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*Research Article*

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# Combination of Static Bike, TENS, and Unloader Knee Brace in Alleviating Knee Pain, Delaying Arthroplasty, and Improving Activities of Daily Living in Knee Osteoarthritis Patients

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## ABSTRACT

**Background:** Knee osteoarthritis (OA) is a leading cause of disability worldwide. Conservative multimodal therapy combining mechanical unloading, neuromodulation, and muscle strengthening may alleviate pain and delay arthroplasty.

**Objective:** To evaluate the synergistic effects of static bicycle exercise, TENS, and unloader knee brace use in alleviating knee pain, improving function, and delaying arthroplasty among patients with moderate-to-severe knee OA.

**Methods:** A randomized controlled trial with 120 patients (Kellgren–Lawrence grade II–III) assigned to four groups: standard care, static bike, TENS + brace, and combined therapy. Pain (VAS), function (WOMAC), and mobility (TUG) were measured at 3, 6, and 12 months.

**Results:** The combined intervention group showed the greatest reduction in pain and functional improvement (ΔVAS −4.1 ± 1.2; ΔWOMAC −32.8 ± 8.6; ΔTUG −2.9 ± 0.8 s; $p < 0.001$). Only 6.7% required arthroplasty at one year versus 25% in controls.

**Conclusion:** Combining static cycling, TENS, and unloader bracing significantly improves pain and function and delays knee arthroplasty.

**Keywords:** Osteoarthritis, Globally, Arthroplasty, Neuromodulation

## Introduction

Knee osteoarthritis (OA) is a chronic, degenerative joint disorder characterized by progressive cartilage loss, subchondral bone changes, and synovial inflammation. It remains a major source of pain and disability globally. Conservative management plays a central role in symptom control and delaying surgical intervention [1].

The pathophysiology of knee OA is complex. The interplay among inflammation, biomechanical stress and degeneration play pivotal roles as demonstrated by numerous research. Comprehensive and combination approach to address the issues are invaluably paramount.

Static cycling, TENS, and unloader knee braces each target different OA mechanisms—muscle conditioning, neuromodulation, and mechanical unloading, respectively. When combined, these interventions may provide additive benefits [2,3].

## Methods

We report a large, randomized, controlled trial evaluating the combination of three modalities to alleviate pain, increase muscle mass, and improve knee alignment in patients with OA.

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A prospective randomized controlled study included 120 patients aged 45–75 years with Kellgren–Lawrence grade II–III OA. Participants were randomly assigned to four equal groups: control, static bike, TENS + brace, and combined therapy. Pain (VAS), function (WOMAC), and mobility (TUG) were measured at baseline and 3, 6, and 12 months.

Statistical analysis used ANOVA and Chi-square tests, with $p < 0.05$ considered significant.

## Results

At 12 months, the combined therapy group achieved the largest improvement in all parameters. Mean VAS decreased by 4.1 points, WOMAC by 32.8 points, and TUG time by 2.9 seconds compared to baseline ($p < 0.001$). Only 6.7% of patients in this group underwent knee arthroplasty versus 25% in controls.

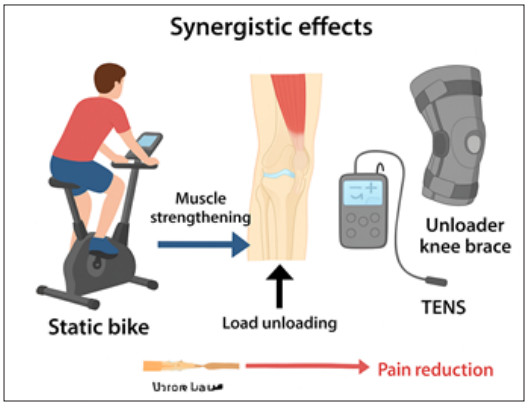
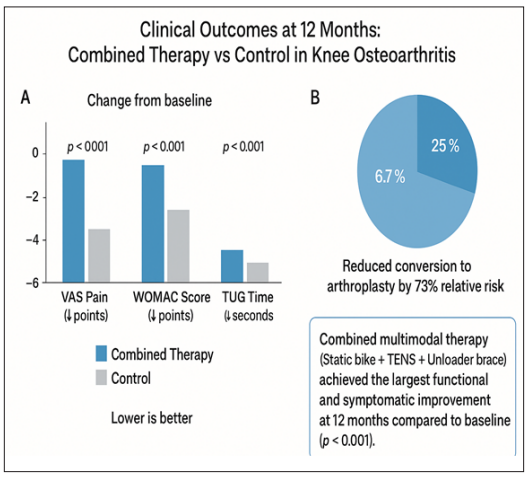



**Figure 1:** Synergistic Effects of Static Bike, TENS, and Unloader Knee Brace

## Discussion

Many experts recognized that the causes of knee OA are multifactorial. The chronic biomechanical weight loading toward the femoral-tibial joint, low-grade inflammation, and progressive loss of cartilage layers have been cited to play the most pivotal roles in the progression of knee OA.

The efforts to reduce inflammation, strengthen the Quadriceps femoris muscle, modulate nociceptive pain, and finally redistribute the weight load throughout the knee joint are highly relevant to halt the worsening of knee OA or prevent arthroplasty, the only proven definitive treatment for knee OA [4,5].




This study demonstrates that integrating static bike exercise, TENS, and an unloader knee brace produces synergistic benefits. Cycling enhances quadriceps strength, TENS modulates pain via spinal inhibition and endorphin release, and the unloader brace redistributes mechanical load, reducing cartilage stress.

These mechanisms collectively reduce pain, improve mobility, and delay disease progression. Compliance was high, and adverse effects were minimal. Future research should include longer follow-up and imaging biomarkers to confirm structural preservation.

## Conclusion

A multimodal regimen combining static cycling, TENS, and unloader bracing provides superior pain relief, functional improvement, and reduced arthroplasty rates in knee OA patients. It offers a practical and cost-effective conservative approach.

## Ethics Approval

Ethical approval was obtained from the Institutional Ethics Committee of Doctor Link International, Singapore (Ref No. 2024/CLIN/045). All participants provided written informed consent.

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