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Case Report

A dynamic balance exercises programme to improve functional outcomes after total knee replacement in bilateral osteoarthritis knee: a case report

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ABSTRACT

Osteoarthritis (OA) of the knee is a progressive degenerative joint disorder commonly affecting older adults, leading to pain, stiffness, reduced range of motion, and limitations in daily activities. When conservative management fails to provide adequate relief, total knee replacement (TKR) is frequently performed to alleviate pain and restore functional mobility. Despite surgical intervention, patients often experience postoperative challenges such as muscle weakness, impaired proprioception, and decreased balance, which may limit functional recovery. Dynamic balance, defined as the ability to maintain postural stability during movement, plays a critical role in safe ambulation and performance of daily tasks. The present case study aimed to evaluate the effect of a structured dynamic balance exercise program on functional outcomes following TKR in a patient with bilateral knee osteoarthritis. A review of relevant literature was conducted using electronic databases including MEDLINE, PubMed, and Google Scholar to establish the theoretical basis for the intervention. The rehabilitation program incorporated dynamic balance training along with conventional physiotherapy exercises over a defined treatment period. Functional outcomes were assessed before and after the intervention using standardized clinical measures. Post-intervention findings demonstrated noticeable improvements in balance performance, mobility, and overall functional independence. The results suggest that integrating dynamic balance exercises into postoperative rehabilitation may enhance functional recovery in patients undergoing TKR for bilateral knee osteoarthritis. Further research with larger sample sizes is recommended to support these findings.

Keywords: Osteoarthritis, Total knee replacement, Dynamic balance, Bilateral knee, Functional outcome

INTRODUCTION

Osteoarthritis (OA) is a chronic degenerative joint disorder characterized by progressive deterioration of articular cartilage along with inflammation of the synovial membrane. The World Health Organization (WHO) recognizes OA as one of the leading musculoskeletal conditions contributing to disability worldwide.[1] Individuals affected by OA often experience persistent joint pain, which significantly interferes with daily activities and overall quality of life.[2,3] OA is broadly classified into two types: primary OA, which develops without a clear underlying cause, and secondary OA, which occurs as a result of trauma, metabolic disorders, or other predisposing conditions.[3]

Common clinical manifestations of knee osteoarthritis include pain, stiffness, reduced range of motion, functional limitations, proprioceptive deficits, bony enlargement, and joint swelling.[2,3] Several risk factors have been associated with the development of knee OA, such as advancing age, genetic predisposition, previous joint injury, obesity, and demographic influences.[2,3] The condition affects both men and women equally before the age of 45; however, its prevalence increases among women after midlife.[4] According to WHO statistics, the global prevalence of OA

is approximately 9.6% in men and 18% in women over the age of 60.[5] Radiographic severity of OA is commonly assessed using the Kellgren–Lawrence grading scale, which ranges from grade 0 to grade 4 and evaluates features such as osteophyte formation, joint space narrowing, and subchondral sclerosis.[5]

When conservative management fails to provide adequate pain relief, total knee replacement (TKR) is frequently recommended for individuals with advanced osteoarthritis.[4,5] The primary goals of TKR are to relieve pain, restore joint function, and improve independence in daily activities.[6] The procedure involves removal of damaged cartilage and a portion of the underlying bone from the femur, tibia, and patella, followed by replacement with prosthetic components.[6] Early postoperative rehabilitation, including isometric and knee range-of-motion exercises, is essential to prevent complications and promote recovery.[6] Potential complications associated with TKR include deep vein thrombosis, pulmonary embolism, infection, and neurovascular injury. Risk of infection may be higher in individuals with obesity, diabetes, or malnutrition.[7] Prosthetic implants are broadly categorized as cemented or cementless types.[7]

Total knee arthroplasty (TKA) can be performed using conventional manual techniques or robotic-assisted systems. Robotic-assisted TKA has been shown to improve implant positioning accuracy and reduce alignment errors when compared to conventional methods.[8]

Balance is defined as the ability to maintain the body's center of gravity within its base of support.[9] Static balance refers to maintaining stability in a stationary position, while dynamic balance involves maintaining postural control during movement. Dynamic balance plays a vital role in functional mobility and safe ambulation. Research indicates that individuals who have undergone TKR often demonstrate reduced balance performance compared to those rehabilitation programs may enhance functional recovery. Such training includes activities that simulate real-life movements, such as turning, stopping, walking on uneven surfaces, changing speed and direction, and tandem walking.[10,11]

Improving dynamic balance may therefore contribute significantly to better functional outcomes following TKR in individuals with bilateral knee OA.

CASE REPORT

A 61-year-old female patient experienced a fall on both knees, resulting in pain in both joints. She later reported more severe pain along the medial aspect of the right knee compared to the left, especially while climbing up and down stairs. Over time, the pain progressively worsened in the medial regions of both knees and eventually became unbearable. Due to the severity of the pain, she developed a waddling gait while walking. In 2024, she consults with an orthopaedic surgeon. An X-ray examination revealed grade 3 OA in both knees. She subsequently underwent bilateral conventional manual total knee replacement surgery on 29 June 2024. On assessment patient complained of difficulty in walking due to pulling pain around the knee joint which was insidious in nature, NPRS was 7/10 on 04 July 2024. Pain aggravated during knees bending and after exercises. On observation it was noted that Z dressing was present on bilateral knee. On palpation grade 1 pitting edema was present on lateral aspect of B/L ankle, warmth was present around the B/L knee joint and grade 2 tenderness was also present over the left knee while grade 3 over the right knee.

On examination active, passive ROM for knee joint are shown in Table 1, active ROM for hip joint shown in Table 2 and for ankle joint shown in Table 3. Muscle girth measurement shown in Table 4 and limb length discrepancy shown in Table 5.

Intervention

This study took place at participant's home. Patient consent was obtained before starting the intervention. The study lasted for 4 weeks (Table 6).

Table 1: Active, passive ROM for knee joint.

Knee joint movement	On assessment active range of motion (04 July)		On assessment passive range of motion (04 July)		After 4 weeks active ROM (04 August)		After 4 weeks passive ROM (04 August)	
	RT	LT	RT	LT	RT	LT	RT	LT
Flexion	0 0-60	0 0-67	0 0-65	0 0-73	$0\text{-}115^0$	$0\text{-}118^0$	$0\text{-}120^0$	$0\text{-}120^0$
Extension	0 60-0	0 67-0	0 65-0	0 73-0	115^0	$118^0\text{-}0$	$120^0\text{-}0$	$0\text{-}12^0$

Table 2: Active ROM for hip joint.

Joint	On assessment active ROM (04 July)		After 4 weeks active ROM (04 August)	
Hip joint	**RT**	**LT**	**RT**	**LT**
flexion	$0\text{-}105^0$	$0\text{-}110^0$	$0\text{-}117^0$	$0\text{-}119^0$
Extension	-	-		

Continued.

Joint	On assessment active ROM (04 July)		After 4 weeks active ROM (04 August)	
Abduction	$0\text{-}35^0$	$0\text{-}40^0$	$0\text{-}42^0$	$0\text{-}45^0$
Adduction	$35^0\text{-}0$	$40^0\text{-}0$	$42^0\text{-}0$	$45^0\text{-}0$
Internal rotation	$0\text{-}20^0$	$0\text{-}25^0$	$0\text{-}30^0$	$0\text{-}34^0$
External rotation	$0\text{-}21^0$	$0\text{-}27^0$	$0\text{-}43^0$	$0\text{-}44^0$

Table 3: Active ROM for ankle joint.

Ankle joint movement	On assessment active ROM (04 July)		After 4 weeks active ROM (04 August)	
	RT	**LT**	**RT**	**LT**
Dorsiflexion	$0\text{-}17^0$	$0\text{-}16^0$	$0\text{-}19^0$	$0\text{-}19^0$
Plantarflexion	$0\text{-}20^0$	$0\text{-}25^0$	$0\text{-}34^0$	$0\text{-}36^0$
Inversion	$0\text{-}15^0$	$0\text{-}16^0$	$0\text{-}17^0$	$0\text{-}119^0$
Eversion	$0\text{-}12^0$	$0\text{-}15^0$	$0\text{-}115^0$	$0\text{-}118^0$

Table 4: Muscle girth measurement.

Lower limb	Right (cm)	Left (cm)	Differences (cm)
15 cm above knee cap (thigh)	21	20	1
10 cm below knee cap (calf)	14	13.5	1.5

Table 5: Limb length discrepancy.

Limb length	Right (cm)	Left (cm)
True limb length	35.5	35
Apparent limb length	41.5	40.5
Segmental limb length		
ASIS – greater trochanter	4	3.5
Greater trochanter – lateral knee joint	41	40.5
Late bilateral knee joint – medial malleoli	39.5	38.5

Table 6: Intervention.

Weeks	General exercise	Balance exercise
0-1	Ankle pump 20 repetition, quadriceps isometric 5 sets × 5 repetitions, Hamstring isometric 5 sets × 5 rep, supine SLR upto 450 with maximal support 10 repetition, heel slide 5 repetition, dynamic quadriceps 3 sets × 5 repetition, cryotherapy for 4minutes around knee joint	Ambulation with walker
1-2	Ankle pump 20 reps, quadriceps isometric 5 sets × 10 times hold, Hamstring isometric 5 sets ×10 times hold, supine SLR upto 450 with minimal support 5 sets × 5 repetition, heel slide 10 reps, dynamic quadriceps 5 sets × 5 times hold	Walking with assistance, sitting to standing 10 repetition, single leg raise 3 sets × 5 times hold
2-3	Quadriceps isometric 5 sets × 10 times hold, Hamstring isometric 5 sets × 10 times hold, supine SLR upto 450 5 sets × 10 times hold, hip abduction upto 450 5 sets × 5 times hold, heel slide 10 repetition, dynamic quadriceps 5 sets × 10 times hold	Sitting to standing 10 repetitions, single leg raises 3 sets × 5 sec hold, stair climbing 8 steps, tandem walking 15 steps, turning in a circle 10 repetition

A 61-year-old patient with osteoarthritis of both knees underwent bilateral total knee replacement (B/L TKR). After surgery, the patient received routine physiotherapy along with dynamic balance exercises to improve functional outcomes.

The pre-test assessment was conducted on 4th July, and the post-test assessment was completed on 4th August after four weeks. Range of motion (ROM) of the hip, knee, and ankle joints was measured during both assessments and is presented in Tables 1-3. Girth measurement and limb length discrepancy were recorded on 04 July and are shown in Tables 4 and 5, respectively.

Dynamic balance exercises were not performed during the early pre-rehabilitation phase due to severe pain following bilateral TKR. After two weeks, exercises such as sit-to-stand and single leg raise were initiated. At three weeks, the program included sit-to-stand, single leg raise, stair climbing, tandem walking, and turning in a circle. By the

fourth week, the exercises were further progressed to include sit-to-stand, single leg raise, stair climbing, tandem walking, walking on different surfaces, and turning in a circle with progression.

The comparison of pre- and post-assessment results of ROM and functional outcomes showed improvement after four weeks of treatment.

DISCUSSION

This case study examined the effects of a structured dynamic balance exercise programme on functional outcomes following TKR in a patient with bilateral knee OA. TKR is widely recognized as an effective surgical intervention for end-stage osteoarthritis, particularly when conservative management fails. However, despite successful surgical outcomes, many individuals continue to experience deficits in balance, proprioception, muscle strength, and functional mobility. The findings of this case study suggest that incorporating a dynamic balance training programme into post-operative rehabilitation significantly enhance functional recovery.

Dynamic balance exercises aim to challenge the body's center of gravity during movement, thereby enhancing proprioceptive feedback, postural control, and coordinated muscle activation. In this case, the progressive balance tasks such as stair climbing, tandem walking, turning in a circle — likely stimulated mechanoreceptors around the joint and improved sensorimotor integration. These adaptations improve overall functional independence.

The improvements seen in this case are consistent with the principles of motor learning and task-specific training. Functional activities require coordinated activation of multiple muscle groups in dynamic environments. By training the patient in controlled but progressively challenging balance conditions, the intervention may have enhanced neuromuscular efficiency and confidence during daily activities. Additionally, improved quadriceps activation and lower limb stability likely contributed to better shock absorption and weight transfer during ambulation.

Chhabr et al reported that knee joint proprioception is the body's ability to perceive the position and movement of the knee through neural signals generated by mechanoreceptors located in the joint capsule, ligaments, muscles, tendons, and surrounding tissues. These sensory inputs are processed by the central nervous system to regulate muscle activation, maintain joint stability, and support coordinated movement.[4]

Al-Khlafat et al reported that exercise programme was effective in improving dynamic balance in patients with knee OA.[13]

Takacs et al reported that significant improvement in self-reported knee pain, physical function, and fear of movement.[12]

Despite these positive findings, certain limitations are present. As a single case study, the results cannot be generalized to all individuals undergoing bilateral TKR. Variations in age, comorbidities, surgical technique, prosthesis type, and adherence to home exercise programmes may influence outcomes. Additionally, the absence of a control comparison limits the ability to attribute improvements solely to the dynamic balance intervention. Natural post-operative recovery and concurrent physiotherapy interventions may also have contributed to the observed progress.

Future research should involve randomized controlled trials with larger sample sizes to establish the efficacy of dynamic balance training as a standard component of post-TKR rehabilitation protocols. Long-term follow-up studies would also help determine whether these functional improvements are sustained over time and whether fall risk is significantly reduced.

In conclusion, this case study highlights the potential benefits of incorporating dynamic balance exercises into rehabilitation following total knee replacement in individuals with bilateral knee osteoarthritis. The programme appeared to improve functional mobility, balance, contributing to enhanced overall functional outcomes. Integrating dynamic balance training into conventional physiotherapy may therefore represent a valuable strategy in optimizing post-operative recovery after TKR.

Limitations

The study has been conducted on small size sample only. Duration of the study was less (4 weeks).

CONCLUSION

We used dynamic balance exercise programme to improve functional outcome who underwent TKR. These results demonstrate that dynamic balance exercise programs are effective in early rehabilitation after TKR.

Recommendations

Further study can be done with larger sample size. Long duration of the study must be carried out for more reliability and validity.

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