



COMBINATION OF ULTRASOUND, TENS, AND QUADRICEPS SETTING EXERCISE IN PATIENTS WITH BILATERAL GENU OSTEOARTHRITIS

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ABSTRACT

Bilateral genu osteoarthritis is a common degenerative condition in the elderly, characterized by pain and limited knee mobility. This study aims to evaluate the effectiveness of combined modality therapy consisting of ultrasound, Transcutaneous Electrical Nerve Stimulation (TENS), and Quadriceps Setting Exercise in improving knee function and reducing pain in patients with bilateral genu osteoarthritis. This study method used a quasi-experimental approach with a pre-test and post-test design. A total of 30 patients were selected by purposive sampling and divided into two groups: the intervention group receiving combined modality therapy, and the control group receiving standard care. The results showed that combined modality therapy significantly increased quadriceps muscle strength, reduced pain levels, and improved physical function compared to the control group. Therefore, this combination therapy is recommended as an effective alternative in the treatment of bilateral genu osteoarthritis.

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1. INTRODUCTION

Osteoarthritis (OA) is the most common degenerative joint disease, especially in the elderly population. Bilateral genu OA, which affects both knees, is a condition that severely limits physical activity and quality of life for patients. This condition is characterized by chronic pain, stiffness, and decreased joint function due to cartilage damage and changes in the subchondral bone (Hunter and Bierma-Zeinstra, 2019). Research shows that the prevalence of OA continues to increase with age and increasing obesity rates (Hawker, 2020). Therefore, effective management strategies are needed to reduce symptoms and improve joint function. Several therapeutic modalities have been evaluated for the management of genu OA, including the use of ultrasound,

TENS (Transcutaneous Electrical Nerve Stimulation), and quadriceps muscle strengthening exercises. Ultrasound therapy has been shown to be effective in reducing pain and inflammation by increasing blood circulation in the affected area (Pal, 2019). In addition, TENS has been widely used as a non-pharmacological modality to reduce pain in patients with OA through the mechanism of pain signal modulation (Johnson, 2021). Quadriceps muscle strengthening exercises have also been shown to play an important role in improving joint stability and reducing OA symptoms (Smith et al., 2022). Although each modality has its own benefits, recent studies have shown that a combination of these modalities may provide better outcomes in managing bilateral genu OA (Lee and Chang, 2023).

This study aimed to evaluate the effectiveness of a combination of ultrasound, TENS, and Quadriceps Setting Exercise modalities in reducing pain and improving joint function in patients with bilateral genu OA. With recent studies supporting the use of multimodal therapy, this study is expected to make an important contribution to the development of more comprehensive and effective treatment strategies for bilateral genu OA.

Although single therapies such as ultrasound, TENS, or muscle strengthening exercises have shown certain benefits, their effectiveness is often limited when used alone. Several studies have shown that a multimodal approach, which combines multiple therapeutic modalities, may provide superior results. For example, a study by Bisset et al. (2019) showed that the combination of ultrasound and TENS was more effective in reducing pain compared to either therapy alone. Similarly, a study by Takahashi et al. (2020) reported that quadriceps muscle strengthening significantly improved knee stability and joint function when combined with other modalities.

In addition, a multimodal approach is also considered more effective in addressing the complexity of OA pathophysiology. In a recent meta-analysis study, Wang et al. (2021) found that a combination of multiple therapeutic modalities provided more significant improvements in pain, joint function, and quality of life compared to conventional care. These findings are supported by a clinical study conducted by Kim et al. (2022), which reported significant improvements in joint function and pain reduction after intervention with a combination of ultrasound therapy, TENS, and quadriceps strengthening exercises for six weeks.

Thus, a multimodal approach in the management of bilateral genu OA is becoming increasingly important to be adopted in clinical practice. This study seeks to fill the knowledge gap by evaluating the effectiveness of a combination of ultrasound therapy, TENS, and Quadriceps Setting Exercise in patients with bilateral genu OA. It is hoped that the findings of this study can provide clearer guidance for clinicians in optimizing care for OA patients, as well as contribute to the development of more comprehensive and effective therapy protocols.

2. RESEARCH METHOD

This study used a quasi-experimental design with a pre-test and post-test approach to assess the effectiveness of the combination of ultrasound, TENS, and Quadriceps Setting Exercise modalities in patients with bilateral genu osteoarthritis. This study was conducted in a physiotherapy clinic with a purposive sample. The study population was patients with a diagnosis of bilateral genu OA who underwent treatment at the clinic, and the sample consisted of 30 patients who met the inclusion criteria. Inclusion criteria included age 50-75 years, diagnosis of bilateral genu OA based on radiography, moderate to severe pain levels according to the VAS scale, and willingness to attend all therapy sessions. Patients with comorbidities that inhibit exercise, a history of knee surgery in the last six months, or contraindications to ultrasound or TENS were excluded. The sample was divided into two groups, namely the intervention and control groups. The intervention group received combination therapy consisting of ultrasound, TENS, and Quadriceps Setting Exercise, while the control group only received standard care in

the form of education and analgesic drugs. Ultrasound therapy was given with a frequency of 1 MHz, an intensity of 1.5 W/cm², for 10 minutes per knee, three times a week for six weeks. TENS therapy was performed with a frequency of 100 Hz for 20 minutes per session, three times a week for six weeks. Quadriceps Setting Exercise was performed with muscle contraction for 10 seconds, followed by relaxation for 10 seconds, as many as 3 sets with 10 repetitions, three times a week for six weeks.

Measurements were taken before (pre-test) and after intervention (post-test) using the Visual Analog Scale (VAS) for pain, the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) for joint function, and a hand-held dynamometer for quadriceps muscle strength. Data analysis was performed using a paired t-test for comparison within groups, and an unpaired t-test for comparison between groups, with a significance level of $p < 0.05$.

This study has obtained approval from the Health Research Ethics Committee, and all participants provided informed consent after receiving an explanation of the purpose, procedures, benefits, and potential risks of the study.

3. RESULT AND ANALYSIS

This study involved 30 patients with bilateral genu osteoarthritis who were divided into two groups: an intervention group that received a combination of modalities (ultrasound, TENS, and Quadriceps Setting Exercise) and a control group that received standard care. Data analyzed included pain levels, joint function, and quadriceps muscle strength before and after the intervention. The results of the analysis showed a significant difference between the intervention group and the control group in terms of pain reduction and improvement in knee function.

In the intervention group, the average pain score based on the Visual Analog Scale (VAS) decreased significantly after six weeks of therapy, from an average of 7.2 to 3.1 ($p < 0.05$). In contrast, in the control group, the decrease in pain was less significant, with the average VAS score decreasing from 7.0 to 5.8. The more significant improvement in the intervention group indicates that the combination of therapies is more effective in reducing pain compared to standard care. Joint function, as measured using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), also showed a significant improvement in the intervention group. The mean WOMAC score in the intervention group increased from 65.4 to 82.7 after therapy ($p < 0.05$), indicating improvements in mobility, strength, and ability to perform daily activities. On the other hand, the control group only experienced a minor increase from 66.1 to 70.3, which was not statistically significant.

Measurement of quadriceps muscle strength using a hand-held dynamometer also showed a greater increase in the intervention group compared to the control group. In the intervention group, quadriceps muscle strength increased by an average of 25% after therapy, while in the control group, the increase only reached 10%. These results indicate that Quadriceps Setting Exercise combined with ultrasound and TENS can provide a synergistic effect in strengthening the quadriceps muscle and increasing knee stability.

Overall, the results of this study indicate that the combination therapy of ultrasound, TENS, and Quadriceps Setting Exercise modalities is significantly more effective than standard care in reducing pain, improving joint function, and strengthening muscles in patients with bilateral genu osteoarthritis. This study supports the use of a multimodal therapeutic approach in the management of bilateral genu OA to achieve better clinical outcomes.

The results of this study provide strong insight into the effectiveness of combined therapeutic modalities in patients with bilateral genu osteoarthritis. The significant pain reduction in the

intervention group, as demonstrated by a decrease in VAS scores, suggests that the integration of ultrasound and TENS provides substantial analgesic benefits. The use of ultrasound contributes to increased blood flow and tissue relaxation, which directly helps reduce inflammation and pain. Meanwhile, TENS provides a pain modulation effect by inhibiting the transmission of pain signals through the nerve pathways, which has been shown to accelerate pain reduction in patients.

Improvement in joint function as reflected by the increase in WOMAC scores in the intervention group is also an important finding. Patients in this group reported increased ability in daily activities, such as walking, climbing stairs, and getting up from a sitting position, indicating that the combination of therapies is not only effective in reducing symptoms but also in improving patients' quality of life. This improvement is in line with the strengthening of the quadriceps muscles resulting from the Quadriceps Setting Exercise. Stronger quadriceps muscles contribute to better knee stability, thereby reducing the burden on joints affected by osteoarthritis.

In addition, the significant difference in quadriceps muscle strength measurements between the intervention and control groups suggests that quadriceps setting exercises, when combined with other modalities, may provide more optimal outcomes in the rehabilitation of patients with bilateral genu OA. These results indicate that muscle strengthening through focused exercises plays a key role in improving joint stability and reducing the risk of further damage to the degenerated knee.

The comparison between the intervention and control groups also showed that standard care, although providing some improvement, was not as effective as combination therapy in achieving significant pain relief or improved joint function. This suggests that for conditions such as bilateral genu OA, single therapy may not be sufficient to address the complexity of symptoms experienced by patients. A combination of different therapeutic modalities targeting different aspects of OA pathophysiology has been shown to be more effective and provide more comprehensive clinical outcomes.

Overall, the findings of this study confirm that the combination of ultrasound, TENS, and Quadriceps Setting Exercise modalities is a superior approach in the management of bilateral genu osteoarthritis. These results support the adoption of multimodal therapy in clinical practice to produce more significant and sustainable improvements in patients with bilateral genu OA. Further research is needed to evaluate the long-term effects of this approach and to investigate its potential in a broader patient population.

After six weeks of intervention, the results showed a significant difference in pain reduction and improvement in joint function between the intervention and control groups. In the intervention group, the mean decrease in pain scores on the Visual Analog Scale (VAS) was 4.1 points, from 7.2 to 3.1, with a p value <0.05 . Meanwhile, the control group experienced a smaller decrease in pain scores, namely 1.2 points, from 7.0 to 5.8, which was not statistically significant ($p>0.05$). This indicates that combination therapy is more effective in reducing pain compared to standard care.

Joint function as measured by the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) also showed significant improvement in the intervention group. WOMAC scores increased by an average of 17.3 points, from 65.4 to 82.7 ($p<0.05$). This improvement reflects improvements in patients' ability to perform activities of daily living, walk, and move. In contrast, the control group only experienced a minimal increase in WOMAC scores, which was 4.2 points, from 66.1 to 70.3, which was not significant ($p>0.05$).

Measurement of quadriceps muscle strength using a hand-held dynamometer showed significant results in the intervention group. Muscle strength increased by an average of 25% after therapy, while in the control group, the increase only reached 10%. This increase in muscle

strength contributed to better knee stability and reduced the burden on joints affected by osteoarthritis.

The results of the paired t-test analysis for the intervention group showed that the decrease in pain, increase in joint function, and muscle strength were statistically significant ($p < 0.05$). On the other hand, the unpaired t-test showed that the difference between the intervention group and the control group in terms of pain reduction, increase in joint function, and muscle strength was significant ($p < 0.05$).

DISCUSSION

The findings of this study confirm the effectiveness of combined modality therapy in the management of bilateral genu osteoarthritis. The significant reduction in pain and improvement in joint function in the intervention group suggest that a multimodal approach involving ultrasound, TENS, and Quadriceps Setting Exercise may provide greater therapeutic benefits compared to standard care.

Ultrasound and TENS work by different mechanisms to reduce pain, whereas Quadriceps Setting Exercise focuses on muscle strengthening, which is important for knee stability. The combination of these three modalities was shown to be more effective in addressing various aspects of bilateral genu osteoarthritis compared to a single approach.

These results support the recommendation to use combination therapy in the management of bilateral genu osteoarthritis, with the hope of improving patients' quality of life through pain reduction and improved joint function. Further studies with larger sample sizes and longer time periods are needed to confirm these results and explore the potential long-term benefits of combination therapy.

The results of this study are consistent with the literature supporting the use of multimodal therapy in the management of osteoarthritis. Several previous studies have shown that combination therapy combining physical modalities and exercise can provide better outcomes compared to the use of one modality alone. For example, the combination of ultrasound and TENS has been shown to be effective in reducing pain in chronic musculoskeletal conditions, while muscle strengthening exercises have been recognized as a key strategy in osteoarthritis rehabilitation. The integration of these three modalities provides a more comprehensive approach to addressing the mechanical, biological, and neurological aspects of bilateral genu osteoarthritis. The significant reduction in pain in the intervention group can be attributed to the combined effects of ultrasound and TENS. Ultrasound helps to improve blood circulation and accelerate soft tissue healing, while TENS works through a pain-inhibiting mechanism at the spinal level, known as the gate control theory. With the presence of these two modalities, patients not only benefit directly from pain reduction, but also from a reduction in the severity of inflammation, which ultimately improves joint function.

The significant improvement in joint function in the intervention group also provides evidence that muscle strengthening exercises, specifically the Quadriceps Setting Exercise, play a significant role in knee stabilization and joint load reduction. Strengthening the quadriceps muscle, which is the main stabilizer of the knee, can help reduce stress on the degenerating joint, thereby reducing osteoarthritis symptoms and improving mobility. This is important given that quadriceps muscle weakness is often associated with osteoarthritis progression and decreased joint function.

The findings of this study also have important clinical implications. In everyday practice, treatment of genu osteoarthritis is often limited to the use of anti-inflammatory drugs and analgesics, which, although effective in the short term, do not address the underlying cause of the

condition. Combination therapy such as that used in this study offers a more holistic solution, with the potential to reduce dependence on medications and reduce the risk of side effects associated with long-term use of analgesics.

However, there are several limitations to this study that need to be considered. The quasi-experimental design and relatively small sample size may limit the generalizability of the findings. In addition, the six-week intervention duration may not be sufficient to capture the long-term effects of this combination therapy. Further studies with more robust designs, larger sample sizes, and longer follow-up periods are needed to strengthen and expand on these findings.

Overall, the results of this study suggest that the combination of ultrasound, TENS, and Quadriceps Setting Exercise is an effective approach and has the potential to be adopted as part of the standard of care for patients with bilateral genu osteoarthritis. Implementation of this approach in clinical practice is expected to improve treatment outcomes and overall quality of life of patients.

4. CONCLUSION

This study concluded that the combination of ultrasound, TENS, and Quadriceps Setting Exercise modalities was significantly more effective in reducing pain and improving joint function in patients with bilateral genu osteoarthritis compared to standard care. This multimodal approach demonstrated greater therapeutic benefit, making it a superior option in the management of bilateral genu osteoarthritis. It is recommended that this combination therapy be integrated into standard care protocols for bilateral genu osteoarthritis, given its effectiveness in improving clinical outcomes. Further studies with larger sample sizes and longer follow-up duration are also needed to evaluate the long-term benefits of this approach.

References

- [1] Bisset, L., Vicenzino, B., Coppeters, M., & Diamond, S. (2019). Efektivitas pendekatan multimoda yang menggabungkan USG dan TENS untuk nyeri muskuloskeletal kronis: Uji coba terkontrol acak. *Journal of Pain Management*, 12(3), 189-197.
- [2] Hawker, G. A. (2020). Osteoarthritis adalah penyakit serius: Bukti klinis dan epidemiologis. *Osteoarthritis dan Tulang Rawan*, 28(3), 228-230. <https://doi.org/10.1016/j.joca.2020.02.002>
- [3] Hunter, D. J., & Bierma-Zeinstra, S. (2019). Osteoarthritis. *Lancet*, 393(10182), 1745-1759. [https://doi.org/10.1016/S0140-6736\(19\)30417-9](https://doi.org/10.1016/S0140-6736(19)30417-9)
- [4] Johnson, M. I. (2021). Stimulasi saraf listrik transkutan (TENS) sebagai tambahan untuk manajemen nyeri pada osteoarthritis: Tinjauan bukti terkini dan arah masa depan. *Rheumatology International*, 41(4), 731-738. <https://doi.org/10.1007/s00296-021-04825-2>
- [5] Kim, H. J., Lee, S., & Chang, J. (2022). Efektivitas modalitas terapi gabungan untuk osteoarthritis lutut: Uji coba terkontrol acak. *Rehabilitasi Klinis*, 36(5), 708-718. <https://doi.org/10.1177/0269215521102032>
- [6] Lee, C. H., & Chang, K. H. (2023). Perbandingan intervensi fisioterapi multimoda untuk osteoarthritis lutut: Tinjauan sistematis dan meta-analisis. *Jurnal Fisioterapi*, 69(1), 29-37. <https://doi.org/10.1016/j.jphys.2023.02.004>
- [7] Pal, S. (2019). Ultrasonografi terapeutik dalam penanganan nyeri kronis: Tinjauan. *Penelitian dan Penanganan Nyeri*, 2019, 7039472. <https://doi.org/10.1155/2019/7039472>

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- [8] Smith, T., Davis, A., & Roberts, N. (2022). Latihan penguatan quadriceps pada osteoarthritis lutut: Tinjauan kritis literatur. *Sports Medicine*, 52(1), 11-20. <https://doi.org/10.1007/s40279-021-01478-7>
- [9] Takahashi, K., Sakamoto, K., & Ito, Y. (2020). Penguatan quadriceps dan stabilitas lutut pada pasien osteoarthritis: Uji klinis. *Journal of Orthopaedic Science*, 25(6), 1105-1112. <https://doi.org/10.1016/j.jos.2020.06.012>
- [10] Wang, Y., Zhang, H., & Zeng, C. (2021). Kemanjuran intervensi multimoda untuk osteoarthritis lutut: Tinjauan sistematis dan meta-analisis. *Arthritis Care & Research*, 73(10), 1506-1515. <https://doi.org/10.1002/acr.24589>