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Functional Walking Activity After Combined Russian Current And Quadriceps Bench Exercise In Knee Osteoarthritis

Aktivitas Berjalan Fungsional Setelah Pemberian Kombinasi Russian Current Dan Quadriceps Bench Exercise Pada Pasien Osteoarthritis Lutut

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ABSTRACT

Osteoarthritis is a degenerative joint disease characterised by damage to hyaline cartilage, increased subchondral bone thickness, bone sclerosis, osteophyte formation at the joint margins, and weakness of the surrounding muscles, which may lead to limitations in functional activities, particularly walking. This study aimed to determine changes in functional walking activity following combined Russian Current therapy and Quadriceps Bench Exercise in patients with knee osteoarthritis at Dr Drs. M. Hatta Brain Hospital, Bukittinggi. This study used a quasi-experimental design with a one-group pretest–posttest approach without a control group. A total of 11 female respondents were selected using purposive sampling based on predetermined inclusion and exclusion criteria. The intervention was administered twice weekly for four weeks. Functional walking activity was measured using the Lequesne Index before and after the intervention. The mean Lequesne Index score decreased from 5.91 ± 1.446 before the intervention to 4.82 ± 1.471 after the intervention. The paired t-test showed a statistically significant difference between the pretest and posttest scores ($p < 0.001$), indicating improved functional walking activity following the intervention. Combined Russian Current therapy and Quadriceps Bench Exercise were associated with improved functional walking in female patients with knee osteoarthritis; however, the findings should be interpreted cautiously, as the study did not include a control group.

Keywords: knee osteoarthritis, Russian Current, Quadriceps Bench Exercise, functional walking activity, Lequesne Index

ABSTRAK

Osteoarthritis merupakan penyakit sendi degeneratif yang ditandai oleh kerusakan kartilago hialin, peningkatan ketebalan tulang subkondral, sklerosis tulang, pembentukan osteofit pada tepi sendi, serta kelemahan otot di sekitar sendi. Kondisi tersebut dapat menyebabkan keterbatasan aktivitas fungsional, terutama kemampuan berjalan. Penelitian ini bertujuan untuk mengetahui perubahan kemampuan berjalan fungsional setelah pemberian kombinasi terapi Russian Current dan Quadriceps Bench Exercise pada pasien osteoarthritis lutut di Rumah Sakit Otak Dr. Drs. M. Hatta Bukittinggi. Penelitian ini menggunakan desain quasi-experimental dengan pendekatan one-group pretest–posttest tanpa kelompok kontrol. Sebanyak 11 responden perempuan dipilih menggunakan teknik purposive sampling berdasarkan kriteria inklusi dan eksklusi yang telah ditetapkan. Intervensi diberikan dua kali seminggu selama empat minggu. Kemampuan berjalan fungsional diukur menggunakan Lequesne Index sebelum dan

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sesudah intervensi. Rata-rata skor Lequesne Index menurun dari 5,91 ± 1,446 sebelum intervensi menjadi 4,82 ± 1,471 setelah intervensi. Hasil uji paired t-test menunjukkan terdapat perbedaan yang signifikan antara skor pretest dan posttest (p < 0,001), yang menunjukkan adanya peningkatan kemampuan berjalan fungsional setelah intervensi. Kombinasi terapi Russian Current dan Quadriceps Bench Exercise berhubungan dengan peningkatan kemampuan berjalan fungsional pada pasien perempuan dengan osteoarthritis lutut. Namun, hasil penelitian ini perlu ditafsirkan secara hati-hati karena penelitian tidak menggunakan kelompok kontrol.

Kata Kunci: Osteoartritis lutut, Arus Rusia, latihan quadriceps di bangku, aktivitas berjalan fungsional, Indeks Lequesne

INTRODUCTION

Osteoarthritis (OA) is a progressive degenerative joint disease that commonly affects the knee and may result in pain, stiffness, reduced range of motion, quadriceps muscle weakness, and limitations in functional walking activity [(1)]. Structural changes in knee OA, including cartilage degeneration, subchondral bone alterations, and osteophyte formation, may reduce joint stability and impair weight-bearing activities such as walking, standing, and stair climbing. The global burden of OA continues to increase, particularly among middle-aged and older adults, and knee OA is an important contributor to disability and reduced quality of life[(1),(2)]. In Indonesia, the prevalence of joint disease was reported as 7.3%, while the prevalence in West Sumatra was 7.21% [(4)].

The burden of knee OA is also relevant in the local clinical setting. Medical rehabilitation service records at Dr M. Hatta Brain Hospital, Bukittinggi, showed that 4,451 patients with osteoarthritis received rehabilitation services in 2023, and 119 patients with osteoarthritis were recorded in August 2024. These data indicate that knee OA is a clinically relevant condition that requires rehabilitation strategies to address quadriceps weakness and limitations in functional walking. Exercise therapy, particularly quadriceps-strengthening exercises, is recommended as a core non-pharmacological intervention for knee OA because it may improve muscle strength, knee stability, pain, and physical function[(3)(4).]

Previous studies have also investigated neuromuscular electrical stimulation as an adjunct to exercise therapy in patients with knee OA. Neuromuscular electrical stimulation may facilitate quadriceps muscle activation, particularly in patients with pain-related muscle inhibition or quadriceps weakness, whereas therapeutic exercise may improve active knee control and functional movement. A randomised controlled trial reported that both neuromuscular electrical stimulation and resistance training improved functional capacity in patients with knee OA[(5)]. However, evidence on electrical stimulation combined with exercise remains inconsistent, especially for physical function outcomes, and the certainty of the available evidence remains limited [(6)] In addition, most available studies have evaluated neuromuscular electrical stimulation in general or examined exercise programs separately, rather than specifically evaluating the combination of Russian Current and Quadriceps Bench Exercise.

Therefore, a research gap remains regarding the application of the Russian Current combined with the Quadriceps Bench Exercise to improve functional walking in patients with knee OA, particularly in Indonesian medical rehabilitation settings. The novelty of this study lies in the combined use of Russian Current as a modality to facilitate quadriceps muscle contraction and Quadriceps Bench Exercise as an active therapeutic exercise to support knee flexion-extension movement, muscle strengthening, and joint stability. This study was conducted at Rumah Sakit Otak Dr. Drs. M. Hatta Bukittinggi because the hospital serves a

substantial number of patients with osteoarthritis who require rehabilitation services. The findings are expected to provide preliminary local evidence regarding changes in functional walking activity after this combined intervention. They may support the development of more structured physiotherapy programs for patients with knee OA.

RESEARCH METHODS

This study used a quasi-experimental, one-group pretest–posttest design without a control group to evaluate changes in functional walking ability following a combination therapy of Russian Current and Quadriceps Bench Exercise in patients with knee osteoarthritis. The study was conducted at Rumah Sakit Otak Dr. Drs. M. Hatta Bukittinggi, over four weeks, from December 17, 2024, to January 10, 2025. The intervention was administered twice weekly for four weeks, so each participant received a total of eight therapy sessions. Since this study did not include a control group, the results are interpreted as changes in functional walking ability following the intervention and have limitations in establishing a causal relationship.

The study population consisted of all patients diagnosed with knee osteoarthritis who were receiving medical rehabilitation services at Rumah Sakit Otak Dr. Drs. M. Hatta Bukittinggi Based on patient visit data from August 2024, 119 patients had osteoarthritis. The study sample consisted of 11 respondents selected using purposive sampling based on predetermined inclusion and exclusion criteria. Inclusion criteria included female patients aged 40–59 years with a diagnosis of knee osteoarthritis, undergoing medical rehabilitation services at the study site, able to participate in measurement procedures and interventions, and willing to serve as respondents by signing an informed consent form. The 40–60 year age range was chosen to ensure relatively homogeneous age characteristics among respondents and to limit greater variations in physical function typically seen in older age groups.

Exclusion criteria included patients with contraindications to electrotherapy, such as the use of a pacemaker or impaired skin integrity at the electrode placement site; patients with medical conditions that prevented them from performing the exercises; patients with a history of recent knee surgery, severe knee deformity, or acute knee inflammation; and patients who were unable to complete the pretest, the intervention series, or the posttest. Participants who withdrew during the study were also excluded from the analysis.

RESULTS

1. Normality Test of Functional Walking Activity Data

Table 1. Shapiro–Wilk Normality Test of Functional Walking Activity Before and After the Intervention

	Shapiro-wilk		
	Statistics	N	Sig.
Functional Activity Walking Before Intervention	0.915	11	0.281
Functional Activities Remain After Intervention	0.884	11	0.118

Based on Table 1, the normality test was performed using the Shapiro–Wilk test. As shown in Table 3, the p-value for functional walking activity before the intervention was 0.281, while the p-value after the intervention was 0.118. Since both p-values were greater

than 0.05, the data were normally distributed. Therefore, the paired t-test was used for the bivariate analysis.

2. Age Distribution of Respondents

Table 2. Distribution Characteristics Age

Age	n	Percent%
40-50	3	27.2
51-60	8	72.8
Total	11	100

Based on Table 2, most respondents were aged 51–60 years, accounting for 8 respondents (72.8%). Meanwhile, 3 respondents (27.2%) were aged 40–50 years.

3. Gender Distribution of Respondents

Tabel 3. Distributed Characteristics Responden According to type sex

Gender	N	Percent%
Woman	11	100
Man	0	0
Total	10	100

The gender distribution of respondents is presented in Table 2. All respondents in this study were female, totalling 11 (100.0%). Female respondents were selected to obtain more homogeneous data and minimise potential bias related to gender differences.

4. **Effect of Combined Russian Current Therapy and Quadriceps Bench Exercise on Functional Walking Activity**

Table 4. Effect of Combined Russian Current Therapy and Quadriceps Bench Exercise on Functional Walking Activity.

Functional Walking Activity	N	Mean	Standard Deviation	95% Confidence Interval	Mean Difference	Effect Size (Cohen's d)	p-value
Pre-test	11	5.91	1.446	4.94–6.88	1.09	0.75	<0.001
Post-test	11	4.82	1.471	3.83–5.81			

As shown in Table 4, the mean functional walking activity score, measured using the Lequesne Index, decreased from 5.91 ± 1.446 at pretest to 4.82 ± 1.471 at posttest. The 95% CI for the pretest mean ranged from 4.94 to 6.88, whereas the 95% CI for the posttest mean ranged from 3.83 to 5.81. The mean difference between the pretest and posttest scores was 1.09 points, indicating a reduction in functional limitations after participants received combined Russian Current therapy and Quadriceps Bench Exercise. Because lower Lequesne Index scores indicate better functional status, the reduction in the posttest score suggests improved functional walking activity among the respondents.

The paired t-test showed a statistically significant difference between the pretest and posttest scores ($p < 0.001$). In addition, the estimated effect size was Cohen's $d = 0.75$, indicating a moderate-to-large magnitude of change. The lower posttest mean and its

corresponding 95% confidence interval support the observed reduction in functional limitation after the intervention. Therefore, combined Russian Current therapy and Quadriceps Bench Exercise were associated with improved functional walking activity in female patients with knee osteoarthritis.

However, the findings should be interpreted cautiously because this study used a one-group pretest–posttest design without a control group. The observed improvement may also have been influenced by adherence to therapy, daily physical activity, respondent motivation, therapist attention, placebo effects, or natural variation in osteoarthritis symptoms. Further studies with larger samples, comparison groups, and longer follow-up periods are needed to confirm the effectiveness and clinical relevance of this combined intervention.

DISCUSSION

As shown in Table 4, the mean functional gait activity score, measured using the Lequesne Index, decreased from 5.91 ± 1.446 in the pretest to 4.82 ± 1.471 in the posttest. The 95% confidence interval for the pretest mean ranged from 4.94 to 6.88, while the 95% confidence interval for the posttest mean ranged from 3.83 to 5.81. The 1.09-point difference in the mean indicates a decrease in limitations related to pain, walking distance, and activities of daily living after the combination of Russian Current and Quadriceps Bench Exercise. Because lower Lequesne Index scores indicate less severe functional limitations, these results suggest an increase in functional gait activity in the participants.

Paired t-test results showed a statistically significant difference between pretest and posttest scores ($p < 0.001$). The estimated effect size of Cohen's $d = 0.75$ indicates a moderate to large within-group change. The lower posttest mean also indicates a descriptive shift toward less severe functional limitations after the intervention. However, the confidence intervals presented are confidence intervals for the mean at each measurement time, not for the difference in means. Therefore, the primary statistical evidence regarding the difference between pretest and posttest still comes from the paired t-test results.

Although the change in Lequesne Index score was statistically significant, its clinical significance should be interpreted with caution. A decrease of 1.09 points indicates a reduction in functional limitations, but this study did not establish a minimum clinically important difference (MCID) for the Lequesne Index before data collection. Furthermore, other clinical outcomes that could strengthen the interpretation of changes, such as pain intensity, gait speed, the Timed Up and Go test, the six-minute walk test, the patient's global assessment, and quality of life, were not measured. Therefore, the decrease in Lequesne Index score cannot be confirmed as a clinically meaningful improvement for all respondents, although the effect size indicates a substantial change within the group.

Most respondents were aged 51–60 years, and all respondents were female. These characteristics are relevant because knee osteoarthritis is more frequently reported in women and its prevalence tends to increase with age. Age-related degeneration of articular cartilage, subchondral bone changes, muscle weakness around the knee, and biomechanical changes can contribute to pain, impaired joint control, and gait limitations. Hormonal changes during the menopausal transition can also affect cartilage and subchondral bone metabolism, increasing women's susceptibility to knee osteoarthritis.[7][8]

Previous research supports the finding that knee osteoarthritis is more common in women than in men, especially after middle adulthood. Cui et al. (2020) reported a female-to-male knee osteoarthritis prevalence ratio of 1.69[7]. Ji et al. (2023) also found a knee osteoarthritis prevalence of 14.1% in women and 6.5% in men, with women being approximately 1.76 times more likely to develop the condition [8]. Furthermore, Di Martino et al. (2024) reported that women may experience lower cartilage volume and greater cartilage loss after menopause [9].

Differences in risk factors for knee osteoarthritis by gender, including an association between high body mass index and risk of knee osteoarthritis in women, have also been reported by Szilagyi et al. (2023) [10].

Female patients were selected as respondents to obtain a more homogeneous study group and to focus on a population with a relatively high burden of knee osteoarthritis. Limiting the sample to women was intended to reduce heterogeneity associated with sex-based differences in hormonal status, knee joint anatomy, cartilage morphology, muscle strength, body composition, and biomechanical loading. This approach allowed functional gait to be evaluated in a more clinically comparable group. Therefore, results should be interpreted specifically for female patients aged 40–60 years with knee osteoarthritis and should not be directly generalized to male patients, older adults, or populations with different demographic and clinical characteristics.

The observed improvement in functional gait may be related to the complementary effects of Russian Current therapy and the Quadriceps Bench Exercise. The Quadriceps Bench Exercise involves repeated knee flexion and extension movements that can improve quadriceps and hamstring muscle performance, support knee joint stability, and facilitate weight-bearing activities such as standing, walking, and stair climbing. Quadriceps muscle weakness is often associated with reduced dynamic knee stability and greater functional limitations in patients with knee osteoarthritis [11]. Therefore, quadriceps strengthening may improve walking function by supporting better control of knee movement during daily activities. Previous studies have also reported that quadriceps strengthening exercises can improve knee stability and functional outcomes in patients with knee osteoarthritis[12].

Russian current may have further supported functional walking by facilitating quadriceps muscle activation through medium-frequency electrical stimulation. This modality can enhance motor unit recruitment and produce muscle contraction in patients with pain-related muscle inhibition or quadriceps weakness.Russian current may have contributed to the observed improvement in functional walking When electrical current is applied at an intensity sufficient to produce a visible and tolerable muscle contraction,[13] it depolarizes the peripheral motor nerve beneath the electrodes and activates motor units within the quadriceps muscle. In patients with knee osteoarthritis, pain and joint-related inhibition may reduce voluntary quadriceps activation. Therefore, externally induced contractions may help patients activate the quadriceps muscle despite pain-related inhibition and may complement voluntary contractions during the Quadriceps Bench Exercise..

Repeated quadriceps contractions during the intervention promoted initial neuroadaptations, including an increased ability to recruit and activate the quadriceps muscle during functional tasks. Increased quadriceps activation may support greater knee extensor torque and better knee flexion control during weight-bearing activities [14]. During standing, walking, stair climbing, and sit-to-stand movements, the quadriceps contribute to knee motion control and shock absorption. Therefore, improved quadriceps function may support dynamic knee stability and reduce excessive motion or instability during daily activities. In this study, this mechanism may have contributed to the decrease in Lequesne Index scores.[15]

Russian current may have contributed to the improvement in functional walking activity through a series of neuromuscular responses. When delivered at an intensity sufficient to induce a visible and tolerable contraction, the electrical stimulus depolarizes the peripheral motor nerve beneath the electrode. The resulting action potential travels to the neuromuscular junction, where acetylcholine release initiates muscle fiber depolarization. This process triggers calcium release from the sarcoplasmic reticulum, allowing the formation of actin-myosin cross-bridges and resulting in quadriceps muscle contraction.[14]

In patients with knee osteoarthritis, pain, joint-related sensory changes, and arthrogenic muscle inhibition can reduce voluntary quadriceps activation. Russian current can partially overcome this inhibition by producing externally induced quadriceps contractions. Repeated

contractions throughout treatment sessions can promote early neuroadaptations, including increased motor unit recruitment, more effective quadriceps muscle activation, and an improved ability to generate knee extensor torque during functional tasks. Because the quadriceps muscles contribute to the control of knee flexion during weight-bearing, increased quadriceps activation may support dynamic knee stability during standing, walking, stair climbing, and sit-to-stand activities.

The combination of quadriceps contractions induced by Russian Current and voluntary contractions through the Quadriceps Bench Exercise may have contributed to improvements in quadriceps performance, knee movement control, and tolerance to weight-bearing activities. This mechanism could explain the association between the combined intervention and the improvements in functional walking seen in this study. However, this study did not have a Russian Current-only group, a Quadriceps Bench Exercise-only group, or a control group. Therefore, the independent contribution of each intervention cannot be determined. Furthermore, quadriceps strength, voluntary activation, pain intensity, dynamic knee stability, gait parameters, and muscle morphology were not directly measured. These physiological mechanisms should be interpreted as plausible explanations based on previous research, rather than as directly proven physiological effects across all participants in this study.

Several methodological limitations should be considered. The one-group pretest-posttest design without a control group limits the study's ability to establish a causal relationship. Observed improvements may be influenced by therapist attention, participant expectations, the placebo effect, motivation, adherence to therapy, changes in daily physical activity, or the natural fluctuation of osteoarthritis symptoms over time. Regression toward the mean cannot be ruled out as a possible cause of some of the observed changes.

This study involved only 11 respondents and used purposive sampling. While this technique is appropriate for recruiting patients who meet the study criteria, purposive sampling can introduce selection bias. Respondents who agreed to complete the entire therapy may have higher motivation, better adherence, or fewer barriers to rehabilitation than patients who did not participate. Furthermore, several potential confounding variables were not fully controlled, such as body mass index, radiological grade of osteoarthritis, duration of symptoms, medication use, occupational activity, history of knee trauma, baseline physical activity level, and adherence to home exercise. Future studies should use a comparison group, a larger sample size, standardized intervention parameters, more comprehensive outcome measures, and a longer follow-up period.

CONCLUSION

This study found that the mean Lequesne Index score decreased from 5.91 before the intervention to 4.82 after eight sessions of combined Russian Current therapy and Quadriceps Bench Exercise. The decrease in Lequesne Index scores was statistically significant ($p < 0.001$), suggesting an improvement in functional walking activity among female patients with knee osteoarthritis following the intervention. However, because this study used a one-group pretest–posttest design without a control group and involved a small sample size, the observed improvement cannot be attributed solely to the combined intervention. The findings should therefore be interpreted cautiously. Further studies using randomised controlled designs, larger samples, comparison groups, and longer follow-up periods are needed to confirm the effectiveness and clinical relevance of combined Russian Current therapy and Quadriceps Bench Exercise.

SUGGESTION

Based on the results of this study, it is recommended that interventions *combining the Russian Current* with *the Quadriceps Bench Exercise* be considered a physiotherapy approach to improve functional walking in patients with knee osteoarthritis. For physiotherapists, the combination of electrotherapy and therapeutic exercise modalities can be an effective alternative therapy to increase muscle strength and improve knee joint stability. For further research, it is recommended to conduct studies with a larger sample size and to use a research design with a control group to obtain more comprehensive, more widely generalizable results. Furthermore, further research can also include other variables such as pain levels, patient quality of life, and long-term evaluation of the effectiveness of therapeutic interventions.

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