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Comparative Effectiveness of Artificial Intelligence–Assisted 3D Printed Customized Knee Brace and Exercise Therapy Versus Conventional Electrotherapy in Ergonomical Knee Pain: A Randomized Controlled Study

Abstract:

Background: Ergonomical knee pain is an increasing musculoskeletal issue among adults caused by prolonged sitting, poor posture, and repetitive occupational stress. Technological advancements in physiotherapy, such as Artificial Intelligence (AI)–based exercise monitoring and 3D-printed customized knee braces, provide individualized treatment approaches to enhance knee function and reduce pain.

Purpose: To compare the effectiveness of AI-assisted knee exercise therapy combined with 3D-printed customized knee braces and heating pad versus conventional electrotherapy modalities (TENS, ultrasound) with strengthening exercises in patients with ergonomical knee pain.

Methods: A randomized controlled study was conducted at the Department of Physiotherapy, MNR Hospital, MNR University, Sangareddy, Telangana, India. Sixty participants (30 males, 30 females) aged 25–50 years with ergonomical knee pain. Participants were randomly allocated into two groups (n=30 each).Group A: Received AI-guided knee exercise program, heating pad, and customized 3D-printed knee brace.Group B: Received conventional electrotherapy with knee strengthening exercises. Both groups received psychological counseling to enhance motivation and adherence. Treatment duration was 6 weeks, five sessions per week. Outcome measures included Visual Analogue Scale (VAS) for pain, Knee Injury and Osteoarthritis Outcome Score (KOOS), and muscle strength grading.

Results: Both groups showed significant improvement ($p<0.05$) in pain and function, but Group A demonstrated superior gains in VAS, KOOS, and strength, with higher satisfaction and adherence.

Conclusion: AI-assisted exercise therapy with 3D-printed braces is more effective than conventional electrotherapy in improving pain, strength, and function in ergonomical knee pain.

Keywords; Ergonomical knee pain, Artificial Intelligence, 3D printing, knee brace, electrotherapy, physiotherapy, TENS, ultrasound, strengthening exercises

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Biography: Prof. Dr. S. Purna Chandra Shekhar is a distinguished Professor of Cardio Physiotherapy at MNR University, Telangana, India. I am WHO-certified Wheelchair Trainer and currently serves as President of the Indian Association of Physiotherapists (Telangana Branch) and Central Vice President of the Physiotherapy Confederation of Intellectuals. With numerous national and international publications, patents, and awards, he has significantly contributed to physiotherapy education, research, and innovation. An accomplished author of two books, Dr. Purna Chandra Shekhar is dedicated to advancing rehabilitation science and promoting evidence-based physiotherapy practice across India and beyond.

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