RESEARCH

Deep Front Line Myofascial Release Versus Novel Soft Tissue Kinetic Chain Activation Technique (K-CAT) on Pain, Radiological Patellar Position and Dynamic Knee Valgus in Knee Osteoarthritis: A Randomized Clinical Trial

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https://doi.org/10.3822/ijtmb.v18i1.1101

Background: Knee osteoarthritis (OA) is the most common degenerative condition, afflicting large number of people globally. Fascia is a three-dimensional network of connective tissue that helps in force transmission along the myofascial chains to bone level causing malalignments and movement dysfunctions. Myofascial dysfunctions have been identified in osteoarthritis of knee as a pain-causing component. Recently, clinicians have aimed a variety of therapeutic techniques at fascia. There is a lack of literature to determine the effect of kinetic chain activation technique (K-CAT) as well as deep front line (DFL) release technique in OA knee.

Purpose: The current study aimed to determine and compare the effectiveness of DFL release and K-CAT in knee OA.

Methods: The study was a randomized clinical trial conducted in an outpatient department of a tertiary care hospital. Thirty-two (n = 32) participants between 45 and 60 years of age with knee osteoarthritis (grades 2 and 3) were included and randomized into two groups based on selection criteria. Group A received DFL myofascial release and Group B received K-CAT, along with common conventional therapy (modality + exercises), three sessions per week for 2 weeks. Pain intensity using Numeric Pain Rating Scale, skyline view of knee radiographic parameters including lateral patellar tilt angle (LPTA) and bisect offset (BO), dynamic knee valgus (DKV) by single leg squat using Kinovea software and quality of life using Knee Injury and Osteoarthritis Outcome Score on day 1 and day 14 of intervention were assessed.

Results: Within-group analyses showed significant improvements in both the groups for pain, BO on x-ray, DKV, and Knee Injury and Osteoarthritis Outcome Score ($p < 0.05$). LPTA showed statistical significance only in the DFL group. However, between-group comparisons showed no statistical difference in all the outcomes ($p > 0.05$).

Conclusion: Both DFL myofascial release and K-CAT were found to be equally effective in alleviating pain, improving quality of life and knee malalignments.

Trial registered under Clinical Trial Registry of India (CTRI/2023/11/059388).

KEYWORDS: Fascia; osteoarthritis; myofascial release; exercise therapy; quality of life

INTRODUCTION

Osteoarthritis (OA) is the most prevalent and progressive form of arthritis affecting adults worldwide.[1] It is associated with several structural and physiological changes in the joint such as inflammation of synovium, progressive loss of cartilage, reduced joint space, subchondral sclerosis, osteophyte production, and meniscal damage which further cause pain, swelling, muscle weakness, restricted joint motion, stiffness, altered proprioception, activity and participation limitations, multiple functional impairments, and reduced quality of life (QOL).[1–3] The tibiofemoral and patellofemoral joints are frequently affected. The risk of OA increases with age, and women are more commonly affected. The pooled global prevalence of knee OA is found to be 22.9% in individuals aged 40 and above.[4] Based on the scale by Kellgren and Lawrence (K-L), the prevalence in India was found to be 28.7%. Physical inactivity, sedentary lifestyle, physically demanding lifestyle, and high body mass index (BMI) were associated with a higher prevalence among multiple cities in India.[5]

Static or dynamic malalignment at knee is associated with symptoms and progression of the disease.[6,7] Lateral patellar malalignment and valgus malalignment of the TF joint increase the forces and stresses at the lateral facet of the patella.[8] Excessive internal femoral rotation during weight-bearing knee bending activities has also been attributed to be a cause for altered patellofemoral kinematics and lateral displacement of the patella.[8,9] Patellar maltracking during knee open or closed kinematic motion is commonly present due to disproportionate strength between vastus medialis obliquus (VMO) and vastus lateralis, tightness of the iliotibial band (ITB) and lateral retinacular structures.[8,9] Dynamic malalignment like DKV seen during multiple functional activities like squatting and gait is a suboptimal movement pattern.[10] It is perceived as a dysfunction within the myofascial or kinetic chain, subsequently impacting the alignment of the lower limb and the position of the patella, which increases susceptibility to non-contact injuries including ACL injury, patellofemoral pain, TF, and PF OA.[11,12]

Fascia is a continuous viscoelastic, three-dimensional network of connective tissue.[13,14] Myofascia is the fascial tissue surrounding and separating the muscles, which provides support, maintains body structure/shape, and helps in force transmission along the myofascial chains, even to the bone, and hence has the potential to cause malalignments and movement dysfunction.[15–17] The concept of myofascial chains or meridians was developed by Myers.[18] Fascia has the ability to cause pain as it consists of nociceptors and mechanoreceptors, which mediate pain via substance P.[19] Myofascial dysfunctions have been identified in OA of knee as a pain-causing component. Multiple studies have found a preponderance of myofascial pain in OA knee with the common occurrence of myofascial trigger points in rectus femoris, ITB, iliopsoas, gastrocnemius, and adductors.[20–22]

Deep front line (DFL) forms a myofascial connection between the knee and the abdominal structures, and its dysfunction can cause malalignments at the foot, knee, hip, and pelvis. It can also affect the hip adduction moment. DFL release is a form of myofascial manipulation technique for the entire myofascial chain involving passive fascial release technique, active release, and special form of myofascial release.[17,18,23]

Kinetic chain activation technique (K-CAT) is a newer advancement in soft tissue and myofascia founded by Dr. K. M. Annamalai. It involves activation of the fascia by various techniques including tapping with cupped hands and myofascial release to treat fascial dysfunctions and restrictions, realigning the collagen network and improving its viscoelasticity, which in turn helps to reduce pain and correct movement dysfunction.[24,25] A kinetic chain is a concept, that the joints and segments have an effect on each other during movement and muscle activation occurs in a patterned manner to bring about an integrated movement. Multiple therapeutic modalities, strengthening, stretching, and manual therapy techniques have been described in the literature to improve function in knee osteoarthritis (KOA).[26–29]

Over the last century, clinicians have developed and used a plethora of techniques aimed at fascia and yet it is the least studied component. There is a lack of literature to determine the effect of K-CAT as well as DFL release technique in KOA. Hence, the current study aimed to compare the effect of DFL release and novel soft tissue and fascial K-CAT on pain, radiological patellar position, DKV, and QOL in individuals with KOA.

MATERIALS AND METHODS

Study Design

The study was a single-blinded randomized clinical trial conducted at a tertiary care center in Belagavi city, Karnataka, India, between August 2023 and April 2024. Ethical clearance was obtained from the Institutional Ethical Committee (KIPT/SI No. 861/10.08.2023). The trial was pre-registered under the Clinical Trial Registry of India (CTRI/2023/11/059388). CONSORT 2010 guidelines were followed for the reporting of the trial.

Fifty-three (n = 53) participants were screened for eligibility. Thirty-two subjects (n = 32) met the selection criteria and were allocated by 1:1 allocation ratio using the chit method, into two groups: Group A—DFL release (n = 16) and Group B—K-CAT (n = 16). Written informed consent was obtained prior to enrolling the participants, and a brief explanation about the investigation was given (Figure 1).

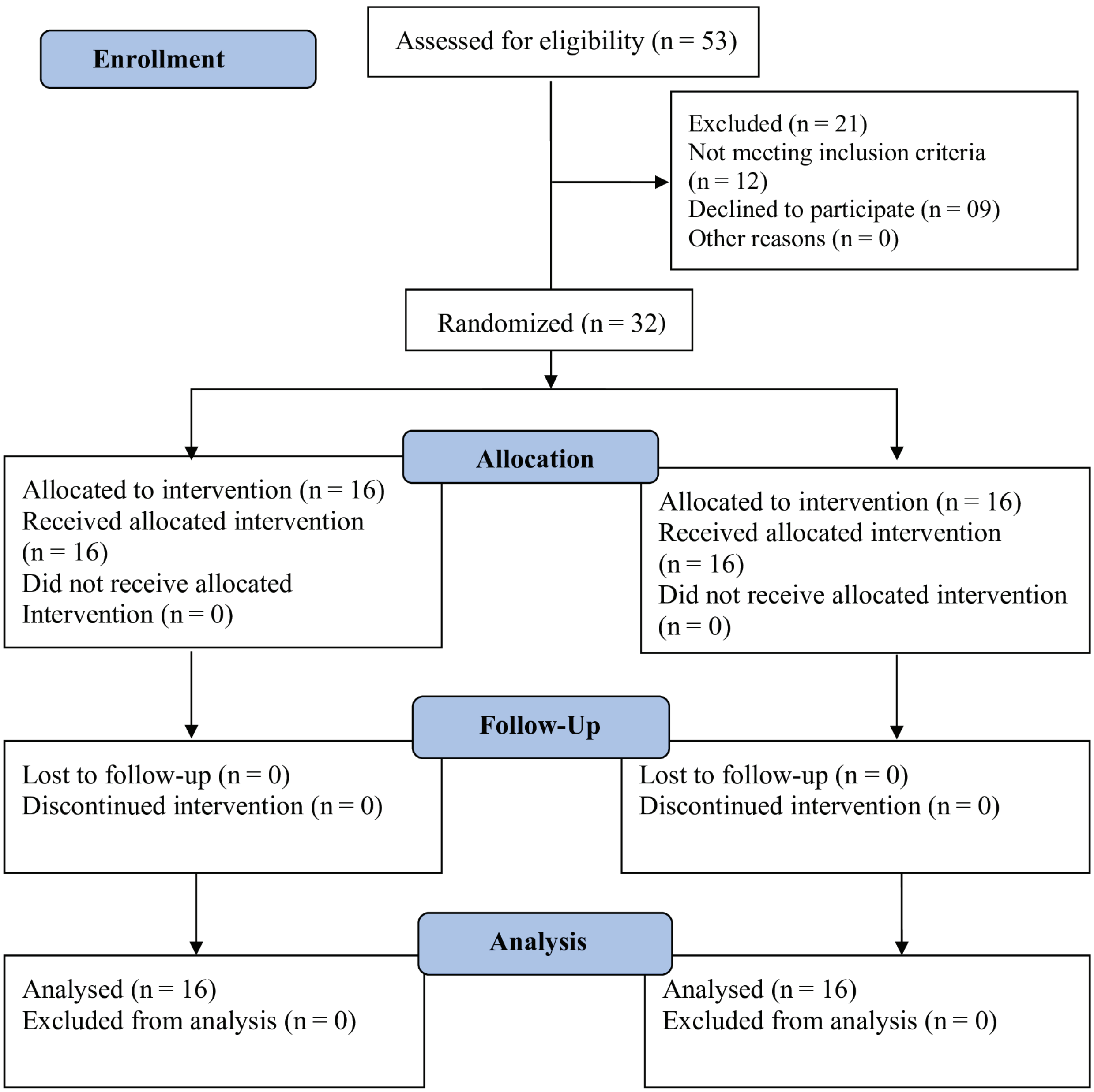

Figure 1. CONSORT flow chart.

Participants

Individuals clinically diagnosed with OA of knee with grades 2 and 3 by K-L classification, in the age category of 40–65 years with patellar maltracking that was assessed clinically via x-ray; participants willing to participate and who can comprehend commands were included in the study. The subjects were excluded if they reported acute trauma, fresh and unhealed fractures, open wounds, active infections, malignancies, neurological involvement, immobile subjects, vascular diseases, known cases of polyarthritis, uncontrolled diabetes mellitus, and subjects who had undergone any other treatment in the last 3 months.

Intervention

Guidelines from CERT and TiDier have been implemented in order to enhance better reporting and care for subjects receiving the current treatment. The interventions were given by a qualified manual therapist, and exercises performed were individualized and under supervision.

DFL release group

The subjects in the DFL release group received six sessions of intervention for 2 weeks along with conventional therapy.

Passive myofascial release technique was performed for the long toe flexors, tibialis posterior, pes anserinus, adductors, medial and posterior intermuscular septum, and lateral raphe. For long toe flexors, subjects were in prone lying with knee bent to 90° and passive upward-directed myofascial release was given to the muscles (Figure 2A and B). For tibialis posterior, pes anserine, adductors, and related intramuscular septa, the subjects were in side-lying position and similar technique was followed (Figure 2C–E). For the lateral raphe, the subjects were in a sitting position and passively upward-directed myofascial release (MFR) was given[23] (Figure 2F).

Active myofascial release was given to iliacus and psoas major. For iliacus, the subjects were lying on their back with hip and knee bent. Contact was maintained with iliacus with pressure, and the subjects were instructed to slide their heel and straighten the lower limb (Figure 2G). Active release for psoas major was performed by instructing the patient to lift their pelvis from the couch and gradually lowering it making contact with a single vertebra, while maintaining the contact pressure on the psoas major muscle.[23]

Special form of myofascial release was given to quadratus lumborum (QL), abdominal fascia, and diaphragm. For QL, pressure was applied over the muscle and the pelvis was taken into side bending, lengthening the QL muscle under its fascia. Special form of release for diaphragm was done in supine lying with the therapist's fingers maintaining contact with the diaphragmatic fascia at the lower costal margin and the patient was instructed to perform breathing for five repetitions. For abdominal fascia, the therapist's fingers were inserted below the rectus abdominis providing a lift to the navel and subjects were asked to perform breathing for five repetitions[23] (Figure 2H).

K-CAT group

The subjects in the K-CAT group received six sessions of K-CAT for hamstring fascia, calf, thoracolumbar fascia, and ITB for 2 weeks with conventional therapy.

Hamstring fascia activation: Subjects were in a prone lying position, and tapping technique was used over the hamstrings from origin to insertion for 7–8 seconds. After this, the subjects were asked to perform knee bending and straightening action in prone lying. This was repeated 15 times[24] (Figure 3A). Subjects were in a chair sitting position with feet resting on the ground. The subjects were instructed to perform medio-lateral rotation of foot for hamstring muscle activation for 15 repetitions.

ITB release: The subjects were in a side-lying position with a pillow between the knees. Fascia was released using the therapist's forearm from origin to insertion and the patient was asked to perform knee flexion and extension simultaneously. This was done for three repetitions (Figure 3B).

Calf activation: Subjects were in prone lying. Tapping technique was used over the calf for 7–8 seconds, after which the subjects were asked to perform plantar flexion movement. This was repeated 15 times. Followed by this subjects were asked to sit in a chair with feet resting on the floor and perform heel raises for 15 repetitions (Figure 3C).

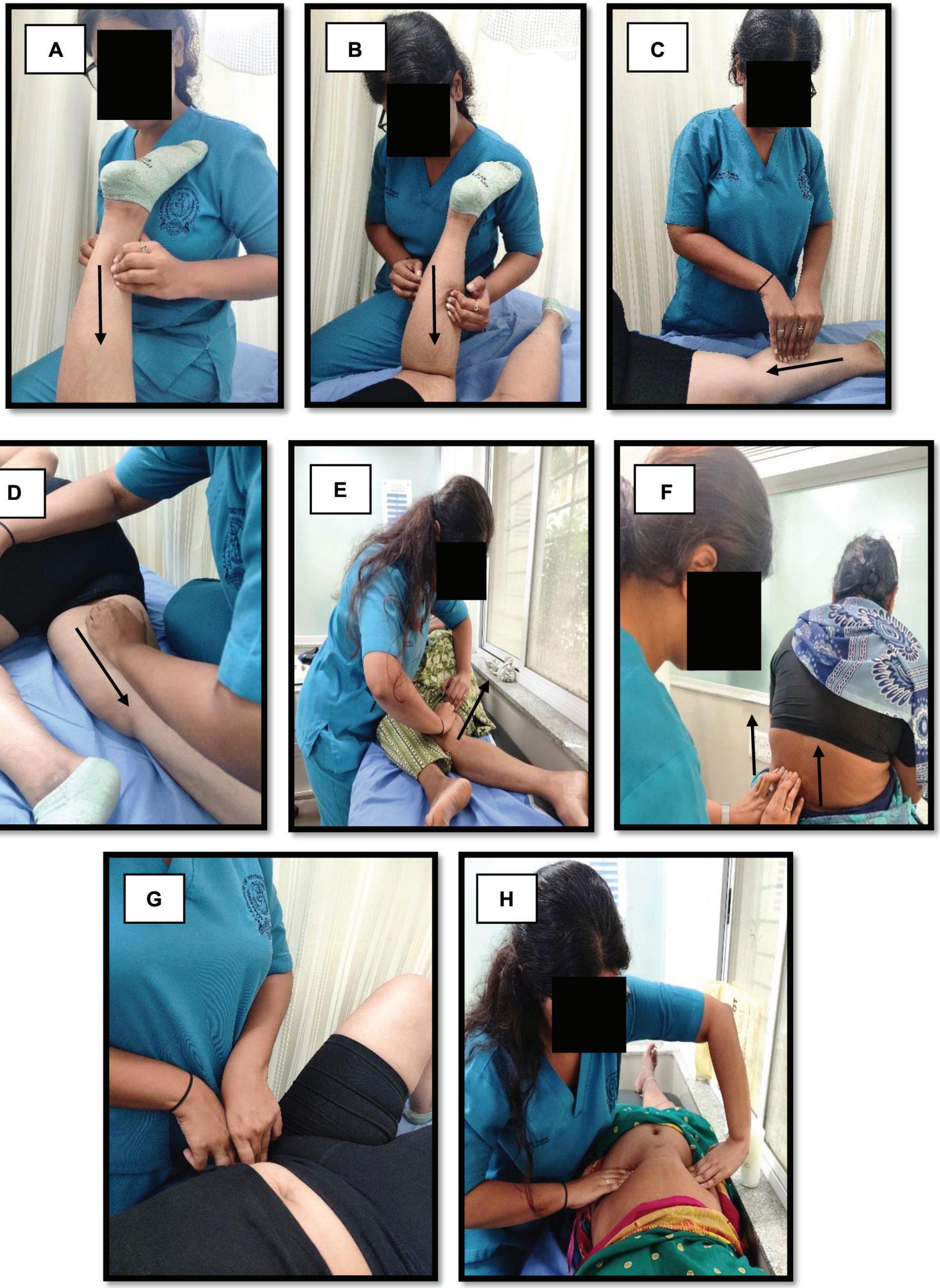

FIGURE 2. Deep front line (DFL) release. (A–C) DFL release for long toe flexors and tibialis posterior. (D) DFL release for adductors. (E) DFL release for intermuscular septum. (F) DFL release for lateral raphe. (G) DFL release for iliacus. (H) DFL release for abdominal fascia.

Figure 3. Kinetic chain activation technique (K-CAT). (A) K-CAT for hamstring fascia. (B) K-CAT for Iliotibial band. (C) K-CAT for calf. (D) K-CAT for thoracolumbar fascia.

Thoracolumbar fascia activation: Tapping technique was used over the thoracolumbar fascia with the subjects in prone lying and was repeated 15 times (Figure 3D).

Conventional therapy was given to both groups, which included pain relieving modality along with stretching and strengthening exercises prescribed for core, hip, and knee musculature as a home exercise program.[30–33] Rest time of 1 minute was given between each set.

Outcome Measures

Numeric Pain Rating Scale (NPRS) was used to grade pain intensity. Subjects were tasked with assessing their pain intensity experienced within the preceding 24 hours on a written form of this scale established on a horizontal line with a range of 0–10.[34]

Patellar alignment was measured by lateral patellar tilt angle (LPTA) and bisect offset (BO) on skyline view knee joint x-ray. The x-ray was taken by a qualified technician, and the measurements were performed by a qualified radiologist, both were blinded to the allocated groups. LPTA is formed by the condylar line posteriorly and another drawn through the lateral inner bony edge of the patella. BO was found by the line through the posterior femoral condyles and line at 90° from the lower most point of the femoral sulcus and through the patella. The distance of outer most border of patella to the line (a) and between inner most border of patella and this upright line (b) was evaluated. The BO was calculated according to the formula: BO = (a/(a + b))100[9,35] (Figure 4A and B).

The dynamic knee valgus (DKV) angle while performing single leg squat was assessed in frontal plane by videographic analysis using kinovea software. Stick-on

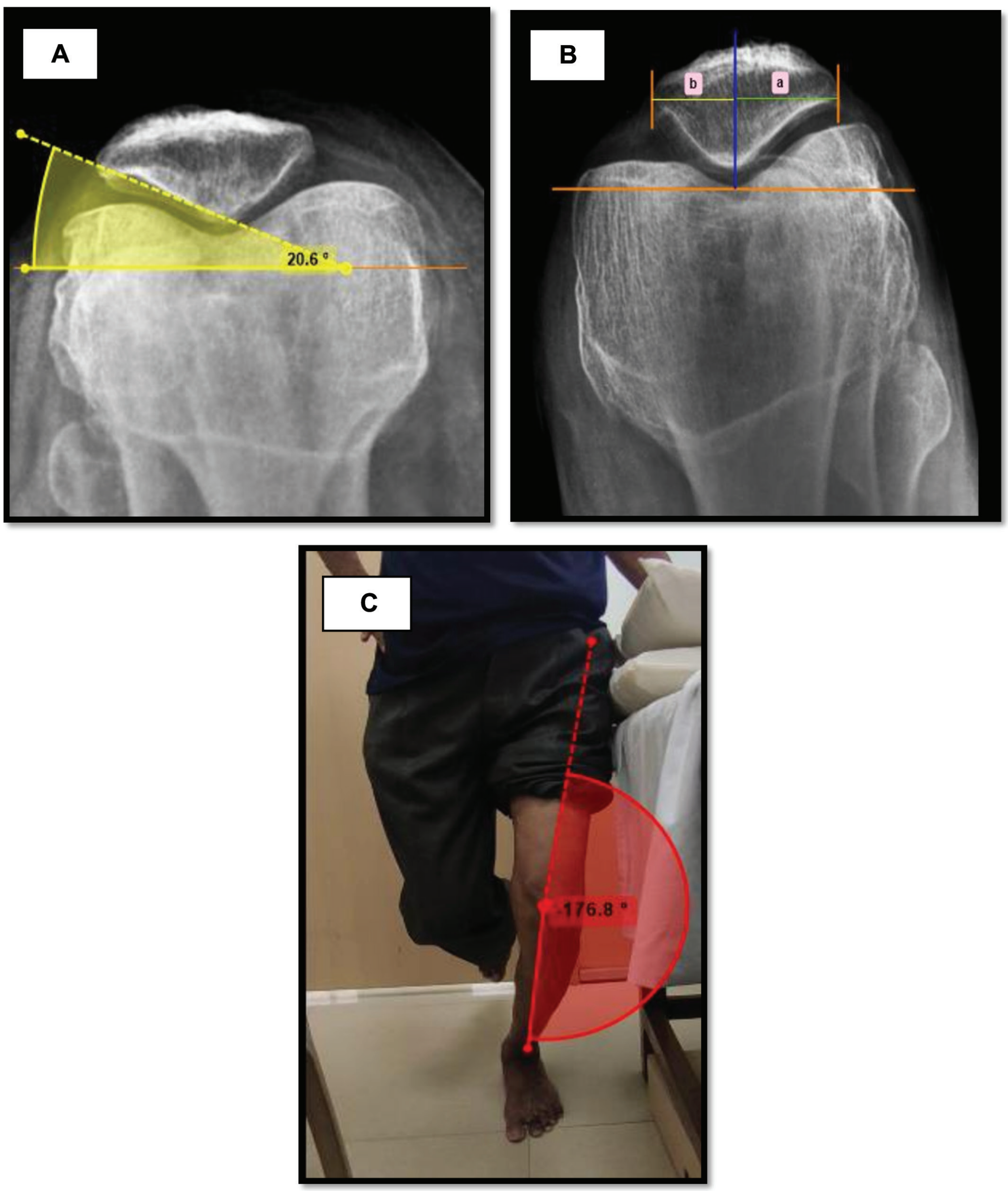

FIGURE 4. Outcome measures. (A) Lateral patellar tilt angle. (B) Bisect offset. (C) Dynamic knee valgus.

markers were placed on anterior superior iliac spine, ankle joint center (center point between two malleoli), and knee joint center (center point of both femoral epicondyles). A universal goniometer was set with the fulcrum at the lateral femoral epicondyle, and both the stationary arm and moving arm were fixed via Velcro straps in line with the thigh and leg, respectively. Subjects were asked to perform a single leg squat for three repetitions only until 45° of knee flexion and videos were recorded. The same were uploaded in the kinovea software, and DKV was measured as the average of the three repetitions[36] (Figure 4C).

Knee Injury and Osteoarthritis Outcome Score (KOOS) is a questionnaire comprising 42 items categorized into subscales representing five domains: pain, symptoms, activities of daily living (ADL), sports and recreational function, and QOL. Responses are recorded, ranging from zero (indicating no problems) to four (indicating extreme/maximal problems). The subjects were asked to fill all the domains of the scale.[37]

Sample Size

The size of the sample was computed using the formula: $n = (2(Z_\alpha + Z_\beta)^2 * \sigma^2)/d^2$, where $Z_\alpha = 1.96$, $Z_\beta = 0.84$ with a mean difference of 2.6 taken from the reference article.[38]

Statistical Analysis

Statistical analysis was completed using Statistical Package of Social Sciences version 23 (IBM, Armonk, NY, USA) and Microsoft Excel. A significance level of 5% was used. The normality was checked by the Kolmogorov–Smirnov test. Pre–post values were analyzed using dependent *t*-test for data following normal distribution and Wilcoxon-matched test for data that were not normally distributed. Similarly, between groups were analyzed using independent *t* and Man–Whitney *U* test.

RESULTS

Thirty-two subjects were included in the study, with 16 in each group. The age of the participants included was between 40 and 65 years. The DFL release group consisted of seven (43.75%) males and nine (56.25%) females. The K-CAT group consisted of 6 (37.50%) males and 10 (62.50%) females. There was no statistically significant difference (SSD) in terms of gender distribution between both the groups ($p = 0.7190$). There was no remarkable difference in the demographic factors (age distribution, height, weight, and BMI) between both the groups (Table 1). All data except NPRS scores followed normal distribution.

Within-group analysis for the DFL release group demonstrated significant difference ($p < 0.05$) in pain ($p = 0.0004$, % change = 53.64), LPTA ($p = 0.0016$, % change = 3.24), BO ($p = 0.0001$, % change = 1.16), DKV angle ($p = 0.0001$, % change = 6.06), and KOOS-QOL ($p = 0.0001$, % change = 7.03).

Within-group analysis for the K-CAT group showed significant improvement in pain ($p = 0.0004$, % change = 57.80), BO ($p = 0.0164$, % change = 2.24), DKV ($p = 0.0001$, % change = 5.93), and KOOS-QOL scores ($p = 0.0001$, % change = 6.42). LPTA improved only in the DFL release group with a medium effect size ($d = 0.4960$). The effect size for change in BO in the K-CAT group was 0.3270, indicating medium effect/low magnitude of change. Significant difference was

TABLE 1. Age, Height, Weight and BMI Distribution

Variables	*Group A*	*Group B*	*t-Value*	*p-Value*
	Mean ± SD	*Mean ± SD*		
Age (years)	53.69 ± 7.01	54.19 ± 8.96	−0.1758	0.8616
Height (m)	1.64 ± 0.06	1.66 ± 0.09	−0.8538	0.4000
Weight (kg)	70.38 ± 4.95	71.75 ± 6.38	−0.6809	0.5012
BMI (kg/m^2)	26.34 ± 1.54	26.11 ± 1.74	0.3881	0.7006

BMI = body mass index; Group A = deep front line release; Group B = kinetic chain activation technique; SD = standard deviation.

also seen in the other domains of KOOS in both the groups (Tables 2 and 3).

Between-group analyses for post-test scores showed no significant difference ($p > 0.05$) in pain ($p = 0.5095$), LPTA ($p = 0.2345$), BO ($p = 0.2015$), DKV ($p = 0.8848$), and KOOS-QOL scores ($p = 0.4204$) along with other domains of KOOS (Tables 4 and 5).

DISCUSSION

The investigatory findings of the present trial support the null hypothesis, which states that "there will be no difference in the effect of DFL release and kinetic chain activation technique on pain, radiological patellar position, DKV and QOL in individuals with knee osteoarthritis."

Literature suggests that apart from changes within the joint, myofascial dysfunctions lead to pain and movement problems in KOA.[14,22] According to the evidence, myofascial releases either manual or using instruments have a positive effect on pain, function, and flexibility in KOA and anterior knee pain.[39] In the current study, reduction in pain was seen in the DFL release group post-intervention, which is in accordance with a previous study conducted on four cases with arthritic changes in the knee where DFL release effectively reduced pain immediately post-session between 50% and 100% and absence of pain during an extended follow-up post-discharge.[23] Firstly, the sense of pressure during MFR propagates quicker than the pain stimuli and can modulate the pain perception by blocking the pain gate. Secondly, it helps to relieve spasm and improve blood circulation and tissue texture which in turn reduces pain. Another study also showed a notable reduction in pain along with improvement in function and knee movements after DFL release.[40]

Previous literature shows that myofascial dysfunctions can lead to malalignment and muscular imbalance.[16,19] LPTA

TABLE 2. Within-Group Comparison of Pre-Test and Post-Test Scores in Group A and Group B

Variables	*Groups*	*Times*	*Mean ± SD*	*Mean Diff. ± SD Diff.*	*% of Change*	*Z-Value*	*p-Value*	*Effect Size*
NPRS	Group A	Pre-test	6.88 ± 0.72	3.69 ± 0.70	53.64	3.5162	0.0004*	0.9670
		Post-test	3.19 ± 0.40					
	Group B	Pre-test	6.81 ± 0.91	3.94 ± 0.93	57.80	3.5165	0.0004*	0.9500
		Post-test	2.88 ± 0.62					
LPTA	Group A	Pre-test	22.74 ± 3.04	0.74 ± 0.77	3.24	3.8433	0.0016*	0.4960
		Post-test	22.01 ± 3.14					
	Group B	Pre-test	22.13 ± 2.69	0.13 ± 1.86	0.58	0.2760	0.7863	0.0050
		Post-test	22.00 ± 3.74					
BO	Group A	Pre-test	61.93 ± 3.75	0.72 ± 0.45	1.16	6.4125	0.0001*	0.7280
		Post-test	61.21 ± 3.82					
	Group B	Pre-test	63.51 ± 6.93	1.43 ± 2.11	2.24	2.7012	0.0164*	0.3270
		Post-test	62.08 ± 6.70					
DKV	Group A	Pre-test	159.53 ± 3.68	9.67 ± 3.32	6.06	−11.6626	0.0001*	0.9010
		Post-test	169.20 ± 3.45					
	Group B	Pre-test	160.53 ± 3.15	9.51 ± 2.70	5.93	−14.0870	0.0001*	0.9300
		Post-test	170.04 ± 3.89					

SD = standard deviation; Diff = difference; Group A = deep front line release; Group B = kinetic chain activation technique; NPRS = numeric pain rating scale; LPTA = lateral patellar tilt angle; BO = bisect offset; DKV = dynamic knee valgus.
*$p < 0.05$ indicates significant difference.

TABLE 3. Within-Group Comparison of Pre-Test and Post-Test Scores of KOOS in Group A and Group B

KOOS Domains	*Groups*	*Times*	*Mean ± SD*	*Mean Diff. ± SD Diff.*	*% of Change*	*t-Value*	*p-Value*	*Effect Size*
Pain	Group A	Pre-test	83.55 ± 4.07	9.55 ± 3.06	11.43	−12.4896	0.0001*	0.9130
		Post-test	93.10 ± 2.27					
	Group B	Pre-test	85.48 ± 5.24	9.19 ± 4.81	10.75	−7.6384	0.0001*	0.7950
		Post-test	94.67 ± 2.14					
Symptoms	Group A	Pre-test	84.66 ± 4.13	6.93 ± 2.61	8.19	−10.6242	0.0001*	0.8830
		Post-test	91.59 ± 2.76					
	Group B	Pre-test	86.89 ± 2.98	6.64 ± 1.78	7.65	−14.8930	0.0001*	0.9380
		Post-test	93.53 ± 2.07					
ADLs	Group A	Pre-test	85.23 ± 2.16	8.32 ± 2.43	9.76	−13.6739	0.0001*	0.9260
		Post-test	93.54 ± 2.40					
	Group B	Pre-test	86.59 ± 0.97	7.49 ± 1.21	8.65	−24.7754	0.0001*	0.9770
		Post-test	94.08 ± 0.73					
Sports/recreation	Group A	Pre-test	79.90 ± 3.37	6.64 ± 4.32	8.31	−6.1440	0.0001*	0.7140
		Post-test	86.54 ± 3.25					
	Group B	Pre-test	81.38 ± 4.31	5.34 ± 2.42	6.56	−8.8209	0.0001*	0.8370
		Post-test	86.72 ± 2.99					
QOL	Group A	Pre-test	85.91 ± 1.78	6.04 ± 1.84	7.03	−6.0375	0.0001*	0.9210
		Post-test	91.94 ± 1.32					
	Group B	Pre-test	86.72 ± 1.15	5.57 ± 1.40	6.42	−15.8735	0.0001*	0.9430
		Post-test	92.29 ± 0.90					

ADLs = activities of daily living; Diff = difference; Group A = deep front line release; Group B = kinetic chain activation technique; KOOS = Knee Injury and Osteoarthritis Outcome Score; QOL = quality of life; SD = standard deviation.
*$p < 0.05$ indicates significant difference.

and BO values have been correlated with pain intensity and functional levels.[7,9] In the current study, a significant difference was seen post-intervention in both measures of patellar alignment on x-ray in the DFL release group with moderate effect size suggesting a small change. This can be due to the shorter duration of intervention, which may not be sufficient to demonstrate notable changes on radiograph. These changes can be attributed to the fact that myofascial restrictions cause a disturbance in the typical biomechanical functions of the body, leading to an elevation in the level of tension applied to the system and releasing these restrictions would have helped improve the static alignment.[14,16,19]

The present study demonstrated a significant difference in DKV values post-DFL release, suggesting the use of a holistic approach for myofascial correction rather than a local approach only. DKV is regarded as a biomechanical alteration during closed kinematic movement of the lower limb. Previous studies have proven that DKV increases the risk of PF joint dysfunction, arthritic changes, and ACL injuries and is also positively correlated to reduction in activation of VMO.[10,11] A study describes DKV angle as a movement dysfunction occurring due to poor stabilization at the pelvis and hip leading to a chain of faulty movements. It highlights the importance of a global approach in the treatment of DKV, taking the myofascial chains into

TABLE 4. Between-Group Comparison with Pre-Test and Post-Test Scores

Variables	*Times*	*Group A*	*Group B*	*Z-Value*	*p-Value*	*Mean Diff.*	*95% CI for Mean Diff.*	
		Mean ± SD	*Mean ± SD*				*Lower*	*Upper*
NPRS	Pre-test	6.88 ± 0.72	6.81 ± 0.91	0.1131	0.9100	0.06	−0.53	0.65
	Post-test	3.19 ± 0.40	2.88 ± 0.62	1.2626	0.2067	0.31	−0.06	0.69
	Difference	3.69 ± 0.70	3.94 ± 0.93	−0.6596	0.5095	−0.25	−0.85	0.35
LPTA	Pre-test	22.74 ± 3.04	22.13 ± 2.69	0.6073	0.5482	0.62	−1.45	2.69
	Post-test	22.01± 3.14	22.00 ± 3.74	0.0051	0.9959	0.01	−2.49	2.50
	Difference	0.74 ± 0.77	0.13 ± 1.86	1.2132	0.2345	0.61	−0.42	1.64
BO	Pre-test	61.93 ± 3.75	63.51 ± 6.93	−0.8016	0.4291	−1.58	−5.60	2.44
	Post-test	61.21 ± 3.82	62.08 ± 6.70	−0.4536	0.6534	−0.88	−4.81	3.06
	Difference	0.72 ± 0.45	1.43 ± 2.11	−1.3059	0.2015	−0.70	−1.81	0.40
DKV	Pre-test	159.53 ± 3.68	160.53 ± 3.15	−0.8258	0.4154	−1.00	−3.47	1.47
	Post-test	169.20 ± 3.45	170.04 ± 3.89	−0.6491	0.5212	−0.84	−3.50	1.81
	Difference	9.67 ± 3.32	9.51 ± 2.70	0.1461	0.8848	0.16	−2.03	2.34

BO = bisect offset; CI = confidence interval; Diff = difference; DKV = dynamic knee valgus; Group A = deep front line release; Group B = kinetic chain activation technique; LPTA = lateral patellar tilt angle; NPRS = Numeric Pain Rating Scale; SD = standard deviation.

TABLE 5. Between-Group Comparison of Pre-Test and Post-Test Scores of KOOS

KOOS Domains	*Times*	*Group A*	*Group B*	*t-Value*	*p-Value*	*Mean Diff.*	*95% CI for Mean Diff.*	
		Mean ± SD	*Mean ± SD*				*Lower*	*Upper*
Pain	Pre-test	83.55 ± 4.07	85.48 ± 5.24	−1.1621	0.2544	−1.93	−5.31	1.46
	Post-test	93.10 ± 2.27	94.67 ± 2.14	−2.0047	0.0500*	−1.57	−3.16	0.03
	Difference	9.55 ± 3.06	9.19 ± 4.81	0.2531	0.8020	0.36	−2.55	3.27
Symptom	Pre-test	84.66 ± 4.13	86.89 ± 2.98	−1.7496	0.0904	−2.23	−4.83	0.37
	Post-test	91.59 ± 2.76	93.53 ± 2.07	−2.2488	0.0320*	−1.94	−3.70	−0.18
	Difference	6.93 ± 2.61	6.64 ± 1.78	0.3623	0.7197	0.29	−1.33	1.90
ADLs	Pre-test	85.23 ± 2.16	86.59 ± 0.97	−2.0050	0.0513	−1.36	−2.57	−0.16
	Post-test	93.54 ± 2.40	94.08 ± 0.73	−0.8535	0.4002	−0.54	−1.82	0.75
	Difference	8.32 ± 2.43	7.49 ± 1.21	1.2191	0.2323	0.83	−0.56	2.22
Sports/recreation	Pre-test	79.90 ± 3.37	81.38 ± 4.31	−1.0798	0.2888	−1.48	−4.27	1.32
	Post-test	86.54 ± 3.25	86.72 ± 2.99	−0.1592	0.8746	−0.18	−2.43	2.08
	Difference	6.64 ±4.32	5.34 ± 2.42	1.0509	0.3017	1.30	−1.23	3.83
QOL	Pre-test	85.91 ± 1.78	86.72 ± 1.15	−1.5445	0.1330	−0.82	−1.90	0.26
	Post-test	91.94 ± 1.32	92.29 ± 0.90	−0.8614	0.3958	−0.34	−1.16	0.47
	Difference	6.04 ± 1.84	5.57 ± 1.40	0.8169	0.4204	0.47	−0.71	1.65

ADLs = activities of daily living; CI = confidence interval; Diff = difference; Group A = deep front line release; Group B = kinetic chain activation technique; KOOS = Knee Injury and Osteoarthritis Outcome Score; QOL = quality of life; SD = standard deviation.

consideration.[41–43] Imbalance in the hip musculature has been associated with the presence of DKV where there is weakness of hip abductors, external rotators, and extensors along with contralateral muscle tightness.[42] In the present study, the DFL release primarily focused on MFR for hip adductors and flexors. Along with this, conventional therapy for strengthening the opposite set of muscles was added. This could be attributed to the significant difference observed in DKV values pre- and post-DFL release.

Significant reduction in pain intensity can be considered as one of the reasons for the improvement in KOOS scores for ADL, sports and recreation as well as QOL domains. A previous study demonstrated significant improvement in KOOS, post-myofascial release for hamstrings in knee OA.[44] Another study also reported significant improvement in pain, ADLs, and QOL in KOA patients after myofascial release of popliteus muscle and VMO training.[45] The findings of the present investigation are supported by the previous literature.

This study demonstrates considerable decline in pain intensity via NPRS scores post 2 weeks of K-CAT. It is a newer advancement that works on correcting the fascial dysfunction and activating the fascia to improve its viscoelasticity. K-CAT focuses on providing a good sensory input, stimulating the mechanoreceptors and cutaneous receptors by tapping with cupped hands along the fascial lines which helps in reducing pain. These might be the reasons for the observed reduction in pain in this group. According to a kinetic chain rehabilitation concept presented by Aaron Sciascia and Robin Cromwell, when one or more kinetic chain links are broken, the resulting disorganized biomechanical output may result in discomfort.[46]

Previous studies also suggest that fascia training aids in restoring fiber orientation, distribution, and modulation of fascial mobility.[47] A study conducted on K-CAT for hamstring tightness has demonstrated significant improvements in the flexibility checked via sit and reach test in students. Due to these effects of K-CAT on fascia, the remarkable reduction in pain is seen.[24] These might be the reasons for the observed reduction in pain in this group. K-CAT used in the current study focused upon ITB release, warming the fascia and aligning the collagen fibers. This could be the possible reason for a sustainable difference seen in patellar alignment improvements post-intervention although the effect size was moderate. DKV values showed a significant difference in the K-CAT group post-intervention. Firstly, as K-CAT focused on treating along the myofascial chains and was combined with exercises to correct muscle imbalance, it could be a probable reason for improved movement pattern during single leg squat. Secondly, DKV is also related to inactivation of appropriate muscles, whereas the tapping technique used in K-CAT activates the fascia, in turn enhancing the muscle activation.[42] Multiple studies on myofascia have proven positive effects on the pre and post scores of each sub-scale of KOOS. The results of the present study can be considered to be in accordance with the previous literature reporting notable changes in the values.[44,48]

Based on the evidence till date, there is a dearth in the literature on the individual effect as well as comparative effects of DFL release and K-CAT in KOA. There were no substantial variations seen in the comparative effect of both techniques as they were primarily focused upon the myofascia and directed toward correcting its restrictions and patterns. Also, conventional strengthening and stretching exercises were given to both groups, which could also be the probable reason for no SSD between both interventions.

The present trial poses a few limitations. The changes seen in the present study are a combined effect of conventional therapy and myofascial interventions with no ideal control group due to which the individual effects of DFL release and K-CAT are not known. The study was single-blinded and open-label with only assessor being blinded. However, it was not possible to blind the patients, since the objective of the study was to compare the two interventions and not placebo effects. The long-term effects were not assessed due to which the carryover effects were not understood. Lastly, the home exercise protocol was unsupervised and hence it was not known whether it was followed regularly and may have affected the results.

In future, long-term effects and carryover effects can be studied, MRI can be used for tracking the patella in dynamic action, and an additional control group with conventional therapy can be added to overcome the masking effect.

The study concludes that six sessions of deep frontline release and K-CAT when given in addition to conventional therapy are equally effective in reducing pain and improving DKV and patellar alignment. Along with this, both techniques are effective in significantly improving QOL, ADLs, and sports/recreation parameters as well.

CONFLICT OF INTEREST NOTIFICATION

The authors declare there are no conflicts of interest.

FUNDING

No sources of funding were used in this study.

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ACKNOWLEDGMENT

We are thankful to Dr. S. B. Javali, Associate Professor at USM-KLE, International Medical College for helping us with the data analysis.

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