients with injured ligaments is a clear step-by-step rehabilitation action plan[4].

The detection of movement deficiencies, how the movement function develops and recovers is the significant challenge for this category of patients. Different instrumental movement tests can be used for studying movement and support function: walking [Skvortsov D.V., 2007] and balance test in the vertical stance [Batysheva T.T., Skvortsov D.V., 2007, Skvortsov D.V., 2007]. In spite of the fact that one can observe the active development of clinical biomechanical researches, their diagnostic possibilities are still not proved due to their compartmentalization and focus on narrow-range studies. This prevents from seeing the full picture of the existing movement deficiency and estimation of how accuratelythese methods can diagnose the deficiency. There are studies, in which biomechanics of walking and stabilometry are used to evaluate treatment results [Skvortsov D.V. , 2007]. At the same time, it is still not clear if one can use the biomechanical research methods focused on walking and the vertical stancefor evaluation of the treatment impact [Skvortsov D.V., 2007]. Studying the biomechanical characteristics of the musculoskeletal system in dynamics allows to effectively estimate the results of the treatment applied [Batysheva T.T., Skvortsov D.V., 2007, Skvortsov D.V., 2007]. It should be noted that the modern stabilographic complexes such as Gamma Platform (Ac international east) can be used not only for diagnostics and forecasting, but also for the deficient function recovery [Roy I., Zinchenko V., Kravchuk L., Rusanov A., 2015, Zinchenko V.V., Rusanov A.P., Rusanova O. M., 2014].

Biomechanical methods for detecting the movement deficiency are the important part of recovery medicine, which includes specific technologies for diagnostics, treatment and effectivenesscontrol; at the same time, biomechanical diagnostics is an obligatory diagnostic examination during recovery treatment among patients with movement and support deficiencies with the aim of movement deficiency detection and changes control in dynamics. The existing complexes of physical rehabilitation after ACL reconstruction for such patients are still not complete and satisfactory, so the search of the new physical rehabilitationcomplex programs is a problem, which needs the scientific solution. According to this, the further studies of the aspect are very ambitious. Research aimed to detect the changes in stabilometry and isokinetic dynamometry indicators in injured limbs and conservative and operative treatment of ACL tear showed, that ACL injuries cause the damage of posture control [Hussein Mohammed Mukhi , 2016].

The failure of the stretched or injured ligament in providing proper feedback can cause the deficiency in function and degeneration of knee joint [Hussein Mohammed Mukhi, 2016]; there is a correlation between the deficiency in knee joint stability in the sagittal part and bilateral deficiency of the statokinetic posture among patients with isolated old ACL injuries[Hussein Mohammed Mukhi , 2016].

Thus, in case of such knee joint injuries the proprioceptive movement analysis in the joint is broken. The lack of stability is constantly progressing, involving other, previously undamaged passive and active stabilizing structures into this pathological process and causing persistent inflammatory and degenerative processes in the joint [Fedoruk G.V., Goleva A.V., Brovkin S.S., Nevzorov A.M., 2012].

Proprioceptive connections with the central nervous system, which become broken in case of ACL tear, can cause the higher risk of trauma and the tear of the transplant;therefore, it is necessary to find the proper ways to improve the receptors function after ACL operative recovery.

The above-mentioned topic has defined the aim of the study.

Material and methods.

To evaluate the tools and methodseffectiveness, which are proposed as a part of the physical rehabilitation program for the patients who undergone ACL reconstruction with the help of arthroscopic operative interventions according to the stabilographic examination data.

We used the following **methods of stud**y: literature analysis, stabilography method, statistical data processing method. All the materials for this workwere 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.

All the hospitalized patients underwent the following measures: definition of patients' claims and anamnesis collection; clinical examination, palpation; examination of the injured joint functioning, evaluation of instability level, presence of block, synovitis, infiltration, muscular atrophy, etc.; the joint was immobilized with the help of a semi-rigid brace (if necessary); X-ray examination, ultrasound of knee joint; MRT (if possible).

The received data was recorded into the patients' medical history. All patients (52 people) underwent the rehabilitation treatment in the rehabilitation department of ITO NAMS of Ukraine and were operated in the hospitals of the institute. The femoral end of the transplant was fixed with the help of "Rigid-fix" or "Cross-pin" systems, and the tibial end – using "Biointrafix" or "Biosure-synk" systems.

Medication wereapplied according to the prescriptions. According to the proposed program, 21 patients (the main group of patients) underwent rehabilitation after ACL reconstruction. 31 patients received the traditional program of physical rehabilitation. The results registered on the previous study stage showed the lack of statistically meaningful discrepancies in the studied indicators and the age among the patients of the control and the main groups.

Stabilography analysis was used to evaluate the support reaction among patients with ACL injuries. The patients were proposed to pass a balance test on a stabiloplatform "Gamma Platform" (AC International East, Poland). The given complex allows to provide stabilography and to analyze the received data with the help of a graphic and numeric presentation and the calculation of the main stabilography indicators.

Results.

52 patients underwent the course of recovery treatment in SE ITO NAMS of Ukraine. To evaluate the effectiveness of the physical rehabilitation programs the patients were divided into two groups – the main group, who underwent the recovery according to our authors' program (n = 21), and the control group (n = 31), who performed the recovery treatment complex including remedial gymnastics, classic massage and physical therapy methods according to the hospital program.

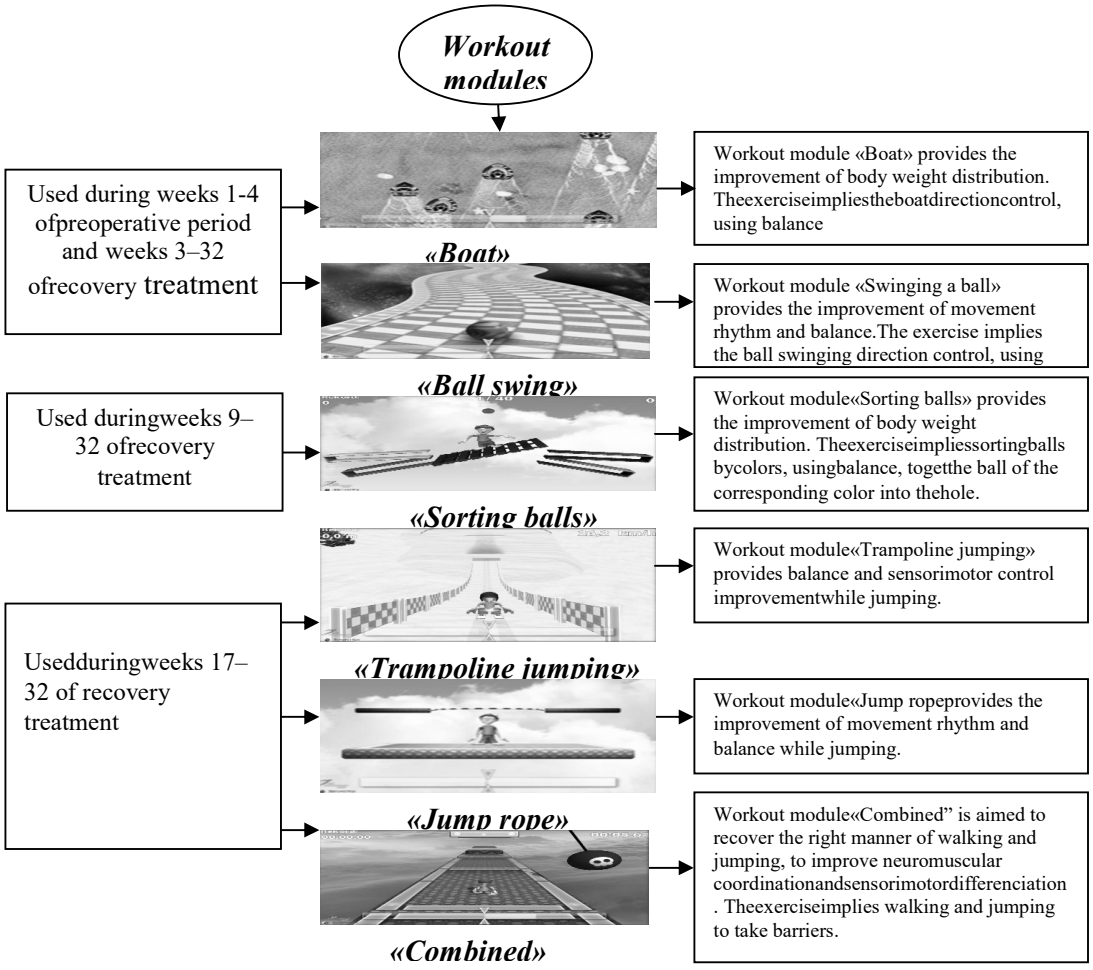
Outcoming (preoperative) indicators for the studied parameters among the patients of the groups didn't show statistically meaningful discrepancies ($p<0,05$). The results examination in comparison to the outcoming data, registered during preoperative period (from 1 to 4 weeks before operative intervention), and the evaluation were made before the discharge from the hospital during the early postoperative period (up to 2 weeks after operative intervention), during the late postoperative period (from 3 to 16 weeks after operative intervention) and functional (from 17 to 20 weeks after operative intervention) period of recovery treatment.

Our proposed complex program of physical rehabilitation differs from standard programs in the complex approach to the problem of rehabilitation. Its main task was not only to normalize the functioning of the operated limb, to recover limb stability and mobility, muscular tone of the injured limb, but also to restore proprioceptive sensibility, to remove asymmetry in limbs weight distribution, which allowed to prevent orthopedic complications.

The created physical rehabilitation program consisted of 5 periods: preoperative, early postoperative, late postoperative, functional periods and a period of intense physical activity, which made it possible to distribute the used methods and tools considering step-by-step recovery of the joint stability and mobility, local status of knee joint, muscular tone of the limb, dosed axis load and decrease of lower limbs weight distributional symmetry.

The program included three movement modes: gentle, gentle-training and training mode. The workouts were performed in the gentle mode individually, and in the gentle-training and training mode – individually and in small groups. The program implied the use of the following measures: remedial gymnastics, massage and physical therapy according to standard programs, particularly: electromyostimulation, magnetotherapy, laser therapy, mechanotherapy with the help of the joints workout machine; theoretical training for the patients, namely, the explanation of the aim, tasks and contents of the treatment measures.

During the rehabilitation process (according to the created program) among patients with ACL injuries (except early postoperative rehabilitation period) a balance training was performed, using"Gamma Platform" according to the exercise modules "Boat", "Swinging a ball", "Sorting balls", "Trampoline jumping", "Jump rope", "Combined".



2. Exercise modules on "Gamma Platform", used among patients with ACL injuries during physicalrehabilitation.

The program effectiveness is proved by the indicators dynamics showing time of the intact and injured limb load, registered during a balance test among patients in the main and the control groups having ACL injuries and being in the process of recovery treatment (table 1), as the main group patients have shown much more positive dynamics in these indicators under the impact of physical rehabilitation methods, than the control group patients. Dynamics of indicators showing the intact and injured limb load time during a balance test among patients of the main and the control groups having ACL injuries and being in the process of recovery treatment (n=52)

Studied indicators		Preoperative period		p	Early postoperative period		p	Late postoperative period		p	Functional period		p
		MG	CG		MG	CG		MG	CG		MG	CG	
		x±S			*x±S*			*x±S*			*x±S*		
Load, kg	injured	37,47±5,46	36,60±8,81	p > 0,05	37,04±5,39	36,84±4,88	p > 0,05	36,45±6,96	36,49±5,02	p > 0,05	37,18±5,46	39,81±8,32	p > 0,05
	intact	38,12±6,20	38,71±6,45	p > 0,05	41,05±7,94	41,57±8,88	p > 0,05	37,51±6,82	38,61±6,15	p > 0,05	37,51±6,82	41,4±10,71	p > 0,05
Validity of discrepancies		p > 0,05	p > 0,05	–	p > 0,05	p > 0,05	–	p > 0,05	p > 0,05	–	p > 0,05	p > 0,05	–
Load time (dominant), %	injured	35,6±9,4	32,22±9,6	p > 0,05	25,05±3,84	7,58±1,43	**p < 0,05**	33,71±6,94	25,39±2,91	**p < 0,05**	46,8±4,93	29,64±13,45	**p < 0,05**
	intact	61,55±9,23	64,42±9,01	p > 0,05	73,97±4,33	90,83±3,31	**p < 0,05**	64,01±5,98	74,06±3,78	**p < 0,05**	53,25±5,35	68,17±13,41	**p < 0,05**
Validity of discrepancies		**p < 0,05**	**p < 0,05**	–	**p < 0,05**	**p < 0,05**	–	**p < 0,05**	**p < 0,05**	–	p > 0,05	**p < 0,05**	–
Difference in load time (dominant) of the injured and intact limb, %		25,95±18,02	32,2±8,2	p > 0,05	58,89±7,2	83,24±24,04	**p < 0,05**	30,3±14,82	48,67±6,29	**p < 0,05**	6,45±2,26	38,53±6,74	**p < 0,05**

Furthermore, the outcoming data of the average indicators for the load time (dominant) of the intact and injured limb, registered during the preoperative period of recovery treatment, didn't have significant variations between patients of the main group (MG) and the control group (CG) (p>0,05).

There were positive changes detected in the dynamics of examination, which were manifested in the smaller difference of the load time (dominant) of the intact and injured limb, i.e. in the early postoperative period

the examined average indicators varied ($p<0,05$) between the patients of MG and CG as follows: MG – 58,89±7,2 % ($\bar{x}$ ±S), CG – 83,24±24,04 % ($\bar{x}$ ±S) accordingly. In the late postoperative period the MG patients had the following average indicators: 30,3±14,82 % ($\bar{x}$±S), the CG patients - 48,67±6,29 % ($\bar{x}$ ±S) accordingly ($p<0,05$). In the functional period of recovery treatment the asymmetry in the intact and injured limb load among the MG patients has decreased to 6,45±2,26 % ($\bar{x}$±S), the CG patients have reached the preoperative level of the indicators - 38,53±6,74 % ($\bar{x}$ ±S) ($p<0,05$). The analysis of changes in the indicators of the load time (dominant) (%) of the intact and injured limb shows the gradual increase in the indicators of the injured limb load. It should be noted that in the early postoperative period there was the decrease of the load indicators of the injured limb comparing to the outcoming data, MG patients – for 19,04-35,8 %, CG patients – for 72,81-78,45 % accordingly. The difference between MG and CG indicators is statistically true with $p<0,05$.

In the late postoperative period the average indicators of the load time (dominant) (%) of the injured limb in the main group significantly exceeded the results in CG and showed 33,71±6,94 % ($\bar{x}$ ±S) and 25,39±2,91 % ($\bar{x}$ ±S) accordingly. The difference between MG and CG results is statistically true with $p<0,05$. The indicators of the CG patients corresponded to the indicators of MG patients in the early postoperative period ($p>0,05$). In the functional period of recovery treatment the indicators of the load time (dominant) (%) of the intact and injured limb didn't significantly varied among the MG patients ($p>0,05$), which means that the asymmetry in the intact and injured limb load among the MG patients was removed with the help of the physical rehabilitation methods proposed by the authors. The indicators of the MG patients comparing to the preoperative level have increased in average for 1,14-1,59 times. The indicators of the load time (dominant) (%) of the intact and injured limb among the CG patients in the functional period significantly varied ($p<0,05$), at the same time the intact limb indicators exceeded the ones of the injured limb for 1,89-3,38 times, the patients continued to overload the intact limb, the balance function among the CG patients still left damaged. The indicators of the injured limb comparing to ones in the preoperative level among the CG patients have grown in average for 0,28 times, of the intact limb – have decreased insignificantly ($p>0,05$).

Discussion.

For today in medical practice the expediency of usage of minimally invasive arthroscopic technique is proved, it provides low traumatism of intervention and adequate reconstruction of the damaged knee joints [Karaseva T.Yu., Karasev E.A.,2013, Lazishvili G.D., 2005, Hart H.F., Collins N.J., Ackland D.C. et al.,2015].

Patients with pathology of the musculoskeletal system remain one of the most difficult contingents for the system of medical rehabilitation. One of the measures that is able to improve the treatment of patients with damaged ligamentous apparatus of the knee joint can be the introduction of accurate phased rehabilitation actions [Sayed S., 2016,. Zduński S., Rongies W., Ziółkowski M., Kozieł T. et al., 2015, Dubljanin Raspopovic E., Kadija M., Matanovic D.,2006]. A significant problem for this category of patients is the diagnosis of motor function disorders and the determination of the dynamics of its development and recovery. To study motion and support functions, instrumental motor tests are used: walking and balancing research in a vertical rack [Skvortsov D.V.,2007]. There are known works, where methods of biomechanic walking and stoichiometry were used to assess healing effects [Skvortsov D.V., 2007, Hussein Mohammed Mukhi, 2016]. In these cases, the possibility of using biomechanical methods of studying the moves and the vertical rack for determination the effectiveness of therapeutic effects remains unclear. Modern technologies of biomechanical diagnostics that are used in clinical practice can be divided into two main directions: clinical analysis of movements and stabilometrics. Clinical analysis of movements in the main are represented by the direction that uses human walking as a global motor test, and the stabilometrics uses as a motor test the balance process in a vertical rack. Due to the clinical analysis of movements and stabilometricsat the present time, we can speak about the formation of an independent direction - functional diagnosis of motor pathology. Introduction of functional diagnostics of motor pathology allows to determine the existing of motor disturbances of the patient: the instability of the vertical rack, the existence of the mechanism of passive closure of the knee joint, reducing the capacity of the limb, etc. Investigation of the biomechanical characteristics of the function of the locomotor system in dynamics allows to objectively determine the effectiveness of the performed restorative treatment (Hussein Mohammed Mukhi, 2016). At the same time, modern stabilometrics systems such as "Gamma Platform" (Ac international east) can be used not only for diagnostics or forecasting, but also directly for the restoration of disordered function.

Conclusions.

The analysis of the dynamics in the indicators showing the difference in the load time (dominant) of the intact and injured limb among patients in the early, late postoperative and functional periods proves the faster

terms of recovery in the balance control function due to the methods of the authors' physical rehabilitation program among the main group patients comparing to the control group ($p < 0,05$).

The further studies perspective. The study proving the effectiveness of the proposed rehabilitation methods and tools among patients after ACL reconstruction with arthroscopic operative interventions according to the instrumental research methods data.

References

Batysheva T.T., Skvortsov D.V. (2007). Functional approach to restorative treatment of patients with pathology of support and movement. .Health care. 2007. № 3. P.23-27.

Bottoni C. R., Smith E. L., Shaha J. [et al.] (2015). Anterior cruciate ligament reconstruction: A prospective, randomized clinical study with a minimum 10-year follow-up. Am. J. Sports Med. Vol. 43 (10). P. 2501-2509.

Claes S., Verdonk P., Forsyth R., Bellemans J. (2011).The "ligamentization" process in anterior cruciate ligament reconstruction: what happens to the human graft? A systematic review of the literature. Am. J. Sports Med. 2011. Vol. 39. P. 2476–2483.

Dubljanin Raspopovic E., Kadija M., Matanovic D.. (2006). Evaluation of the intensive rehabilitation protocol after arthroscopically assisted anterior cruciate ligament reconstruction/ Srp. Arh. Celok Lek. Vol. 134. P. 532-536.

Fedoruk G.V., Goleva A.V., Brovkin S.S., Nevzorov A.M. (2012). Modern technologies in endoprosthetics of the anterior cruciate ligament of the knee joint. Zemsky doctor: Orthopedics and traumatology. Medical aspects of prosthetics. -M., No. 2.-2012, P. 21-24.

Gorshova I., Bohuslavska V., Furman Y., Galan Y., Nakonechnyi I., Pityn M. (2017). Improvement of adolescents adaptation to the adverse meteorological situationby means of physical education. Journal of Physical Education and Sport, 17(2), 892-898. DOI:10.7752/jpes.2017.02136

Hart H.F., Collins N.J., Ackland D.C. [et al.] (2015). Characteristics of people with lateral knee OA after ACL reconstruction. Med. Sci. Sports Exerc. Vol. 47, №11. P. 2406-2415.

Herasymenko O., Mukhin V., Pityn M., Kozibroda L. (2016). Shift of physical activity index for individuals with lower limb amputations as influenced by the comprehensive program of physical rehabilitation. Journal of Physical Education and Sport, 16, Supplement issue (1), 707-712. DOI:10.7752/jpes.2016.s1115

Hussein Mohammed Mukhi, Nail Mustafovich Valeev, Vladimir Vladimirovich Arkov (2016) Influence of kinesiotherapy on the parameters of stabilometry and isokinetic dynamometry in restoring patients after reconstruction of the anterior cruciate ligament of the knee joint. Uchenye zapiski universiteta im. P.F. Lesgaft, St. Petersburg, No. 5 (135), p. 241-244.

Ilinca I., Rosulescu E., Zavaleanu M., Constantinescu L. (2013). Exercise Therapy Program in Rehabilitation of Patients with Primary Hip Osteoarthritis. Journal of Physical Education and Sport, 13(1), 82-87. DOI:10.7752/jpes.2013.01014

Karaseva T.Yu., Karasev E.A. (2013) Arthroscopic technologies for treating patients with knee instability. Genius of orthopedics. No. 4/2013, P.38-43.

Lazishvili G.D. (2005). Surgical treatment of injuries of the ligamentous-capsular apparatus of the knee joint: the author's abstract. dis. . Dr. med. sciences. : spec. specialist. 14.01.15 - traumatology and orthopedics. M., 2005. 36 pp.

Roy I., Zinchenko V., Kravchuk L., Rusanov A. (2015) Use of the stabilographic method for assessing the effectiveness of rehabilitation treatment of patients after arthroscopic reconstruction of the anterior cruciate ligament. Youth Scientific Bulletin. -Lutsk. Issue 18.- P.171-175.

Roy I.V., Bayandina O.I., Kostogriz O.A, Bila I.I., Gorbunov O.A. (2013). Development of approaches to the development of a criterion-oriented program for rehabilitation of patients after reconstruction of anterior cruciate ligament. Trauma. Volume 14. No. 6, P. 56-60.

Sayed S. (2016). Effectiveness of accelerated rehabilitation for arthroscopic anterior cruciate ligament (ACL) reconstruction in football players Int. J. Phys. Med. Rehabil. № 4. P. 335-341.

Skvortsov D.V. (2007) Diagnosis of motor pathology by instrumental methods: gait analysis, stabilometry. M., 2007.-640 p.

Zduński S., Rongies W., Ziółkowski M., Kozieł T. [et al.] (2015). Evaluation of the effectiveness of preoperative physiotherapy using the lysholm-gillquist scale in patients qalified for surgical arthroscopic anterior cruciate ligament reconstruction -pilot study. Ortop. Traumatol. Rehabil. Vol. 17(3). P. 249-258.

Zinchenko V.V., Rusanov A.P., Rusanova O. M. (2014). Computer stabilography in the process of restorative treatment of patients after reconstruction of the anterior cruciate ligament. Sports Medicine, Therapeutic Physical Education and Valeology. 2014: XVII International Scientific and Practical Conference (May 29-30, 2014). Odessa, 2014. P. 84-85.