

## GAIT PARAMETER ADJUSTMENT AFTER KNEE ARTHROPLASTY BY KINESIOTHERAPY IN SUSPENSION

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The study is relevant due to persistent postural control impairment and gait disorder in patients post total knee arthroplasty (TKA), despite pain relief and restoration of the range of motion. The study aimed to assess the effects of kinesiotherapy in suspension on the patients' stabilometry and gait phase parameters in the long term after TKA. A prospective comparative study was conducted that involved 93 patients (39 males and 54 females; average age  $62.3 \pm 5.1$  years) enrolled 36 months after surgery. The patients were randomized into the index group (standard rehabilitation involving kinesiotherapy in suspension) and comparison group (standard program). The efficacy was assessed using stabilometry and gait phase analysis before and after the 3-week rehabilitation course. In the index group, a significant decrease in the normalized vectorogram area from  $320 \pm 60$  to  $190 \pm 40$  mm<sup>2</sup> ( $p = 0.001$ ) and mean center of pressure movement linear speed from  $15.5 \pm 2.8$  to  $8.7 \pm 2.1$  mm/s ( $p = 0.002$ ) was revealed. The stance phase duration increased by 18%, and the walking phase symmetry increased from  $74 \pm 5$  to  $90 \pm 4\%$  ( $p < 0.01$ ). In the comparison group, the changes were non-significant ( $p > 0.05$ ). The decrease in WOMAC scores was reported for both groups, there were no intergroup differences. The data obtained confirm the efficacy of using kinesiotherapy in suspension to adjust postural and locomotor disorders after TKA.

**Keywords:** total knee arthroplasty, medical rehabilitation; kinesiotherapy, stabilometry, gait, axial skeleton, stance phase

**Author contribution:** Minasov BSh — study concept and design, academic advising, manuscript approval; Yakupov RR — study design, clinical phase management, interpretation of the results; Akbashev VN — surgical treatment of patients, clinical assessment of the results; Evgrafov IO — clinical data acquisition, part in the rehabilitation program implementation; Malsagov YuM — clinical and functional assessment of patients, research database creation; Karimov KK — statistical data processing, analysis of the study results; Minasov IB — instrumental tests (stabilometry, gait phase analysis), data processing and interpretation; Akhmeddinova AA — course of kinesiotherapy in suspension, compliance with the rehabilitation protocol; Shveykin AA — scientific literature review, interpretation of the results, manuscript writing.

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## КОРРЕКЦИЯ ПАРАМЕТРОВ ПОХОДКИ ПОСЛЕ ЭНДОПРОТЕЗИРОВАНИЯ КОЛЕННОГО СУСТАВА МЕТОДОМ АППАРАТНО-ПОДВЕСНОЙ КИНЕЗИОТЕРАПИИ

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Актуальность исследования обусловлена сохраняющимися нарушениями пострального контроля и походки у пациентов после тотального эндопротезирования коленного сустава (ТЭКС), несмотря на устранение болевого синдрома и восстановление объема движений. Целью исследования было оценить влияние аппаратно-подвесной кинезиотерапии на стабилметрические и фазовые параметры походки у пациентов в отдаленные сроки после ТЭКС. Проведено проспективное сравнительное исследование с участием 93 пациентов (39 мужчин и 54 женщины; средний возраст  $62,3 \pm 5,1$  года), включенных через 36 месяцев после операции. Пациенты были рандомизированы в основную группу (стандартная реабилитация с включением аппаратно-подвесной кинезиотерапии) и группу сравнения (стандартная программа). Эффективность оценивали с использованием стабилметрии и фазового анализа походки до и после трехнедельного курса реабилитации. В основной группе выявлено достоверное снижение нормированной площади векторограммы с  $320 \pm 60$  до  $190 \pm 40$  мм<sup>2</sup> ( $p = 0,001$ ) и средней линейной скорости перемещения центра давления с  $15,5 \pm 2,8$  до  $8,7 \pm 2,1$  мм/с ( $p = 0,002$ ). Длительность фазы опоры увеличилась на 18%, симметрия фаз ходьбы — с  $74 \pm 5$  до  $90 \pm 4\%$  ( $p < 0,01$ ). В группе сравнения изменения были недостоверны ( $p > 0,05$ ). Снижение показателей WOMAC отмечено в обеих группах без межгрупповых различий. Полученные данные подтверждают эффективность аппаратно-подвесной кинезиотерапии в коррекции постральных и локомоторных нарушений после ТЭКС.

**Ключевые слова:** тотальное эндопротезирование коленного сустава, медицинская реабилитация, кинезиотерапия, стабилметрия, походка, осевой скелет, фаза опоры

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Under conditions of the increasing prevalence of degenerative-dystrophic lesions of large joints, the modern clinical practice is shaped as an integrated medical rehabilitation system based on combining medicinal, surgical, and functional technologies [1, 2]. Motor activity that ensures regulation of the connective tissue structural and functional state and the physiological motor stereotype development represents the key mechanism underlying restoration. The key role in these processes is played by the central and peripheral postural regulation links, and the strength imbalance results in the coordination disorder and decreased neuromuscular regulation efficiency [3].

Reduced motor activity is associated with the increase in the prevalence of musculoskeletal degenerative-dystrophic disorders, including those affecting large joints and segments of the pelvic girdle, which are accompanied by chronic systemic disorders with mostly local clinical manifestations [4]. Decompensated knee osteoarthritis reflecting the progressive structural and functional balance loss is accompanied by pain, hypodynamia, and involvement of various organs and systems [5, 6].

Despite the total knee arthroplasty high efficacy for pain relief and restoration of the range of motion, the long-term functional outcome is largely determined by the quality of medical rehabilitation considered as a continuous adaptation process aimed at restoring movement and ensuring the patient's social re-integration [7]. One of the factors limiting the physiological gait restoration is insufficient stabilization of the axial skeleton, primarily the lumbopelvic complex. The impaired neuromuscular control of the stabilizer muscles and asymmetric load result in alteration of the stance and walking phases [8, 9].

In this regard, modern rehabilitation programs are aimed at adjusting postural disorders, proprioceptive control restoration, and motor pattern optimization with the use of kinesiotherapy. The use of stabilization exercises with the load control contributes to better postural stability and return of the gait phase characteristics back to normal. The use of automated and robotic systems makes it possible to objectify assessment of the patients' functional state [10, 11]. At the same time, the data on the clinical efficacy of such methods in the late postoperative period are limited, which determines the relevance of further research.

The scientific novelty of this study lies in conducting a comprehensive instrumental assessment of the impact of kinesiotherapy in suspension on the postural control and locomotion parameters in patients post total knee arthroplasty (TKA). The study aimed to assess the effect of kinesiotherapy in suspension involving the use of the automated complex on the gait stabilometry and phase parameters in patients post TKA in the late postoperative period.

## METHODS

A prospective comparative study aimed to assess the effects of kinesiotherapy in suspension on the postural stability indicators and gait parameters in patients post TKA.

### Study design

The patients were enrolled 36 months after TKA, which corresponded to the period of the completed functional bone tissue remodeling and made it possible to assess the delayed biomechanical impairment and efficacy of the delayed rehabilitation intervention. A total of 93 patients (39 males, 54 females; average age  $62.3 \pm 5.1$  years) meeting the selection criteria were enrolled.

### Surgical intervention

All the patients had earlier undergone primary TKA involving the use of the posterior stabilized (PS) construct. The cemented prostheses (Meril Life Sciences, India) were used. The surgical procedure was performed using a standard method; the medial parapatellar approach was used. Stable fixation of the endoprosthesis components was reported in all patients based on the follow-up clinical and radiography assessment data by the time of enrollment.

### Randomization and allocation of groups

Randomization was performed by simple random sampling using a random number generator. The patients were distributed by independent experts, who did not take part in rehabilitation activities. Two groups were formed: comparison group (control;  $n = 46$ ), study group (index;  $n = 47$ )

#### Inclusion criteria

1. Age 55–75 years.
2. Primary unilateral TKA due to grade 3–4 osteoarthritis deformans (according to Kellgren–Lawrence).
3. Clinically stable condition, no contraindications to physical exercise.
4. No cognitive impairment (MMSE score  $\geq 24$ ).
5. Submitted informed consent to take part in the study
6. Endoprosthesis component stability confirmed by clinical, laboratory, and radiography data.

#### Exclusion criteria

1. Infectious complications, including periprosthetic joint infection.
2. Instability or displacement of the endoprosthesis components based on the clinical and instrumental assessment data.
3. Bilateral knee arthroplasty.
4. Severe limb deformities (valgus/varus  $> 15^\circ$ ) or shortening of the operated leg  $> 2$  cm
5. Severe pain at rest (VAS  $> 5$  points).
6. Severe concomitant disorders limiting physical activity: chronic heart failure (CHF), functional class III–IV according to the New York Heart Association (NYHA) classification; chronic obstructive pulmonary disease (COPD), grade III–IV according to the GOLD (Global Initiative for Chronic Obstructive Lung Disease) classification; unstable coronary artery disease (CAD), including progressive effort angina, angina at rest, early post-infarction angina, and the condition post recent acute coronary syndrome (within 3 months) associated with high risk of coronary complications and limited tolerance to physical exertion.
7. Active or progressive disorders of the central nervous system (Parkinson's disease, multiple sclerosis, stroke sequelae  $< 12$  months).
8. Dementia or severe cognitive impairment (MMSE  $< 24$ ).
9. Severe hearing loss or visual impairment interfering with exercise.
10. Refusal of participation or failure to adhere to the training and visit regimen.

### Rehabilitation program

Comparative characteristics of rehabilitation programs are provided in Table 1. The comparison group was through the

**Table 1.** Comparative characteristics of rehabilitation programs

Direction of therapy	Comparison group (standard program)	Index group (standard + kinesiotherapy)
Physiotherapy	Ultra-high frequency electric field, electrical muscle stimulation	
Breathing exercises	Diaphragmatic breathing exercises	
Passive and active motion	Passive mobilization of the joint, active motion within the permissible range	
Isometric exercises	Tensing muscles of the thigh and gluteal muscles	
Stretching exercises	For the muscles of the thigh, lower leg, and lumbar region	
Coordination and balance exercises	Balancing using the stability ball and balance platform	Suspension exercises with the pressure center control and biological feedback
Kinesiotherapy (in suspension)	Was not used	The suspension system, ORMED Kinezo automated complex (ORMED, Russia) was used
Stabilization of the trunk and axial skeleton	Was not performed	Exercises for activation of the core and pelvic stabilizer muscles
Proprioceptive stimulation	Limited implementation through unstable surfaces	Targeted training involving modulation of the support and moving the center of gravity
Unloaded functional movements	Were not performed	Were performed using suspended unloading
Frequency of sessions	5 times a week, 40–50 min	5 times a week, 50–60 min
Course duration	3 weeks (15 sessions)	3 weeks (15 sessions)

standard rehabilitation program in accordance with the clinical guidelines on restoration after TKA (Table 2). The program included the following physiotherapeutic procedures: exposure to the ultra-high frequency electric field and electrical muscle stimulation (EMS) of the gluteal muscles, as well as the muscles of the thigh and lower leg of the operated and contralateral limbs, breathing exercises, passive and active knee joint mobilization, isometric exercises for the thigh and gluteal muscles, stretching exercises for the lower limb, and coordination exercises using a stability ball and unstable supports. The 40–50 min training sessions were conducted 5 times a week throughout 3 weeks.

In addition to standard therapy, the index group was through the course of kinesiotherapy in suspension (Table 3) involving the use of the automated complex and suspension trainers. The program included exercises aimed at activating deep muscles of the trunk and pelvis (core), proprioceptive training, restoration of the gait phase symmetry, and execution of functional movements with partial bodyweight unloading. The stabilization training elements and biological feedback

technologies were used. The 3-week course consisted of 15 daily 50–60 min sessions controlled by the specialist.

### Method to assess rehabilitation efficacy

The rehabilitation activity efficacy was assessed twice: before the beginning of the course and after the end of the 3-week cycle (on day 21). Objective instrumental and subjective methods were used.

### Stabilometry analysis

The postural stability parameters were assessed using the HUBER 360 stabilometry platform (LPG Systems, France) when standing with the eyes open. The main assessed indicators were as follows:

- normalized vectorogram area (NVA, mm<sup>2</sup>) reflecting the value of the center of pressure spatial distribution;
- mean center of pressure movement linear speed (mm/s) being a compensatory activity indicator;

**Table 2.** Composition and structure of a standard rehabilitation program

Program component	Duration	Aim	Description and execution specifics
Physiotherapy	15 procedures (daily)	Pain relief and reduction of swelling, regeneration stimulation	Electrophoresis with Diclofenac-AKOS, 1% solution for external use; (Sintez, Russia) low-frequency alternating magnetic therapy applied to the knee joint
Breathing exercises	10–15 min / session	Diaphragmatic breathing activation, hypostatic disorder prevention	Performed in a lying and sitting position under the instructor's count; three sets of 10 repetitions
Passive and active motion	10–15 min / session	Restoration of the knee joint motion range	Passive flexion/extension with the instructor's help; active moving in a lying or sitting position, within the painless amplitude
Isometric exercises	7 min / session	Strengthening the gluteal, quadriceps, hamstrings, and lower limb muscles	Static tension of muscles, retention for 3–5 s, 3–4 series of 10 repetitions
Stretching	5–10 min / session	Muscle elasticity improvement, contracture prevention	Metered stretching the anterior and posterior thigh, lower leg, and lumbar region, retention for 15–20 s
Coordination exercises	10 min / session	Stability and balance improvement	Exercises using a stability ball, body weight shifting, execution on unstable platforms with and without support
Overall duration of a single session	40–50 min	Complex motor function restoration	Algorithmic execution of all components under the instructor's supervision, 5 times a week for 3 weeks

**Table 3.** Composition and structure of the rehabilitation program comprising the kinesiotherapy component used in the study group

Kinesiotherapy component	Duration	Aim	Description and execution specifics
Trunk and pelvis stabilization exercises	10–15 min / session	Activation of the deep stabilizer muscles, shaping axial stability	Executed in the suspension system with the trunk position control; retention and movement in the stato-dynamic modes
Proprioceptive training	10–15 min / session	Neuromuscular control and intermuscular coordination improvement	Tasks to maintain balance with the changing support and load direction; using a platform with the variable force vector
Gait symmetry training	10 min / session	Restoration of the phase balance and even load distribution	Step modeling with the feedback based on the stance and swing phase parameters; visual representation of abnormalities
Unloaded functional movements	10–15 min / session	Motor activity improvement with minimal stress on the joint	Walking, half squats and lifts with partial bodyweight unloading in the suspension system; metered load increase
Biological feedback	Embedded in each module	Increasing movement consciousness and adjustment of motor patterns	Using sensory modules for visual control of body position and symmetry of efforts
Total kinesiotherapy exercise duration	20–30 min / session	Comprehensive improvement of the stabilometry and phase parameters	Was part of the common 50–60 min session daily throughout 3 weeks

• center of pressure oscillation amplitude in the sagittal and frontal planes characterizing stability and balance.

*Phase analysis of gait and walking*

The gait kinematic characteristics were assessed using the Walker View system (TecnoBody, Italy) equipped with the treadmill and optical sensors. The following parameters were recorded:

- stance phase and swing phase duration;
- double support index (percentage of the entire walking cycle);
- symmetry of the stance phase and walking for the operated and contralateral lower limbs (%);
- step length and cadence, if technically possible.

*Assessment of the state using scales*

The WOMAC (Western Ontario and McMaster Universities Osteoarthritis Index) scale recommended for assessment of the efficacy of conservative and surgical knee osteoarthritis treatment was used for subjective functional state assessment.

The scale consists of 24 questions distributed across three subscales: pain (five items), stiffness (two items), and physical function (17 items). The answers were rated on a 5-point scale: 0 — no symptom, 4 — severe manifestation. The total score was calculated by summing up all scores (maximum score 96 points). Lower scores corresponded to better clinical condition. The results were interpreted in accordance with the generally accepted scale: 0–14 points — excellent, 15–28 points — good, 29–38 points — satisfactory, over 38 points — unsatisfactory.

**Statistical data processing**

Statistical processing of the data obtained was performed using the SPSS Statistics software package (version 26.0, IBM, USA). The distribution of quantitative variables was tested for normality using the Shapiro–Wilk test before the analysis. The intragroup comparison of the indicators reported before and after the rehabilitation course involved the use of the paired Student’s *t*-test (when normally distributed) or Wilcoxon test for related samples (when non-normally distributed). The intergroup comparison was performed using the two-sample Student’s

**Table 4.** Major clinical and functional indicators before and after rehabilitation

Indicator	Group	Before treatment (M ± SD)	After treatment (M ± SD)	<i>p</i> (intragroup)	<i>p</i> (intergroup)
Stabilometry					
Normalized vectorogram area (mm <sup>2</sup> )	Index ( <i>n</i> = 47)	320 ± 60	190 ± 40	0.001	0.003
	Comparison ( <i>n</i> = 46)	330 ± 70	290 ± 65	0.12	
Mean center of pressure movement linear speed (mm/s)	Index ( <i>n</i> = 47)	15.5 ± 2.8	8.7 ± 2.1	0.002	0.005
	Comparison ( <i>n</i> = 46)	16.1 ± 3.0	14.0 ± 2.9	0.09	
Oscillation amplitude (sagittal area) (mm)	Index ( <i>n</i> = 47)	10.5 ± 2.1	8.7 ± 1.9	0.06	0.11
	Comparison ( <i>n</i> = 46)	10.8 ± 2.0	9.5 ± 1.8	0.08	
Gait phases					
Stance phase duration (s)	Index ( <i>n</i> = 47)	0.68 ± 0.07	0.80 ± 0.05	0.003	0.004
	Comparison ( <i>n</i> = 46)	0.67 ± 0.06	0.71 ± 0.06	0.15	
Phase symmetry (%)	Index ( <i>n</i> = 47)	74 ± 5	90 ± 4	0.001	0.002
	Comparison ( <i>n</i> = 46)	75 ± 6	80 ± 5	0.08	
WOMAC (points)					
Total score	Index ( <i>n</i> = 47)	36 ± 4	22 ± 3	0.001	0.12
	Comparison ( <i>n</i> = 46)	37 ± 5	25 ± 4	0.004	

**Note:** *p* (intragroup) — significance of differences between the indicators reported before and after treatment within the same group; *p* (intergroup) — significance of differences between the index group and comparison group after treatment.

*t*-test (normal distribution) or Mann-Whitney *U*-test. Pearson's chi-squared test ( $\chi^2$ ) was used for categorical variables. The differences were considered significant at  $p < 0.05$ . All data are presented as the mean and standard deviation (M  $\pm$  SD).

## RESULTS

The 3-week rehabilitation course was associated with the changes in stabilometry and kinematic parameters in both groups showing differences in their extent (Table 4). The stabilometry analysis revealed a significant normalized vectorogram area decrease in the index group ( $p < 0.01$ ). No significant differences were revealed in the comparison group ( $p > 0.05$ ). The mean center of pressure movement linear speed decreased significantly in the index group ( $p < 0.01$ ), while in the comparison group the changes were non-significant ( $p > 0.05$ ). The intergroup analysis revealed significant differences in the normalized vectorogram area and mean center of pressure movement linear speed after the rehabilitation course ( $p < 0.01$ ). The gait analysis revealed a significant increase in the stance phase duration and gait phase symmetry improvement in the index group ( $p < 0.01$ ). In the comparison group, the changes in phase parameters were non-significant ( $p > 0.05$ ). The intergroup differences reported after treatment were significant ( $p < 0.01$ ). As for the WOMAC scores, a significant decrease in the total score compared to baseline was reported in both groups ( $p < 0.01$ ). The intergroup differences reported after the rehabilitation course were non-significant ( $p > 0.05$ ).

## DISCUSSION

Kinesiotherapy in suspension has a significant impact on the postural control and gait characteristics in patients post knee arthroplasty. Targeting the deep stabilizer muscles and synergist muscles contributes to shaping the more balanced motor patterns and improvement of motor coordination in the stance and swing phases. The decrease in the center of pressure distribution and the neuromuscular control optimization in the index group are likely to be associated with activation of the deep stabilizer muscles and the increased proprioceptive sensitivity. The combination of these changes contributes to higher stability in the static position and decreased risk of falls, which is in line with the research data showing improvement of postural parameters after TKA. The standard rehabilitation program used in the comparison group had a less pronounced effect on the stabilometry indicators, which emphasizes the importance of targeted exercises involving the use of automated complexes and suspension systems for postural control restoration.

The development of the more balanced locomotion in the index group manifested by the increase in the stance phase duration and movement symmetry improvement reflects the physiological motor stereotype restoration. This results in the reduced asymmetric load on the joints, reduces the risk of the compensatory contralateral limb overload and excess stress on the endoprosthesis components. The findings are consistent with the literature data suggesting that the intense, structured rehabilitation programs are effective for restoration of the gait temporal and spatial parameters after TKA. In the comparison group, the changes were less pronounced, which is in line with the data on the limited efficacy of standard programs when used to adjust biomechanical gait disturbances.

The lack of significant intergroup differences in WOMAC scores, despite the decrease in indicators in both groups, can be due to the limited sensitivity of subjective scales

to biomechanical parameter alterations. According to the literature data, WOMAC reflects pain severity and functional limitations to the greater extent, that the postural control and gait characteristics [12]. This highlights the feasibility of using objective assessment methods, such as stabilometry and gait phase analysis, when analyzing the rehabilitation program efficacy.

The findings suggest that kinesiotherapy in suspension as a version of the structured balance training and proprioceptive exercises has a pronounced effect on the postural control and gait characteristics in patients post total knee arthroplasty. The current systematic reviews and meta-analyses show that inclusion of balance training in rehabilitation programs ensures the more pronounced static and dynamic balance improvement compared to the standard programs that are based mainly on the essential functional exercises [13–16]. The literature data suggest that such programs contribute to the walking speed increase, reduction of the time of executing the TUG and 6MWT tests, reduction of the center of pressure distribution, and increase in movement symmetry, which is in line with the results reported for the index group in this study. The mechanisms underlying the changes identified can be explained in terms of neuromuscular regulation. The balance training and training in suspension systems activate the deep stabilizer muscles and synergist muscles, enhance the proprioceptive afferent output, and contribute to developing more adequate postural responses. The neuromuscular control improvement manifested by reduction of the center of pressure oscillation amplitude and optimization of its trajectory was described in a number of studies as the key factor of stability restoration following TKA [13, 17, 18]. The use of suspension systems makes it possible to safely increase the training intensity, reducing pain and fear of falling, which, according to the authors, accelerates the functional mobility restoration and increases the patient's engagement in rehabilitation [19].

Shaping the more balanced locomotion in the index group manifested by the increased stance phase duration and movement symmetry reflects the physiological motor stereotype restoration. In the literature, such changes are considered as a sign of reduction of the asymmetric load on the contralateral limb and prevention of the limb overload in the postoperative period. Furthermore, optimization of the gait temporal and spatial parameters reduces the excess stress on the endoprosthesis components, which is potentially important for the long-term implant preservation. Similar data are reported in the studies showing the efficacy of the intense, structured rehabilitation programs for adjustment of biomechanical gait disturbances following TKA [20, 21]. In the comparison group, the standard rehabilitation program ensured improvement, but the dynamic changes in stabilometry and biomechanical indicators were less pronounced. Such results are consistent with the data reported in the papers emphasizing that conventional programs are aimed mainly at restoring the motion range and muscle strength; these are less likely to affect postural control and coordination mechanisms [22]. This suggests the importance of the targeted inclusion of the exercises focusing on balance and proprioception in the postoperative rehabilitation structure. The lack of significant intergroup differences in WOMAC scores, despite objective differences in the postural control and gait parameters, is also explained in the literature. It is reported that WOMAC to the greater extent reflect pain severity and subjective functional limitations, than subtle biomechanical and stabilometry characteristics of movement [23, 24]. This emphasizes the subjective scales' limited sensitivity when used to assess the efficacy of the programs aimed at adjusting neuromuscular regulation and confirms the feasibility of using

objective instrumental methods (stabilometry and gait phase analysis) to analyze the rehabilitation outcomes.

It should be noted that the American Physical Therapy Association guidelines suggest the need to include the dynamic balance training and robot-assisted or suspension technologies in the programs of rehabilitation after TKA in order to optimize gait and reduce the risk of falls [13]. The data obtained in our study confirm these provisions and demonstrate clinical relevance of using kinesiotherapy in suspension as a component of the structured rehabilitation program.

Thus, the combination of the changes revealed allows us to consider kinesiotherapy in suspension not only as a method to restore muscle strength and the range of motion, but also as a tool for targeting the mechanisms underlying postural control, neuromuscular coordination and the development of the physiological motor stereotype following knee arthroplasty.

## CONCLUSIONS

Kinesiotherapy in suspension leads to significant changes in the stabilometry and phase parameters in patients post knee arthroplasty. Reduction of the center of pressure distribution, increased stance phase duration and movement symmetry reflect postural control improvement and physiological gait restoration. These changes are associated with shaping balanced locomotion and restoration of physiological locomotor responses ensuring even distribution of the load on the joints and optimal endoprosthesis functioning conditions, which confirms the efficacy of using kinesiotherapy in suspension in the programs for rehabilitation following TKA, especially in the coordination and stability restoration phases. The lack of intergroup differences in WOMAC scores emphasizes the need to use objective assessment methods in rehabilitation.

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