Innovations

Dynamic Exercise Programs for Osteoarthritis: From Pain Management to Performance on Pain and Function – A Case Study

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Abstract

Background: *Knee osteoarthritis (OA) is a chronic degenerative joint disease causing pain, stiffness, and functional impairment globally. Physiotherapy, particularly exercise therapy, is a cornerstone in OA management.* ***Objective:*** *To evaluate the impact of a dynamic exercise program on pain and functional outcomes in a patient with knee OA, assessed through the Numeric Pain Rating Scale (NPRS) and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC).* ***Methods:*** *A single 55-year-old female patient with radiographic Grade II knee OA underwent an 8-week phase-based dynamic exercise program.* ***Results:*** *The patient demonstrated a substantial reduction in pain (NPRS from 6/10 to 2/10) and functional disability (WOMAC from 46/100 to 27/100).* ***Conclusion:*** *Structured dynamic exercise programs significantly improve pain and function in knee OA, supporting their inclusion in routine physiotherapy care.*

Introduction

The most common type of arthritis and a major contributor to disability globally is osteoarthritis (OA). With an estimated global prevalence of symptomatic knee OA ranging from 3.8% to over 15% in persons aged 60 and older, with differences among populations, the knee joint is one of the most frequently affected sites. (Cross et al., 2014; Vos et al., 2018). About 14 million people in the US alone suffer from symptomatic knee OA, which significantly increases the financial and medical costs. (Murphy & Helmick, 2012).

The pathogenesis of OA includes periarticular muscle weakening, subchondral bone remodeling, synovial inflammation, and gradual cartilage

deterioration, all of which lead to discomfort and functional impairment. (Loeser, Goldring, Scanzello, & Goldring, 2012). Due to inactivity, these impairments lower quality of life and mobility while raising the risk of comorbidities like obesity and cardiovascular disease.(Iversen, Fossel, & Katz, 2002).

Exercise therapy is emphasized as the main non-pharmacologic treatment for OA in current clinical guidelines. Exercise strengthens periarticular muscles, increases joint mobility, lessens discomfort, and improves physical function. (McAlindon & Hinman, 2011; Kolasinski et al., 2020). Even though there is a lot of evidence to support exercise, research is still ongoing to determine the best modalities, dosage, and progression methods, especially for dynamic, phase-based programs catered to the needs of specific patients. (Fernandes et al., 2013).This case study investigates the effect of an 8-week structured dynamic exercise program on knee OA pain and function, as measured by NPRS and WOMAC, in a single patient.

Patient Profile

The patient was a 55-year-old female diagnosed with Grade II knee osteoarthritis based on Kellgren-Lawrence radiographic criteria. She reported a two-year history of persistent right knee pain worsened by stair climbing, prolonged standing, and walking. The pain was a dull ache with occasional sharp episodes and associated morning stiffness. Her medical history was unremarkable, with no comorbidities, and she used paracetamol occasionally with limited relief. Prior to intervention, she led a sedentary lifestyle due to knee discomfort, which impacted her daily activities and mobility. She also experienced occasional knee swelling and instability, contributing to reduced activity levels. Consent was procured before treatment session.

Outcome Measures

- **NPRS:** Validated for pain intensity measurement in OA with a minimal clinically important difference (MCID) of 2 points (Salaffi, Stancati, Silvestri, Ciapetti, & Grassi, 2004; Farrar et al., 2001).
- **WOMAC:** Widely used self-administered questionnaire measuring pain, stiffness, and physical function; MCID ranges from 12% to 22% improvement (Bellamy, Buchanan, Goldsmith, Campbell, & Stitt, 1988; Angst, Aeschlimann, & Stucki, 2001).

Outcome Measure	Baseline	Week 8	Change & Clinical Significance
NPRS (0-10)	6	2	↓ 4 points (Clinically significant)
WOMAC (0-100)	46	27	↓ 19 points (41% improvement; clinically meaningful)

Intervention

The patient followed a **progressive 8-week dynamic exercise protocol** incorporating phases focused on pain relief, muscle strengthening, and functional performance.

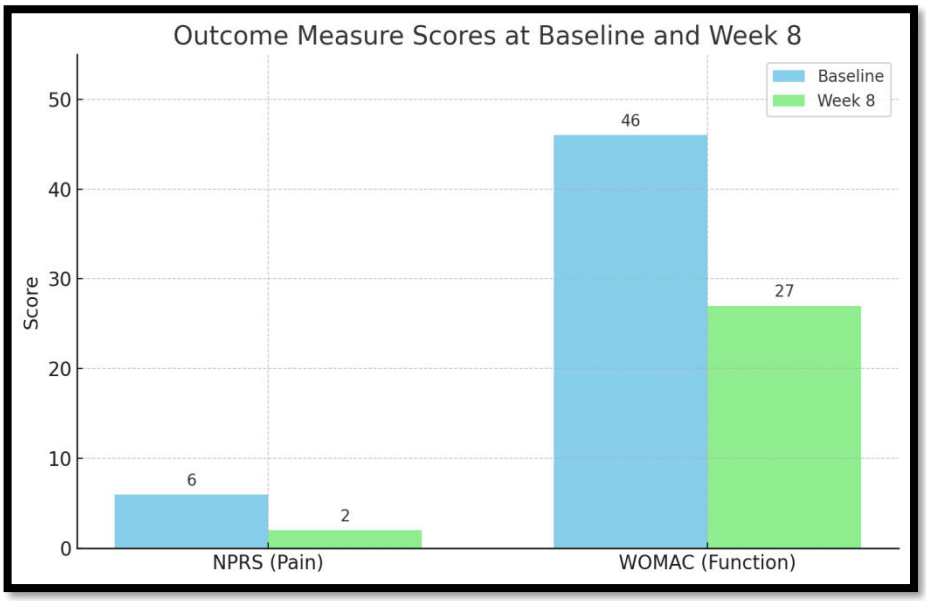
- **Phase 1 (Weeks 1–2):** Pain management and muscle activation with low-impact, isometric, and range-of-motion exercises (Bennell & Hinman, 2011).
- **Phase 2 (Weeks 3–5):** Strength training emphasizing quadriceps and hip musculature with resistance bands and bodyweight functional movements (Øiestad, Juhl, Eitzen, & Thorlund, 2015).
- **Phase 3 (Weeks 6–8):** Advanced endurance and neuromuscular training including balance exercises and aerobic walking (Hughes, Paton, Rosenblatt, Gissane, & Patterson, 2017; Loenneke, Wilson, Wilson, et al., 2012).

Results:

Following the 8-week dynamic exercise program, the patient exhibited notable improvements in both pain intensity and functional ability. The Numerical Pain Rating Scale (NPRS) score decreased substantially from 6 at baseline to 2 at Week 8, reflecting a clinically significant reduction of 4 points. Likewise, the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) score improved from 46 to 27, amounting to a 41% reduction in symptoms and functional limitations, which is considered a clinically meaningful improvement.

These outcome changes indicate a significant positive effect of the dynamic exercise intervention on the patient's osteoarthritis symptoms. Figure 1 graphically depicts the reduction in pain and enhancement in function over the treatment period.

Figure 1. Changes in NPRS and WOMAC scores from baseline to Week 8, demonstrating clinically significant improvements in pain and function



Discussion

This case study highlights the positive impact of a structured dynamic exercise program on pain reduction and functional improvement in a patient with moderate knee osteoarthritis. The observed improvements in NPRS and WOMAC scores exceeded the established minimal clinically important differences, reflecting meaningful clinical benefit (Angst, Aeschlimann, & Stucki, 2001; Farrar et al., 2001). These findings align with a robust body of evidence supporting exercise therapy as a cornerstone intervention for knee OA (Fransen et al., 2015; Kolasinski et al., 2020).

This program's dynamic, staged approach—which starts with muscle activation and pain alleviation, moves on to strength training, and ends with endurance and neuromuscular exercises—seems to be crucial for improving results and promoting patient adherence. Early stages that emphasize low-load isometric exercises aid in pain management and joint stress reduction, which is essential for preventing symptom exacerbation and promoting participation. (Bennell & Hinman, 2011). Targeting the quadriceps and hip musculature, which are critical for knee joint function and the mitigation of mechanical stress on articular cartilage, progressive loading in later phases encourages muscular hypertrophy and enhanced joint stability. (Øiestad et al., 2015; Roos & Arden, 2016).

Crucially, the WOMAC-measured gains in function resulted in noticeable advantages for the patient's everyday activities, including stair climbing and extended walking, which are frequently the main restrictions faced by people with knee OA. (Murphy & Helmick, 2012). In addition to improving quality of life, improved physical function may also promote higher levels of general exercise,

which could reduce the risk of comorbidities associated with OA, such as obesity and cardiovascular disease. (Iversen et al., 2002).

Notwithstanding the favorable results, it is critical to recognize the inherent limits of case studies with a single patient. Results should be interpreted cautiously due to the lack of a control group and the inability to generalize them. Furthermore, no long-term follow-up was done to evaluate how sustainable the advantages were. To determine standardized procedures, the ideal exercise dosage, and the long-term effectiveness of BFRT and dynamic phased exercise programs in the treatment of knee OA, more studies with bigger cohorts and randomized controlled trials are required.

All things considered, this case emphasizes how important customized, research-based exercise regimens are to the rehabilitation of OA. To optimize patient outcomes, clinicians should think about incorporating dynamic, progressive, and multimodal exercise therapies, customizing programs to meet patients' functional goals and tolerance.

Conclusion

A structured, phase-based dynamic exercise program led to clinically significant improvements in pain and function in a patient with moderate knee osteoarthritis. This case supports the integration of individualized, dynamic exercise protocols into routine OA management. Further studies are needed to confirm these findings and establish standardized guidelines.

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