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The effect of manual lymphatic drainage on the postoperative recovery process following total knee arthroplasty

Manual lenfatik drenajın total diz artroplastisini takip eden toparlanma süreci üzerindeki etkisi

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ABSTRACT

Background: Knee joint has great importance on daily living activities thus gonarthrosis does affect quality of life of patients very dramatically. Total knee arthroplasty (TKA) is accepted as gold standard in order to cope with pain, deformity and instability especially in patients with gonarthrosis who are in terminal stage. Physical therapy and rehabilitation programs are known to increase the success of this surgical procedure. As edema around knee joint is one of the major postoperative complications, which prolong recovery process, it is important to use therapeutic modalities against this problem.

Objective: In this study it was aimed to evaluate the effectiveness of manual lymphatic drainage (MLD) following TKA on edema, range of motion, pain, independence of daily living activities, gait distance and knee functionality.

Material and Method: 16 patients with TKA were divided into two groups while one of them is applied standard postoperative rehabilitation procedure (exercise therapy, cryotherapy and positioning) and the other group had MLD therapy on the second and fourth days of the postoperative process for thirty minutes and in one session during the day in addition to standard protocol. On post-op 2nd, 4th, and 6th days, the volumetric changes were calculated based on a formula of Sitzia et al. for each 4 cm segment of the lower extremity, active ROM and knee posture at rest were measured by a universal goniometer, pain by using visual analog scale (VAS), walking distance by calculating total walking distance in a day, independence level in daily living activities by using Functional independence measurement (FIM) scale. In addition, Lysholm knee score was calculated on postoperative 15th day in order to evaluate functionality of knee joint.

Results: At postoperative 2nd day, 4th day and 6th day, the mean of FIM (p=0.972, p=0.575, p=0.398, respectively), active ROM (p=0.288, p=0.522, p=0.622, respectively), knee posture (p=0.870, p=0.521, p=0.445, respectively), gait distance (p=1.000, p=0.258, p=0.113, respectively), volume of the operated lower extremity (p=0.451, p=0.384, p=0.268, respectively), VAS for pain daytime (p=0.192, p=0.488, p=0.506, respectively) and night (p=0.137, p=0.562, p=0.748, respectively) were similar in both MLD and non-MLD groups. The mean of Lysholm score was 46.25±24.50 in MLD group and 61.12±17.70 in non-MLD group (p=0.186).

Conclusion: Although there is no significant difference between groups, the effectiveness of MLD can be showed in studies which will be performed with a larger sample size.

Keywords: Manual lymphatic drainage, total knee arthroplasty, physical therapy

ÖZ

Giriş: Diz ekleminin günlük yaşam aktivitelerinde büyük önemi vardır, bu nedenle gonartroz hastaların yaşam kalitesini çok dramatik bir şekilde etkiler. Total diz artroplastisi (TDA), özellikle terminal dönemdeki gonartrozlu hastalarda ağrı, deformite ve instabilite ile baş edebilmek için altın standart olarak kabul edilmektedir. Fizik tedavi ve rehabilitasyon programlarının bu cerrahi işlemin başarısını arttırdığı bilinmektedir. Diz eklemi çevresindeki ödem, iyileşme sürecini uzatan majör postoperatif komplikasyonlardan biri olduğundan, bu soruna karşı tedavi yöntemlerinin kullanılması önemlidir.

Amaç: Bu çalışmada TDA sonrası manuel lenfatik drenajın (MLD) ödem, hareket açıklığı, ağrı, günlük yaşam aktivitelerinin bağımsızlığı, yürüme mesafesi ve diz fonksiyonelliği üzerine etkinliğinin değerlendirilmesi amaçlandı.

Gereç ve Yöntem: Total diz artroplastisi geçiren 16 hasta iki gruba ayrılarak bunlardan birine standart postoperatif rehabilitasyon prosedürü (egzersiz terapisi, cryoterapi ve pozisyonlama) uygulanırken diğer gruba standart protokole ek olarak, postoperatif sürecin 2. ve 4. günlerde günde bir kez 30 dakikalık MLD terapisi uygulandı. Ameliyat sonrası 2., 4. ve 6. günlerde hacimsel değişiklikler alt ekstremitenin her bir 4 cm'lik segmenti için Sitzia ve ark.'nın formülüne dayanarak hesaplandı; aktif EHA ve istirahatte diz postürü universal gonyometre ile ölçüldü; ağrı görsel analog skala (GAS) ile; yürüme mesafesi, bir gün içindeki toplam yürüme mesafesi hesaplanarak; günlük yaşam aktivitelerindeki bağımsızlık seviyesi Fonksiyonel bağımsızlık ölçeği ile değerlendirildi. Ayrıca diz ekleminin işlevselliğini değerlendirmek için postoperatif 15. günde Lysholm diz skoru hesaplandı.

Bulgular: Postoperatif 2. gün, 4. gün ve 6. gün FİM ortalaması (sırasıyla p=0.972, p=0.575, p=0.398), aktif EHA (sırasıyla p=0.288, p=0.522, p=0.622), diz postürü (sırasıyla p=0.870, p=0.521, p=0.445), yürüme mesafesi (sırasıyla p=1.000, p=0.258, p=0.113), ameliyat edilen alt ekstremite hacmi (sırasıyla p=0.451, p= 0.384, p=0.268), gün içindeki ağrıya yönelik GAS (sırasıyla p=0.192, p=0.488, p=0.506) ve gece ağrısına yönelik GAS (sırasıyla p=0.137, p=0.562, p=0.748) manuel lenfatik drenaj yapılan ve yapılmayan gruplarda benzerdi Lysholm skorunun ortalaması manuel lenfatik drenaj grubunda 46.25±24.50 ve manual lenfatik drenaj yapılmayan grupta 61.12±17.70 idi (p=0.186).

Sonuç: Gruplar arasında anlamlı bir fark olmamasına rağmen MLD'nin etkinliği daha büyük örneklemle yapılacak çalışmalarda gösterilebilir.

Anahtar Kelimeler: Manuel lenfatik drenaj, total diz artroplastisi, fizik tedavi

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INTRODUCTION

Total knee arthroplasty (TKA) is a traumatic event leading to a significant inflammatory process that persistently occurs after the surgical procedure for over six weeks (1). Post-surgical joint swelling and edema are intrinsically related to the inflammation mechanisms as natural consequences of arthroplasty surgeries (2). Post-TKA joint swelling causes pain, a decrease in range of motion (ROM), and a delay in functional recovery (3,4). Standard joint rehabilitation programs after TKA have often focused on mostly ROM, the strength of quadriceps, gait, and functional activities (5). However, a therapy targeting swelling after TKA could improve post-surgical recovery. Yet, it was previously reported that some treatment modalities, such as cryotherapy (6), compression (7), pulsed electromagnetic field (8), demonstrated no effect on knee swelling.

On the other hand, manual lymphatic drainage (MLD) was documented to lead to blood circulation and movement of lymphatic and other soft tissue fluids, thus contributing to softening of tissues (9). It can minimize edema as it increases lymphatic motility and stimulates lymphatic vessels' collateral activity and anastomosis (10-12). It is also believed that MLD favors inflammation-related mediators and interstitial fluid reabsorption (2,13). Therefore, it might be an effective rehabilitation method to reduce post-TKA swelling.The literature hosts some randomized control studies of MLD that demonstrated substantial effectiveness on swelling after distal radius fracture (14,15), hindfoot surgery (16), and TKA (17). Ultimately, we hypothesized that MLD could decrease swelling after TKA and improve knee functionality and recovery. Therefore, we carried out this study to explore the effects of MLD on swelling in the early postoperative period after TKA and its consequences on pain, ROM, and knee functions.

MATERIAL AND METHOD

The Clinical Research Ethics Committee of Kırıkkale University granted ethical approval to our study (Date: 27.11.2018, Decision No: 20/01), and we performed all procedures in accordance with the ethical rules and the principles of the Declaration of Helsinki. This was a randomized study that included 16 patients with TKA who were recruited to a postoperative physical therapy with MLD or without MLD between January and December 2019. On post-op 2nd, 4th, and 6th days, we calculated the volumetric changes through the formula of Sitzia et al. (18) for each 4 cm segment of the lower extremity while measuring active ROM and knee posture at rest using a universal goniometer (19) Moreover, we determined pain on thevisual analog scale (VAS), and walking distance was accepted as the total walking distance in a day. The Functional Independence Measure (FIM) was utilized to discover the patients' independence in activities of daily living (20). Since body mass index (BMI) may affect the outcomes of the study, we also evaluated the BMI of the patients. Finally, we calculated Lysholm knee score (LKS) on the postoperative 15th day to evaluate the functionality of patients' knee joints (21).

We carried out the study with patients undergoing posterior-stabilized TKA. All patients underwent TKA by a single experienced orthopedic surgeon specializing in arthroplasty surgery. Patients were positioned supine on the surgery table with the bilateral arm in an arm sling for the operation. Padded cushions were placed under bony prominences to avoid excessive pressure. Cemented femoral and tibial components of TKA in pre-determined sizes (with the aid of radiographic templates) and an intraoperatively-decided, proper insert (Stryker®, Triathlon®, Total Knee System, USA) were applied through an anterior medial parapatellar approach.

Knee-based exercises were performed in the supine (active-assisted knee flexion, quadriceps strengthening exercises, gluteal settings,and straight-leg raise), seated (active-assisted and active knee flexion, and quadriceps strengthening exercises), and standing (hip and knee flexion, mini squats, active hamstring curls,and hamstring stretch) positions.Between postoperative day-1 to day-7, a physiotherapist moderated these exercises progressively in 15 repetitions three times a day until hospital discharge.

The prosthetic extremity was elevated during MLD treatment. The sessions were launched by stimulating the relevant lymphatic nodes. The decongestion of the collected lymphatic fluid was provided manually through these nodes. Appropriate axillar and inguinal anastomoses were built for therapeutic purposes. Besides, diaphragmatic breathing, having been practicedby the patients before, was performed during the sessions to get better results. Both lymphatic node stimulation and decongestion of the edematous areas were done from proximal to distal.

On the postoperative second day (day-2), we randomly divided the patients into the MLD group and the non-MLD group. MLD group underwent MLD therapy (22) for 30 minutes on the TKA limb by an experienced therapist. After the MLD therapy, we evaluated all patients regarding knee pain, ROM, volumetric changes, independence in activities of daily living, knee posture, and functionality. The treatment process was repeated on postoperative day-4, while the assessment process was repeated both on postoperative day-4 and day-6.

Statistical Analyses

We presented the data as percentages, means, standard deviations, and medians (minimum-maximum). The normality of distribution was checked using a Kolmogorov–Smirnov test. Accordingly, we compared the data showing normal distribution between and within the groups with independent and paired t-tests, respectively, while using Mann-Whitney U and Friedman tests to analyze the data with a non-normal distribution.We performed all statistical analyses on SPSS 22.0 (SPSS Inc., Chicago, Illinois) and accepted a p-value <0.05 statistically significant at the 95% confidenceinterval.

RESULTS

The findings revealed the mean age to be 60.75±7.40 (51-70 years) in the MLD group and 66.25±10.57 (51-86 years) in the non-MLD group. While 14 patients were females, only 2 were males. Moreover, we calculated the mean BMI to be 29.71±11.56 in the MLD group and 35.25±10.39 in the non-MLD group. Although 8 patients were recruited to physical and MLD therapies, the remaining received only physical therapy. **Table 1** presents the demographic characteristics of the patients.

The findings revealed that, on postoperative 2nd day, 4th day and 6th day, mean FIM scores (p=0.972, p=0.575, p=0.398, respectively), active ROM (p=0.288, p=0.522, p=0.622, respectively), knee posture (p=0.870, p=0.521, p=0.445, respectively), walking distance (p=1.000, p=0.258, p=0.113, respectively), volume of the operated lower extremity (p=0.451, p=0.384, p=0.268, respectively), VAS for daytime pain (p=0.192, p=0.488, p=0.506, respectively) and night pain (p=0.137, p=0.562, p=0.748, respectively) were similar in both MLD and non-MLD groups. Moreover, the mean of LKS was found to be 46.25±24.50 in the MLD group and 61.12±17.70 in the non-MLD group (p=0.186). **Table 1** summarizes all the measurements.

Table 1. Details of parameters on follow-up days

	MLD	Non-MLD		
	Mean±SD (min-max)/ Median (min-max)/ N (%)	Mean±SD(min-max)/ Median (min-max)/ N (%)	t /Z /X2	p
Age	60.75±7.40 (51-70)	66.25±10.57 (51-86)	-1.206*	0.248
Sex				
Women	8 (50.0%)	6 (37.5%)	2.286‡	0.131
Men	0 (0.0%)	2 (12.5%)		
BMI	29.71±11.56	35.25±10.39	-1.007*	0.331
Side of TKA				
Right	6 (37.5%)	3 (18.8%)	2.286‡	0.131
Left	2 (12.5%)	5 (31.2%)		
FIM, post-op 2nd day	69.13±15.91	69.38±12.27	-0.035*	0.972
FIM, post-op 4th day	79.87±7.72	77.25±10.39	0.574*	0.575
FIM, post-op 6th day	83.63±5.90	80.50±8.25	0.872*	0.398
Active ROM, post-op 2nd day	62.63±14.14	53.00±20.19	1.104*	0.288
Active ROM, post-op 4th day	77.13±12.71	73.38±9.94	0.657*	0.522
Active ROM, post-op 6th day	83.00±9.84	81.25±4.30	0.461*	0.652
Knee posture, post-op 2nd day	26.50±3.89	26.00±7.50	0.167*	0.870
Knee posture, post-op 4th day	21.25±4.33	20.00±3.16	0.659*	0.521
Knee posture, post-op 6th day	19.63±3.66	18.38±2.62	0.786*	0.445
Gait distance, post-op 2nd day	5.88±3.40	5.88±1.13	0.000*	1.000
Gait distance, post-op 4th day	7.63±3.82	5.75±2.38	1.180*	0.258
Gait distance, post-op 6th day	9.13±4.67	6.00±2.33	1.693*	0.113
Lysholm score	46.25±24.50	61.12±17.70	-1.392*	0.186
Volume, post-op 2nd day	7540.00±707.13	8264.38±2543.78	-0.776*	0.451
Volume, post-op 4th day	7549.50±868.46	8361.63±2403.48	-0.899*	0.384
Volume, post-op 6th day	7341.38±947.11	8445.25±2538.31	-1.152*	0.268
VASforpain, daytime,post-op 2nd day	5.25±2.77	7.25±3.06	-1.372*	0.192
VAS forpain,daytime, post-op 4th day	3.63±1.69	4.38±2.45	-0.714*	0.488
VAS for pain, daytime, post-op 6th day	2.00±1.31	2.75±2.82	-0.683*	0.506
VAS for pain, night, post-op 2nd day	5.37±2.45	7.50±2.93	-1.576*	0.137
VAS for pain, night, post-op 4th day	4.25±2.05	5.00±2.93	-0.593*	0.562
VAS for pain, night, post-op 6th day	4.38±2.83	3.88±3.27	0.327*	0.748

(*) t value, Independentsamples t-test; (†) Z value, Mann Whitney U test; (‡) X2 value, Pearson ki-square test; FIM, Functional independent measurement; ROM, Range of motion; VAS, Visual analog scale;

In general, we concluded that swelling showed significant reduction on the postoperative 6th day compared to the previous follow-up day (p=0.021). However, active ROM significantly increasedon the postoperative 6th day compared to the previous follow-up day in both groups (p=0.027, p=0.025, respectively).The comparison of the parameters by follow-up days is given in **Table 2**.

DISCUSSION

Management of TKA patients with postoperative edema has always been a significant health issue owing to increased pain, decreased active knee ROM, and other associated functional consequences. The swelling, the primary target of the study, was measured for each 4 cm segment of the lower extremity. Despite insignificant compared to the previous postoperative follow-up days, we found the mean volume to decrease in the MLD group on the postoperative 6th day, whereas it increased in the control group.

The lymphatic drainage treatment was shown to improve blood circulation and stimulate lymphatic fluid movement in TKA patients (23). In the current study, knee swelling increased postoperatively until the 4th day in both groups. MLD particularly made a difference on the postoperative 6th day; thus, we found the volume to decrease significantly on that day compared to the post-op 4th day. On the other hand, knee swelling decreased only in the MLD group onthe postoperative 6th day, while knee ROM increased significantly in both groups on all follow-up days despite no significant difference between groups. One possible explanation for our findings may be related to the small number of patients in the study. In addition, the regular physical rehabilitation program of TKA patients may have affected the swelling. Similarly, Fujiura et al. (24) also reported that MLD interventions after surgery accompanied by standard physical therapy did not reduce pain intensity in the patients. Moreover, there was no significant difference between the groups regarding ROM, muscle strength, circumference, walking speed, and walking rate. Conversely, Pichonnaz et al. (2) reported that MLD treatment had no effect on swelling in the early postoperative period in TKA patients; however, it provided a reduction in postoperative knee flexion contractures. Besides, Rigoni et al. (23) demonstrated that lymphatic drainage treatment has a positive effect on rehabilitation outcomes, and Ebert et al. (17) revealed that MLD therapy is highly beneficial for knee ROM in the early postoperative period.

A wide array of factors that may affect knee ROM postoperatively may have also existed in this study. First of all, the rehabilitation program may have affected the study outcomes but is not likely to have affected the differences between groups. The relevant exercise program may have decreased swelling or increased inflammatory response in both groups. Secondly, the living environments of patients and their activity habits, which are not controllable parameters, may have influenced outcomes of MLD on extremities. Finally,

Table 2. Details of swelling and its' consequences on knee parameters.

	MLD		Non-MLD	
	t / Z	p	t / Z	p
FIM, post-op 2nd dayvs post-op 4th day	-3.042*	0.019	-2.943*	0.022
FIM, post-op 2nd dayvs post-op 6th day	-3.679*	0.008	-3.580*	0.009
FIM, post-op 4th dayvs post-op 6th day	-3.319*	0.013	-3.389*	0.012
Active ROM, post-op 2nd dayvs post-op 4th day	-3.885*	0.006	-2.963*	0.021
Active ROM, post-op 2nd dayvs post-op 6th day	-5.351*	0.001	-4.596*	0.002
Active ROM, post-op 4th dayvs post-op 6th day	-2.798*	0.027	-2.852*	0.025
Knee posture, post-op 2nd dayvs post-op 4th day	4.200*	0.004	2.487*	0.042
Knee posture, post-op 2nd dayvs post-op 6th day	6.488*	0.000	3.221*	0.015
Knee posture, post-op 4th dayvs post-op 6th day	2.154*	0.068	2.728*	0.029
Gait distance, post-op 2nd dayvs post-op 4th day	-1.549*	0.165	0.168*	0.871
Gait distance, post-op 2nd dayvs post-op 6th day	-3.265*	0.014	-0.215*	0.836
Gait distance, post-op 4th dayvs post-op 6th day	-1.426*	0.197	-0.607*	0.563
Volume, post-op 2nd dayvs post-op 4th day	-0.052*	0.960	-1.117*	0.301
Volume, post-op 2nd dayvs post-op 6th day	0.922*	0.387	-2.129*	0.071
Volume, post-op 4th dayvs post-op 6th day	2.980*	0.021	-1.196*	0.271
VAS for pain, daytime, post-op 2nd dayvs post-op 4th day	1.879*	0.102	6.524*	<0.001
VAS for pain, daytime, post-op 2nd dayvs post-op 6th day	4.333*	0.003	7.180*	<0.001
VAS for pain, daytime, post-op 4th dayvs post-op 6th day	3.870*	0.006	5.017*	0.002
VAS for pain, night, post-op 2nd dayvs post-op 4th day	1.567*	0.161	5.000*	0.002
VAS for pain, night, post-op 2nd dayvs post-op 6th day	0.748*	0.479	6.085*	<0.001
VAS for pain, night, post-op 4th dayvs post-op 6th day	-0.122*	0.906	3.813*	0.007

(*) t value, PairedSamples t-test; (†) Z value, WilcoxonSignedRanks test; p<0.05; FIM, Functional independent measurement; ROM, Range of motion; VAS, Visual analog scale.

the statistical power of the study was limited because of the sample size. Further, more extensive research is needed to reveal the effects of MLD in TKA patients.

In the current study, MLD demonstrated no significant effect on knee swelling and consequences of swelling such as ROM, pain, FIM, knee posture, and gait. MLD treatment may contribute to improving knee ROM, particularly in the early postoperative period. However, the clinical significance of its effect is still unclear.

ETHICAL DECLARATIONS

Ethics Committee Approval: We carried out the research following ethical approval by the Clinical Research Ethics Committee of Kırıkkale University (Date: 27.11.2018, Decision No: 20/01)

Informed Consent: All patients signed the free and informed consent form.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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REFERENCES

1. Patil N, Lee K, Huddleston JI, Harris AH, Goodman SB. Aseptic versus septic revision total knee arthroplasty: patient satisfaction, outcome and quality of life improvement. Knee2010; 17: 200-3.
2. Pichonnaz C, Bassin JP, Lecureux E. et al. Effect of manual lymphatic drainage after total knee arthroplasty: a randomized controlled trial. Arch Phys Med Rehabil 2016; 97: 674-82.
3. O'Driscoll SW, Giori NJ. Continuous passive motion (CPM): theory and principles of clinical application. J Rehabil Res Dev 2000; 37: 179-88.
4. Bizzini M, Boldt J, Munzinger U, Drobny T. [Rehabilitation guidelines after total knee arthroplasty]. Orthopade 2003; 32: 527-34.
5. Bhave A. Rehabilitation after total hip and total knee arthroplasty. In: Barrack R BR, Lonner J, McCarthy J, Mont M, Rubash H., editor. Orthopedic knowledge update, hip and knee reconstruction. 3 ed. Rosemont: American Academy of Orthopaedic Surgeons; 2006. p. 295-308.
6. Su EP, Perna M, Boettner F. et al. A prospective, multi-center, randomised trial to evaluate the efficacy of a cryopneumatic device on total knee arthroplasty recovery. J Bone Joint Surg Br 2012; 94: 153-6.
7. Munk S, Jensen NJ, Andersen I, Kehlet H, Hansen TB. Effect of compression therapy on knee swelling and pain after total knee arthroplasty. Knee Surg Sports Traumatol Arthrosc 2013; 21: 388-92.
8. Moretti B, Notarnicola A, Moretti L. et al. I-ONE therapy in patients undergoing total knee arthroplasty: a prospective, randomized and controlled study. BMC Musculoskelet Disord 2012; 13: 88.
9. Goats GC. Massage- the scientific basis of an ancient art: Part 2. Physiological and therapeutic effects. Br J Sports Med 1994; 28: 153-56.
10. Tan IC, Maus EA, Rasmussen JC. et al. Assessment of lymphatic contractile function after manual lymphatic drainage using near-infrared fluorescence imaging. Arch Phys Med Rehabil 2011; 92: 756-64 e1.
11. Züther J NS. Lymphedema management: the comprehensive guide for practitioners. 3 ed. New York: Thieme; 2013.
12. RH S. Manual lymphatic drainage (MLD) according to Dr. E. Vodder. In: Földi M FE, editor. Textbook of lymphology for physicians and lymphedema therapists. 3 ed. Munich: Urban & Fischer; 2012. p. 467-84.
13. F. VdB. Therapeutic effects of massage therapy. Stuttgart: Thieme; 2005.
14. Haren K, Backman C, Wiberg M. Effect of manual lymph drainage as described by Vodder on oedema of the hand after fracture of the distal radius: a prospective clinical study. Scand J Plast Reconstr Surg Hand Surg 2000; 34: 367-72.
15. Knygsand-Roenhoej K, Maribo T. A randomized clinical controlled study comparing the effect of modified manual edema mobilization treatment with traditional edema technique in patients with a fracture of the distal radius. J Hand Ther 2011; 24: 184-93; quiz 94.
16. Kessler T, de Bruin E, Brunner F, Vienne P, Kissling R. Effect of manual lymph drainage after hindfoot operations. Physiother Res Int 2003; 8: 101-10.
17. Ebert JR, Joss B, Jardine B, Wood DJ. Randomized trial investigating the efficacy of manual lymphatic drainage to improve early outcome after total knee arthroplasty. Arch Phys Med Rehabil 2013; 94: 2103-11.
18. Sitzia J. Volume measurement in lymphoedema treatment: examination of formulae. Eur J Cancer Care (Engl) 1995; 4: 11-6.
19. Brosseau L, Balmer S, Tousignant M. et al. Intra- and intertester reliability and criterion validity of the parallelogram and universal goniometers for measuring maximum active knee flexion and extension of patients with knee restrictions. Arch Phys Med Rehabil 2001; 82: 396-402.
20. Dodds TA, Martin DP, Stolov WC, Deyo RA. A validation of the functional independence measurement and its performance among rehabilitation inpatients. Arch Phys Med Rehabil 1993; 74: 531-36.
21. Lysholm J, Tegner Y. Knee injury rating scales. Acta Orthop 2007; 78: 445-53.
22. Wittlinger H WD, Wittlinger A, Wittlinger M. Vodder's manual lymph drainage: a pratical guide. Stuttgart: Thieme; 2011.
23. Rigoni S, Tagliaro L, Bau D, Scapin M. Effectiveness of two rehabilitation treatments in the modulation of inflammation during the acute phase in patients with knee prostheses and assessment of the role of the diet in determining post-surgical inflammation. J Orthop 2021; 25: 237-43.
24. Fujiura T, Nagasawa H, Wakabayashi H. Effect of manual lymph drainage for up to 10 days after total knee arthroplasty: a randomized controlled trial. Physical Therapy Research 2020; 23: 39-46.