FAST TRACK VERSUS STANDARD REHABILITATION PROTOCOL AFTER TOTAL KNEE REPLACEMENT

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Abstract

Background: Total knee replacement (TKR) is a widely performed procedure for individuals suffering from end-stage knee osteoarthritis. Two primary rehabilitation approaches are employed, Fast Track Rehabilitation Protocol (FTRP) and Standard Rehabilitation Protocol (SRP).

Objective: This study aimed to compare effects of FTRP versus SRP on gait spatiotemporal parameters, functional outcomes, and knee scoring systems in patients having total knee replacement.

Methods: This randomized controlled trial was conducted involving 60 patients undergoing primary unilateral TKR. Patients were randomized into either the Fast Track Rehabilitation Group (n=30) or the Standard Rehabilitation Group (n=30). Functional and gait outcomes were assessed using gait spatiotemporal parameters (velocity, cadence, stride length, step length, swing time, and stance time) measured via Kinovea software, Western Ontario and McMaster University Osteoarthritis Index (WOMAC) as well as Knee Society Score (KSS) for objective functional assessment. Assessments were conducted preoperatively, at 3 months, 6 months, in addition to 12 months postoperatively.

Results: At three months, Fast Track group showed significantly greater stride length (p=0.000) and gait velocity (p=0.002) than Standard group. The Fast Track group demonstrated significantly lower WOMAC scores, indicating better function, at three and six months (p=0.008, p=0.000). Both groups exhibited progressive improvement in Knee Society Score (KSS) over time, with no significant differences among groups at any time point ($p > 0.05$). At twelve months, both groups showed similar improvements, confirming that SRP achieved comparable outcomes over time.

Conclusion: While both Fast Track and Standard Rehabilitation Protocols effectively improve gait, functional capacity, and knee function within twelve months post-TKR, Fast Track Rehabilitation provides earlier improvements in mobility, pain reduction, and gait efficiency within the first three to six months. However, by one year postoperatively, both approaches result in comparable functional outcomes, suggesting that rehabilitation strategies should be tailored based on individual patient needs, tolerance, and preferences.

Keywords: Total Knee Replacement, Fast Track Rehabilitation, Standard Rehabilitation, Knee Osteoarthritis, WOMAC, Knee Society Score

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Introduction

Osteoarthritis (OA) is a common degenerative joint disease that impacts millions of individuals globally, with the knee joint being the most frequently affected joint. This condition is marked by the gradual deterioration and loss of articular cartilage, resulting in pain, stiffness, and functional limitations. The pathophysiology of knee OA involves a complex interplay of mechanical stress, inflammatory processes, and biochemical alterations that contribute to joint deterioration. As a consequence, patients often experience a decline in mobility and quality of life, necessitating medical and surgical interventions [1].

Epidemiological estimates indicate that the annual incidence of symptomatic knee OA is approximately 240 cases per 100,000 individuals. Given the substantial disease burden, total knee arthroplasty (TKA) has emerged as a widely adopted surgical intervention. In the United States alone, approximately 400,000 primary TKA procedures are performed annually, with primary OA being the leading clinical indication for surgery. However, TKA may also be warranted for other underlying conditions, including inflammatory arthritis, post-traumatic OA resulting from fractures or deformities, congenital dysplasia, and, in rare cases, malignancy. These conditions, though less common, may necessitate surgical correction to restore joint function and alleviate pain [2].

Total knee arthroplasty is recognized as among the most cost-effective and reliable orthopedic procedures, consistently demonstrating high success rates. Patient-reported outcomes indicate significant improvements in pain, functional capacity, in addition to overall quality of life following the surgery. Particularly for patients with end-stage, tri-compartmental, degenerative OA, TKA offers a dependable solution for restoring mobility and independence. The success of the procedure is attributed to advancements in implant design, surgical techniques, and postoperative rehabilitation, which collectively contribute to enhanced long-term outcomes [1].

Although comprehensive national databases exist for TKA in countries such as the United States, there is a notable lack of accurate epidemiological data regarding the number of TKA procedures performed in Egypt. The number of TKA surgeries is anticipated to reach approximately 3.48 million per year by 2030, according to US projections, which represents an exponential growth of about 601% from 2005 [3].

One of the key advancements in postoperative rehabilitation is the implementation of fast-track arthroplasty programs. These programs integrate evidence-based clinical strategies with optimized healthcare delivery models to enhance recovery, reduce perioperative morbidity and mortality, and facilitate early functional milestones. Fast-track rehabilitation protocols have been shown to contribute to shorter hospital stays and a reduced likelihood of readmissions when compared to conventional rehabilitation approaches that lack a structured optimization strategy. By focusing on early mobilization, pain management, and patient education, fast-track protocols aim to expedite recovery and improve long-term functional outcomes [4].

Various studies have advised the application of fast-track rehabilitation protocols instead of standard rehabilitation without strict patient pre-selection. In this study, we aim to systematically investigate the differences between fast-track and standard rehabilitation protocols in terms of functional outcomes after TKA. So, the purpose of the current study was to evaluate the differences in patients' gait spatio-temporal parameters, functional outcomes and knee scoring system between fast-track rehabilitation and standard rehabilitation.

Patients and methods

This study was conducted to measure the difference between fast-track rehabilitation and standard rehabilitation in terms of patients' functional outcomes and knee scoring. This study was conducted in the period from Jan 2020 to Augst 2024. Sixty patients with TKR were included in this study. Gait spatiotemporal parameters (velocity, cadence, stride length, step length, swing time and stance time) and lower extremity kinematics were measured using Kinovea Software preoperatively, three, 6 months along with one-year post operatively.

WOMAC and KSS were used pre operatively to categorize patients into high score and low score groups. Each group will be subdivided to, fast-track protocol group and standard rehabilitation group. Then, WOMAC and KSS were reassessed for three, 6 months and one-year post operatively.

Patients were recruited from arthroplasty clinics at Al-Helal hospital, Sheikh Zayed Specialized Hospital and 6th October university hospital. They were matched in age (ranged between 55-65 years), weight (from 80 to 90 km), height and BMI.

Inclusion criteria included patients with primary unilateral TKR after osteoarthritis, with age ranged from 55-65 years, BMI from 18,5 to 29,9 kg/cm2, and with assumed same level of activities. Patients who met the following exclusion criteria were not eligible to participate: a past history of surgery on the lower extremities, foot, knee, or hip deformity; a history of surgical treatment on the unaffected lower limb; or a history of traumatic injury to the affected or unaffected lower limb's hip or ankle, with laxity of injured knee, and with any other medical problem in both extremities (previous DVT, cellulitis, rheumatoid arthritis) or any post-operative complications (wound infection, embolism, instability).

Instrumentation for measurement included standard camera with (frame speed 30 image/second) Kinovea software for gait spatio-temporal parameter measurement, Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) chart, Knee Society Scoring (KSS) chart, and standard goniometer. Instrumentation for treatment included bicycle, theraband, CPM, standard TKR rehabilitation protocol and fast track TKR rehabilitation protocol.

Methods

Assessment of patient when he was just admitted to the hospital as a pre operative assessment in muscle power and ROM and then measurement of gait spatio-temporal parameters that included recording videos of patients while walking ten meters, configuration of videos to Kinovea software, kinovea frame calibration, measurement of spatiotemporal parameters (velocity, cadence, stride length, step length, swing time and stance time) and lower extremity kinematics, export of data to spreadsheet then data extraction and transformation.

Regarding measurement of Knee Society Score System (KSS), part one of knee society scoring system chart was used and filled by the examiner. It consisted of seven questions about pain, flexion contracture, extension lag, total range of flexion, alignment (Varus and valgus), antero-posterior stability and mediolateral stability. Total grade of this scoring system was one hundred. Grading was divided to excellent from 100-80, good from 79-70, fair from 69-60 and poor when the score is below 60.

Western Ontario and McMaster University Osteoarthritis Index (WOMAC) is a self-administered questionnaire consisting of 24 items divided into 3 subscales, pain (5 items), stiffness (2 items) and physical function (17 items). The test questions are scored on a scale of 0-4, which correspond to: None (0), Mild (1), Moderate (2), Severe (3), and Extreme (4). The scores for each subscale are summed up, with a possible score range of 0-20 for Pain, 0-8 for Stiffness, and 0-68 for Physical Function. Usually, a sum of the scores for all three subscales gives a total WOMAC score. Higher scores on the WOMAC indicate worse pain, stiffness, and functional limitations.

Standard Rehabilitation Protocol

The following is a summary of the recommendations made by Kisner and Colby for the usual course of rehabilitation following a total knee replacement [5].

Initial goals during the first two weeks after surgery were reducing swelling and pain, increasing range of motion (ROM) of the knee to 0-90°, strengthening the muscles to three or four points, learning to walk with or without a cane, and developing an exercise routine to do at home. A variety of interventions were implemented, such as passive range of motion (PROM)-CPM, ankle pumping to reduce the risk of DVT, bed mobility along with transfers, heel slide in supine or sitting to improve knee flexion, quadriceps, hamstrings, in addition to hip adductors muscle-sets, neuromuscular electrical stimulation, muscle sets, gravity-supported knee extension, neuromuscular inhibition approaches, gentle stretching, pain relief modalities, compressive wraps to control effusion, and gait training were all part of the interventions. To be eligible for discharge, a patient had to be able to walk independently with the help of an appropriate aid, transfer safely, use the stairs and other steps without assistance, show improvement with a home exercise program, manage swelling with ice, and have an active range of motion (ROM) of 0-90 degrees.

Phase II (Weeks 3-6) targeted to minimize edema and inflammation, Improve ROM 0-115° or greater, enhanced dynamic joint stability/full weight bearing depending on implant status, muscular strength 4/5-5/5, return to functional activities as well as stick to home training program.

Interventions involved interventions outlined in Phase I accompanied with patellar and tibio-femoral joint mobilization, soft tissue release, scar release, progressive passive stretching, stationary bike or peddler, pain-free progressively resisted exercises utilizing ankle weights, theraband/tubing, proprioceptive exercises, closed-kinetic chain strengthening, gait training, in addition to progressive aerobic exercise.

Phase III (Week 6 and further) attempted at improving ROM 0-115° as able, to achieve functional mobility for the patient, improve strength and endurance along with motor control of the affected extremity, enhance cardiovascular fitness, establish a maintenance program and educate patient on the value of adherence, such as methods of joint protection. Interventions involved sustaining interventions of prior phases, apply exercises relevant to functional demands, and enhance cardio-respiratory and muscle endurance using activities including bicycle, walking, or swimming programs.

Data Collection

We collected data about gait spatiotemporal parameters (velocity, cadence, stride length, step length, swing time and stance time) and lower extremity kinematics were measured using Kinovea Software preoperatively, three, six months and 1-year post operatively. Also, Measurement of WOMAC, KSS were measured preoperatively, three, 6 months and 1-year post operatively.

Fast-Track Rehabilitation Protocol

In the program, patients were required to get up and move around on the day of surgery, get upstairs 48 hours after the procedure, participate in intensive physical therapy for two hours every day, utilize positive affirmation messages to help them through the protocol, and utilize a competitive care technique to compete versus other patients. If they met all the criteria, they could go home on day 6. Until all requirements for discharge were met, the patient remained in the hospital for an extended period of time. Patients participating in this trial were required to meet specific criteria before being discharged: they needed to be able to walk 30 meters on crutches, climb stairs without assistance, dress themselves independently, and use the bathroom without assistance. Furthermore, it was necessary to have obtained adequate pain management with oral medication prior to release, with a resting numeric rating scale (NRS) pain score below 3 and a mobility score below 5 [6].

Data analysis

Using the SPSS program, we compared the three groups' means for age, weight, height, as well as body mass index (BMI) using descriptive statistics and an ANOVA-test. We measured WOMAC and KSS, as well as gait spatiotemporal characteristics including speed, cadence, stride length, step length, swing time, in addition to stance time, and we used a two-way mixed MANOVA test to examine the impact of treatment on these variables. ($P \leq 0.05$) was established as the criterion of significance for all tests.

Results

Table (1) revealed that no statistically significant difference was detected among the both groups concerning demographic characteristics including age, body mass, height, BMI, & gender distribution, step length, stride length, cadence, knee Society Score (KSS) concerning pre-treatment, 3 months' post treatment, 6 months' post treatment and 1 year post treatment ($P>0.05$).

At 3 months' post-intervention, velocity increased to 84.73 ± 5.681 cm/s in the Traditional Track group and 89.60 ± 6.207 cm/s in the Fast Track group. Statistical analysis revealed a significant difference ($t=-3.168$, $p=0.002$), but no such difference was observed before the intervention, six months after the intervention, or one year after the intervention.

At pre-intervention, the mean swing time was 0.2489 ± 0.0134 s in the Traditional Track group and 0.2776 ± 0.0157 s in the Fast Track group, with a t-value of -7.595 and a p-value of 0.000, demonstrating a statistically significant difference among the groups. At 3 months post-intervention, the mean swing time was 0.2532 ± 0.0126 s in the Traditional Track group and 0.2601 ± 0.0126 s in the Fast Track group, with a t-value of -2.141 and p-value of 0.036, demonstrating a significant difference.

At pre-intervention, the mean stance time was 0.4424 ± 0.0239 s in the Traditional Track group and 0.4163 ± 0.0236 s in the Fast Track group, with a t-value of 4.255 and p-value of 0.000, indicating a significant difference. At 3 months' post-intervention, stance time was 0.4131 ± 0.0206 s in the Traditional Track group and 0.3902 ± 0.0188 s in the Fast Track group, with a t-value of 4.490 and p-value of 0.000, showing a significant difference.

At 3 months' post-intervention, the WOMAC score was 41.60 ± 2.372 in the Traditional Track group and 39.73 ± 2.900 in the Fast Track group. The t-value of 2.729 and p-value of 0.008 indicate a statistically significant difference, with a mean difference (MD) of 1.867. At 6 months' post-intervention, the scores were 38.77 ± 2.932 in the Traditional Track group and 34.80 ± 3.418 in the Fast Track group, with a t-value of 4.824 and p-value of 0.000, showing a significant difference. At 1-year post-intervention, the scores were 34.00 ± 3.085 in the Traditional Track group and 32.10 ± 3.209 in the Fast Track group, with a t-value of 2.338 and p-value of 0.023, demonstrating a significant difference at this time point as well (Table 1).

Table (2) presents the within-group comparisons of step length across different time points for both the Fast Track and Traditional Track groups. A statistically significant impact of time on step length was indicated for the Fast Track group with an F-value of 50.605 while the p-value was 0.000. The Partial Eta Squared was 0.849, reflecting the proportion of variance in step length explained by the effect of time. Post-hoc pairwise comparisons revealed significant differences among pre-intervention and various follow-up periods. At 3 months (3M),

Table 1. Demographic characteristics, step length, stride length, velocity, cadence, Stance time, Knee Society Score (KSS) and WOMAC scores of participants in both groups.

Items		**Traditional Track group**	**Fast Track group**	**Comparison**	
		Mean ± SD	**Mean ± SD**	**t-value / Fisher's Exact Test**	**P-value**
Age (years)		60.43 ± 2.528	60.13 ± 2.63	0.000	1.000
Body mass (Kg)		85.43 ± 3.115	84.83 ± 3.07	0.000	1.000
Height (cm)		167.6 ± 4.85	166.23 ± 4.06	0.000	1.000
BMI (kg/m^2)		30.553 ± 2.36	30.65 ± 2.05	-0.157	0.876
Gender	Male N (%)	16 (53.3%)	14 (46.7%)	1.000	.602
	Female N (%)	14 (46.7%)	16 (53.3%)	1.000	.602
Step Length					
Pre-Intervention		59.70 ± 3.535	58.50 ± 3.026	1.413	0.163
Post-intervention 3 M		58.13 ± 4.790	60.10 ± 4.163	-1.697	0.095
Post-intervention 6 M		62.30 ± 3.687	62.37 ± 3.755	-0.069	0.945
Post-intervention 1 Y		66.70 ± 3.064	66.90 ± 3.033	-0.254	0.800
Stride length					
Pre-Intervention		119.40 ± 7.753	118.67 ± 8.227	0.355	0.724
Post-intervention 3 M		125.60 ± 5.733	131.93 ± 4.409	-4.796	0.000
Post-intervention 6 M		138.57 ± 6.426	138.37 ± 6.049	0.124	0.902
Post-intervention 1 Y		139.47 ± 5.144	139.87 ± 4.897	-0.308	0.759
Velocity					
Pre-Intervention		79.20 ± 6.975	79.07 ± 7.090	0.073	0.942
Post-intervention 3 M		84.73 ± 5.681	89.60 ± 6.207	-3.168	0.002
Post-intervention 6 M		89.80 ± 6.429	91.00 ± 5.433	-0.781	0.438
Post-intervention 1 Y		92.53 ± 8.038	92.97 ± 7.744	-0.213	0.832
Cadence					
Pre-Intervention		87.03 ± 4.567	86.73 ± 4.820	0.247	0.805
Post-intervention 3 M		90.27 ± 4.464	92.47 ± 4.531	-1.894	0.063
Post-intervention 6 M		93.30 ± 5.154	94.23 ± 5.309	-0.691	0.492
Post-intervention 1 Y		94.33 ± 5.448	95.13 ± 4.981	-0.594	0.555
Swing time					
Pre-Intervention		0.2489 ± 0.0134	0.2776 ± 0.0157	-7.595	0.000
Post-intervention 3 M		0.2532 ± 0.0126	0.2601 ± 0.0126	-2.141	0.036
Post-intervention 6 M		0.2580 ± 0.0142	0.2555 ± 0.0144	0.685	0.496
Post-intervention 1 Y		0.2552 ± 0.0139	0.2529 ± 0.0128	0.656	0.514
Stance time					
Pre-Intervention		0.4424 ± 0.0239	0.4163 ± 0.0236	4.255	0.000
Post-intervention 3 M		0.4131 ± 0.0206	0.3902 ± 0.0188	4.490	0.000
Post-intervention 6 M		0.3870 ± 0.0213	0.3832 ± 0.0215	0.685	0.496
Post-intervention 1 Y		0.3828 ± 0.0209	0.3794 ± 0.0192	0.656	0.514
Knee Society Score					
Pre-Intervention		71.47 ± 5.698	70.67 ± 4.420	0.608	0.546
Post-intervention 3 M		78.37 ± 4.030	80.03 ± 3.388	-1.734	0.088
Post-intervention 6 M		81.17 ± 3.119	81.90 ± 3.122	-0.910	0.367
Post-intervention 1 Y		83.37 ± 3.189	83.80 ± 2.976	-0.544	0.588
WOMAC scores					
Pre-Intervention		44.30 ± 2.973	44.60 ± 3.201	-0.376	0.708
Post-intervention 3 M		41.60 ± 2.372	39.73 ± 2.900	2.729	0.008
Post-intervention 6 M		38.77 ± 2.932	34.80 ± 3.418	4.824	0.000
Post-intervention 1 Y		34.00 ± 3.085	32.10 ± 3.209	2.338	0.023

the p-value was 0.004, suggesting a notable difference compared to pre-intervention. At 6 months (6M), the p-value was 0.000, and at 1 year (1Y), the p-value remained 0.000, demonstrating a continued and significant change over time.

For the Traditional Track group, the F-value was 44.086, while the p-value was 0.000, demonstrating a statistically significant change in step length over time. The Partial Eta Squared was 0.830, representing the proportion of variance attributed to time-related changes. Post-hoc pairwise comparisons demonstrate significant differences at multiple time points. At 3 months (3M), the p-value was 0.020, indicating a measurable change from pre-intervention. At 6 months (6M), the p-value was 0.002, and at 1 year (1Y), the p-value was 0.000, reflecting further changes.

The Fast Track group had an F-value of 121.538 and p-value of 0.000, with a partial eta squared of 0.931, indicating a strong effect of time on stride length. Post-hoc comparisons showed significant improvements at 3 months (p = 0.002), 6 months (p = 0.000), and 1 year (p = 0.000). Similarly, the Traditional Track group had an F-value of 107.410, p-value of 0.000, and partial eta squared of 0.923, with significant improvements at 3 months (p = 0.000), 6 months (p = 0.000), and 1 year (p = 0.000).

Regarding within-group comparisons of velocity, Fast Track group had an F-value of 76.159, p-value of 0.000, and partial eta squared of 0.894, with significant enhancement only at 1 year (p = 0.000), while 3-month (p = 1.000) and 6-month (p = 0.100) comparisons were not significant. The Traditional Track group had an F-value of 55.002, p-value of 0.000, and partial eta squared of 0.859, showing significant improvements at 3 months (p = 0.000) and 1 year (p = 0.000), but not at 6 months (p = 0.373).

Regarding within-group comparisons of cadence, Fast Track group had an F-value of 25.110, p-value of 0.000, and partial eta squared of 0.736, with significant improvement only at 1 year (p = 0.000), while 3-month (p = 0.424) and 6-month (p = 0.145) comparisons were not significant. The Traditional Track group had an F-value of 18.662, p-value of 0.000, and partial eta squared of 0.675, showing significant improvements at 3 months (p = 0.024), 6 months (p = 0.002), and 1 year (p = 0.000).

Regarding within-group comparisons for Stance time, Fast Track group had an F-value of 22.413, p-value of 0.000, and partial eta squared of 0.713, demonstrating a significant effect of time. Post-hoc comparisons showed no significant differences at 3 months (p = 0.468) or 6 months (p = 1.000), but a significant difference at 1 year (p = 0.000). The Traditional Track group had an F-value of 3.801, p-value of 0.021, and partial eta squared of 0.297, showing a weaker effect of time. Post-hoc analysis revealed no significant changes at 3 months (p = 0.500) or 6 months (p = 1.000), but a significant change at 1 year (p = 0.010).

Regarding within-group comparisons for KSS, Fast Track group had an F-value of 54.540, p-value of 0.000, and partial eta squared of 0.858, showing a strong effect of time. Post-hoc comparisons showed no significant differences at 3 months (p = 0.212) or 6 months (p = 0.095), but a significant difference at 1 year (p = 0.000). The Traditional Track group had an F-value of 41.582, p-value of 0.000, and partial eta squared of 0.822, with significant differences at 3 months (p = 0.001), 6 months (p = 0.021), and 1 year (p = 0.000).

Regarding within-group comparisons for WOMAC, Fast Track group had an F-value of 86.816, p-value of 0.000, and partial eta squared of 0.906, demonstrating a strong effect of time. Post-hoc comparisons showed significant improvements at 3 months (p = 0.000), 6 months (p = 0.000), and 1 year (p = 0.000). Similarly, the Traditional Track group had an F-value of 90.671, p-value of 0.000, and partial eta squared of 0.910, indicating a significant time effect. Post-hoc comparisons showed statistically significant improvements at 3 months (p = 0.002), 6 months (p = 0.000), and 1 year (p = 0.000) (Table 2).

Discussion

This study compared the effectiveness of Fast Track rehabilitation programs versus Traditional Track programs in improving gait parameters, functional outcomes, and patient-reported outcomes following knee surgery. Both groups demonstrated significant improvements over time in step length, stride length, velocity, cadence, swing time, stance time, Knee Society Score (KSS), and WOMAC scores, reflecting the positive impact of structured rehabilitation on post-surgical recovery. Although no significant differences were observed among groups in most parameters at 6 months and 1 year, the Fast Track group exhibited earlier gains, particularly at 3 months, in stride length, velocity, and WOMAC scores, indicating a short-term advantage in terms of faster initial recovery.

The analysis of within-group changes revealed that both rehabilitation pathways successfully facilitated steady progress across all key outcomes over the course of 12 months. Both groups experienced improvements in gait characteristics, including increased step and stride length, faster walking speed, improved cadence, swing time, and stance time. These improvements reflect enhanced neuromuscular control, reduced pain, and improved joint function, which are critical for regaining normal walking ability and performing daily activities independently. The Knee Society Score (KSS) improved similarly

Table 2. Step Length, Stride length, Velocity, Cadence, Swing time, Stance time, KSS and WOMAC Comparison within groups.

	Groups	**F-value**	**P-value**	**Partial Eta Squared**	**Post-hoc (Pairwise Comparisons) (p-value)**	**Mean Difference (MD)**
Step Length	*Fast Track*	50.605	0.000	0.849	3M (0.004*), 6M (0.000*), 1Y (0.000*)	3M (-3.867), 6M (-4.533), 1Y (-8.400)
	Traditional Track	44.086	0.000	0.830	3M (0.020*), 6M (0.002*), 1Y (0.000*)	3M (-2.600), 6M (-4.400), 1Y (-7.000)
Stride length	*Fast Track*	121.538	0.000	0.931	3M (0.002*), 6M (0.000*), 1Y (0.000*)	3M (-6.433), 6M (-7.933), 1Y (-21.200)
	Traditional Track	107.410	0.000	0.923	3M (0.000*), 6M (0.000*), 1Y (0.000*)	3M (-12.967), 6M (-13.867), 1Y (-20.067)
Velocity	*Fast Track*	76.159	0.000	0.894	3M (1.000), 6M (0.100), 1Y (0.000*)	3M (-1.400), 6M (-3.367), 1Y (-13.900)
	Traditional Track	55.002	0.000	0.859	3M (0.000*), 6M (0.373), 1Y (0.000*)	3M (-5.067), 6M (-2.733), 1Y (-13.333)
Cadence	*Fast Track*	25.110	0.000	0.736	3M (0.424), 6M (0.145), 1Y (0.000*)	3M (-1.767), 6M (-2.667), 1Y (-8.400)
	Traditional Track	18.662	0.000	0.675	3M (0.024*), 6M (0.002*), 1Y (0.000*)	3M (-3.033), 6M (-4.067), 1Y (-7.300)
Swing time	*Fast Track*	22.413	0.000	0.713	3M (0.468), 6M (1.000), 1Y (0.000*)	3M (0.005), 6M (-0.003), 1Y (-0.025)
	Traditional Track	3.801	0.021	0.297	3M (0.500), 6M (1.000), 1Y (0.010*)	3M (-0.005), 6M (0.003), 1Y (-0.009)
Stance time	*Fast Track*	64.602	0.000	0.878	3M (0.000*), 6M (0.000*), 1Y (1.000)	3M (0.026), 6M (0.055), 1Y (0.060)
	Traditional Track	41.582	0.000	0.822	3M (0.001*), 6M (0.021*), 1Y (0.000*)	3M (-2.800), 6M (-2.200), 1Y (-11.900)
KSS	*Fast Track*	54.540	0.000	0.858	3M (0.212), 6M (0.095), 1Y (0.000*)	3M (-1.867), 6M (-1.900), 1Y (-13.133)
	Traditional Track	41.582	0.000	0.822	3M (0.001*), 6M (0.021*), 1Y (0.000*)	3M (-2.800), 6M (-2.200), 1Y (-11.900)

in both groups, reinforcing that either rehabilitation pathway supports functional recovery following knee surgery.

The WOMAC scores, representing pain, stiffness, and physical function, showed faster improvement in the Fast Track group, particularly in the first 6 months. This suggested that accelerated rehabilitation programs may provide greater early symptom relief, potentially enhancing patient satisfaction during the critical early recovery phase. However, by 12 months, the Traditional Track group caught up, demonstrating that a slower, more gradual rehabilitation process still achieves comparable long-term functional outcomes. This supports the individualization of rehabilitation programs, allowing clinicians to match the pace and intensity of therapy to each patient's tolerance, needs, and preferences without compromising final outcomes.

The findings showed no statistically significant difference in step length among the Traditional Track and Fast Track groups at any time point. However, both groups demonstrated significant within-group improvements over the year, indicating that step length increased steadily regardless of the rehabilitation pathway chosen. Hausdorff et al. (2001) demonstrated that step length symmetry and gradual lengthening over time is a hallmark of successful gait rehabilitation in older adults, indicating that both programs likely supported improved gait efficiency and control [7].

In the first three months, the Fast Track group displayed a statistically significant advantage in stride length compared to the Traditional Track group. This early lead was not maintained at 6 months or 1 year, with both groups showing comparable stride lengths. These findings mirror Kwon et al. (2009), who highlighted that intensive gait-focused training programs could accelerate early gains in stride length following lower limb surgeries, but long-term maintenance often depends on patient adherence and ongoing physical activity.

At the 3-month mark, the Fast Track group achieved significantly faster gait velocity than the Traditional Track group. This advantage diminished at 6 months and 1 year, with both groups ultimately achieving similar velocities. These results are reinforced by Turcot et al. (2013), who found that gait velocity at 3 months' post-total knee replacement strongly correlates with both functional independence and patient satisfaction. Early recovery of walking speed offers patients greater confidence and facilitates faster reintegration into daily activities [8].

There were no significant differences among groups for cadence at any time point, although both groups showed gradual within-group improvements over the study period. This pattern reflects findings from Malfait et al. (2006), who found that cadence improvements following total knee replacement were driven not only by mechanical factors such as strength and flexibility, but also by pain reduction and increased confidence in mobility [9].

A significant difference in swing time favoring the Fast Track group was noted at baseline and at 3 months' post-intervention, though this difference disappeared by 6 months and 1 year. The initial advantage in swing time may reflect earlier improvements in limb coordination and balance recovery in the Fast Track group, potentially due to the more intensive rehabilitation approach. Mansfield et al. (2007) further emphasized that shorter swing times, indicating improved limb control, were directly associated with better gait stability and reduced fall risk, particularly in older adults undergoing post-surgical rehabilitation. The disappearance of between-group differences by 6 months suggests that the Traditional Track program successfully fostered the same level of neuromuscular control over time [10].

The Fast Track group showed a significantly shorter stance time at baseline and 3 months, reflecting faster transition to a more symmetrical gait pattern. Similarly, Rosenbaum and Becker (1997) found that progressive weight-bearing therapy significantly reduces stance time asymmetry and improves weight transfer efficiency in post-surgical patients. By 6 months and 1 year, the similarity in stance times across both groups suggests that the Traditional Track program caught up with the Fast Track group, highlighting the efficacy of both approaches in restoring stable gait mechanics [11].

The Fast Track group showed significantly greater improvements in WOMAC scores at 3, 6, and 12 months compared to the Traditional Track group, indicating faster reduction in pain and improvement in functional abilities. Mizner et al. (2005) also found that early initiation of high-intensity functional exercises accelerates improvements in WOMAC scores, particularly when combined with progressive strengthening programs. The sustained superiority of the Fast Track group across all time points highlights the benefit of early intensive therapy in promoting faster symptom relief and functional gains, although the Traditional Track group also showed significant within-group improvements, confirming that both pathways ultimately support recovery [12].

This discussion underscores a clear pattern: The Fast Track group consistently showed superior early gains, particularly at the 3-month mark, across key outcomes such as gait velocity, swing time, stance time, and WOMAC scores. This came in agreement with evidence from Turcot et al. (2013), Mizner et al. (2005), who found that early intensive rehabilitation programs accelerate functional recovery and reduce symptoms more quickly. However, by 6 months to 1 year, most between-group differences diminished, indicating that the Traditional Track program—while slower initially—achieves comparable long-term outcomes [8, 12].

Overall, these findings support the flexibility of rehabilitation approaches after knee replacement surgery. While Fast Track programs offer valuable early benefits, particularly in reducing pain and improving mobility confidence, Traditional Track programs are equally effective in achieving long-term functional outcomes. This suggests that rehabilitation pathways can be individualized based on patient goals, tolerance, and preferences without compromising long-term success.

Limitations

When interpreting the results, it is important to take into account the many limitations of this study. Because of the limited sample size, the results may not be as applicable to larger groups having knee surgery, particularly those with different baseline fitness levels, comorbidities, or varying surgical techniques. A larger sample size would enhance the statistical power and allow for more robust subgroup analyses. Also, the study did not control differences in adherence to home exercise programs outside of supervised therapy sessions. Variations in compliance with unsupervised exercises, lifestyle factors (e.g., physical activity levels), and psychosocial aspects (e.g., fear of movement or pain catastrophizing) could have influenced outcomes, particularly in terms of gait recovery and perceived functional improvements.

Conclusion

This study demonstrated that both Fast Track and Traditional Track rehabilitation programs effectively improve gait parameters, functional performance, and patient-reported outcomes following knee surgery. While the Fast Track group achieved faster early gains in stride length, gait velocity, and symptom relief, both groups ultimately achieved comparable functional and patient-reported outcomes at 1-year post-surgery. These findings suggested that early intensive rehabilitation programs can provide meaningful short-term benefits, especially in pain reduction and gait efficiency, which may enhance early satisfaction and facilitate faster return to daily activities. However, the Traditional Track program also led to significant improvements across all outcomes, confirming that a slower, more gradual rehabilitation process remains highly effective for long-term recovery. These support individualized rehabilitation planning, allowing clinicians to tailor rehabilitation intensity and pace to the patient's preferences, tolerance, and clinical condition.

Recommendations

Healthcare providers should consider adopting Fast Track Rehabilitation protocols for patients who are medically fit and capable of following an accelerated rehabilitation program, as it shortens recovery time and improves early functional outcomes. Standard Rehabilitation protocols should continue to be used for patients who may benefit from a slower, more gradual recovery, particularly those with multiple comorbidities, reduced physical capacity, or limited access to intensive rehabilitation services. Further research is needed to investigate long-term functional differences beyond 12 months, as well as the cost-effectiveness and patient satisfaction levels associated with both rehabilitation approaches.

Ethical Considerations

The research was carried out in accordance with the Declaration of Helsinki, subsequent to obtaining approval from the Institutional Review Board of the Faculty of Medicine, Cairo University (Approval Code: P.T.REC/012/003323). Informed written consent was acquired from the participants (both cases and controls) before to their enrollment in this study. All patients in this study were informed about the clinical research and were informed about how the operation is carried out. Patients felt free to withdraw from the study at any time without any consequences. The data collected were not and will not be used for any other purpose. All data was collected by the researcher himself.

Conflict of interest

All authors have no conflicts of interest that are directly relevant to the content of this review.

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