EFFECT OF CORE STRENGTHENING FOR KNEE OSTEOARTHRITIS ON BALANCE, PAIN AND FUNCTION: A PILOT STUDY

Lam JE[1], Mokhtar AH[1], and Mohafez H[2].
[1]Sports Medicine Unit, Faculty of Medicine, Universiti Malaya, 50603 Kuala Lumpur, Malaysia
[2]Department of Biomedical Engineering, Faculty of Engineering, Universiti Malaya, 50603 Kuala Lumpur, Malaysia

Correspondence:
Abdul Halim Mokhtar,
Sports Medicine Unit,
Faculty of Medicine,
Universiti Malaya,
50603 Kuala Lumpur,
Malaysia
Email: drhalim@um.edu.my

Abstract

Background: Knee osteoarthritis (KOA) is the most prevalent joint disease worldwide which reduces function and quality of life. It is linked to balance disorders and increased fall risk. Core strengthening might improve balance, pain, and function in these patients.

Methods: This pre-post intervention study involved 20 subjects who were diagnosed with KOA. Ten KOA patients (55.90 ± 7.74 years) in the control group (CG) received conventional treatment only, while 10 intervention group (IG) patients (56.40 ± 8.87 years) received conventional treatment and core strengthening. Both groups performed thrice weekly home-based exercises for 6 weeks. Static and dynamic balance, functional-performance tests, and Knee Injury and Osteoarthritis Outcome Score (KOOS) assessing pain and function was done at baseline and after 6 weeks, with KOOS repeated after 12 weeks.

Results: There was statistically significant within-group improvement in KOOS pain and function ($p < 0.05$) after 6 and 12 weeks, however the between group difference was insignificant. Functional tests and balance showed more improvement in the IG but were insignificant ($p > 0.05$). No adverse events were reported with core strengthening in the IG.

Conclusion: Core strengthening is a safe, practical, and feasible intervention for KOA patients, which may improve balance, pain, and physical function.

***Keywords*:** Exercise, Osteoarthritis, Balance, Physical Function, Sports Medicine

Introduction

Osteoarthritis (OA) is the most prevalent joint disorder globally, affecting approximately 10% of men and 18% of women over 60 years of age. Knee OA (KOA) accounts for over 80% of the total global disease burden (1, 2). In Malaysia, the knee caused 64.8% of all joint-related complaints, with more than half the patients presenting with knee pain being clinically diagnosed with OA (3). With increasing population age and the rising prevalence of obesity worldwide, the disease burden of OA is postulated to increase, as these are recognized risk factors for the condition (4, 5). This will lead to increased strain on the health care system. Patients with OA present with typical clinical symptoms, namely severe joint pain, stiffness, and a marked reduction in mobility. This subsequently decreases their productivity and quality of life, leading to increased patient and societal socioeconomic (6). KOA is linked to gait and balance disorders especially among the elderly, which will increase the risk of falling (7).

OA treatment recommendations are typically categorized into non-pharmacological, pharmacological, and surgical interventions. Osteoarthritis Research Society International (OARSI) and the European Society for Clinical and Economic Aspects of Osteoporosis, Osteoarthritis, and Musculoskeletal Diseases (ESCEO) suggest stepwise treatment protocols, with an emphasis on empowering patient education and access to medically accurate information, maintaining an ideal weight, and exercise before subsequent pharmacological or surgical management. Both these renowned guidelines advocate exercise therapy, which includes organized and specific land-based exercise regimes comprising strength, cardiovascular, balance and neuromuscular components (8). Core strengthening has not been included in these two guidelines for KOA. Similar recommendations are stated in our Malaysian Clinical Practice Guideline for Osteoarthritis 2013. However, these guidelines do not specify the role of core strengthening despite its convenience and ease to perform (9).

The lumbopelvic-hip complex or "core" is described as a muscular box comprising the abdominal, pelvic floor, hip, paraspinal and gluteal musculature, and also the diaphragm. Core stability is important for functional movement, including standing, walking, and sitting. It functions by controlling trunk position, and pelvic movement. It synergizes force and motion production, transfer, and control to the distal segments of the kinetic chain (10). A vital benefit of core strengthening is improvement in trunk muscle strength and control, spinal maneuvrability, and overall balance. A stronger core would reduce the burden on the affected knees and may improve the balance as a whole. This reduces the risk of falling, which is of paramount importance in the elderly (11).

Current literature regarding the evidence on the utility of core strengthening in the treatment of KOA is sparse, despite its known benefit to improving lower limb strength and balance (12).

Its potential is promising, as a previous study that utilized core exercises in this population did demonstrate significant improvements in pain and physical function if added on to the conventional treatment as per guidelines (13). However, we have not found studies looking into the efficacy of employing core exercises in patients with KOA to improve their balance, and to translate this potential improvement into enhanced physical function.

This pilot study aims to assess the potential efficacy of a core strengthening program, in addition to conventional KOA treatment, compared with stand-alone conventional treatment in improving balance, knee pain, and physical function for patients diagnosed with KOA. We postulated that it would bring about improvements across all those parameters.

Materials and Methods

A pre-post intervention study design was used for this pilot study. The study population was patients with KOA who were undergoing treatment at the Sports Medicine Clinic, University of Malaya Medical Centre. Patients included were aged between 40 to 80 years old with a diagnosis of knee OA based on symptoms (knee pain, stiffness, crepitus, bony tenderness or enlargement) and suggestive clinical examination findings. They also had radiographic evidence of knee OA (Kellgren-Lawrence Classification, grade 2-3) (14). The exclusion criteria were patients who had a history of knee joint fracture, lower limb joint replacement surgery, knee injections within the past 3 months, systemic arthritis, other causes of knee pain (e.g.: knee sprain, Baker's cyst, tumor), and physical limitations to exercise.

The research was conducted by the Declaration of Helsinki and approved by the hospital's Medical Research Ethics Committee (No. 2020819-8995). All participants signed an informed consent form before inclusion. The primary outcome of this study was a change in static and dynamic balance. This was measured using the Postural Stability (PS) and Limits of Stability (LOS) tests using Biodex Balance System (Biodex Medical Systems Inc., New York). Secondary outcomes were pain and physical function. The pain was assessed using a 100-mm visual analog scale (VAG), and the Pain subscale of the Knee Injury and Osteoarthritis Outcome Score (KOOS) questionnaire (15, 16).

Physical function was assessed using functional performance tests, as recommended by OARSI. The tests selected for this study were the 6-Minute Walk Test (6MWT), Timed Up and Go Test (TUG), and 30 Second Chair Stand Test (30CST). The Activities of Daily Living (ADL) subscale of KOOS was also used for ADL function (17). All these instruments have been validated in previous studies (18-22).

The Biodex Balance System SD allows the assessment of multi-plane neuromuscular control in a closed chain. The PS test emphasizes the maintenance of the center of balance. A lower score is more desirable, as deviations from the center are expressed as a variance. The LOS test challenges patients to move and control their center of gravity within their base of support. It indicates dynamic balance control within a normalized sway pattern; thus, a higher score indicates better performance.

6MWT is a submaximal aerobic walking test incorporating elements of cardio-respiratory endurance and balance control during directional change. The maximal distance covered along a 30-m walkway in 6 minutes is recorded. TUG is an ambulatory transition test, where a patient must stand from a sitting position, walk 3 m, turn back, and return to their original sitting position. A shorter duration in seconds indicates better performance where multiple parameters are involved, including lower limb strength and balance. 30CST is a sit-to-stand assessment, where a patient must perform as many repetitions as possible from a seated position on a chair within 30 seconds. It involves the core and lower limb muscular endurance and dynamic balance (17).

KOOS Pain subscale consists of 9 questions, while the functional ADL subscale consists of 17 questions. The timeframe included for assessment is the past week. Standardized answer choices are provided in 5 Likert boxes. Each question is given a score from 0 to 4. A normalized score, with 100 indicating no symptoms and 0 for extreme symptoms is then calculated (16). Subjects were randomized into either an intervention group (IG) or a control group (CG) via a random number generator. Both groups were introduced to conventional exercises, which was a home-based program involving components of a range of motion, flexibility and closed kinetic chain lower limb strengthening (23).

The IG had an additional set of exercises prescribed, which targeted the muscles which were deemed vital to core stability based on electromyography studies (24-26) (Appendix 1). All patients were first provided exercise education by a trained physician or physiotherapist, to ensure proper technique to mitigate the risk of injury. Detailed exercise sheets with instructions were also provided. The exercise was completely home-based, to be performed 3 times a week for 6 weeks. To increase adherence and ease monitoring, patients were instructed to record exercises performed in a standardized diary. They were also contacted via phone calls or text messages weekly to address questions and concerns, detect complications early, and regularly motivate them.

All patients underwent baseline testing of parameters for balance, knee pain, and function: PS, LOS, Visual Analog Scale (VAS), KOOS, 6MWT, TUG, and 30CST. After 6 weeks of exercise therapy, the same parameters were re-tested. At week 12 after initial testing, they were once again asked to answer the KOOS questionnaire for Pain and ADL.

Statistical analysis

One-way analysis of covariance (ANCOVA) was conducted to determine/investigate the effect of conventional treatment and core strengthening plus conventional treatment on post-intervention VAS, PS, LOS, 30CST, TUG, and 6MWT after controlling for pre-intervention VAS, PS, LOS, 30CST, TUG, and 6MWT, respectively.

Also, mixed between-within analysis of variance (ANOVA)/ two-way mixed analysis of variance (ANOVA) was applied to investigate the interaction effect between time and intervention along with the main effects of time and intervention for KOOS ADL and KOOS Pain, separately. Post hoc analysis with a Bonferroni adjustment was used to find out the source of differences for each of the above-mentioned variables when a significant time effect was found. Statistical analyses were performed using SPSS for Windows, version 24. Moreover, the preliminary assumptions were checked without any serious violations.

Results

Demographic profiles

This study was carried out from January 2021 to July 2021 on KOA patients (N = 20) who were equally randomized to conventional treatment only as the control group (CG), and conventional treatment plus core strengthening as an intervention group (IG). All participants were female. The mean age was 55.90 ± 7.74 years, height 1.56 ± 0.56 m, and body mass 75.32 ±17.47 kg for the CG with a body mass index (BMI) of 30.85 ± 6.58 kg/m^2. For the IG, the mean age was 56.40 ±8.87 years, height 1.55 ± 0.38 m, and body mass 66.05 ± 11.58 kg with a BMI of 27.68 ± 6.00 kg/m^2 (Table 1).

Table 1: Demographic characteristics of participants (N = 20, 100% female)

Demographic characteristics	Value (mean ± SD)	
	Control Group	Intervention Group
Age (years)	55.90 ± 7.74	56.40 ± 8.87
Height (m)	1.56 ± 0.56	1.55 ± 0.38
Weight (kg)	75.32 ± 17.47	66.05 ± 11.58
Body Mass Index (BMI) (kg/m^2)	30.85 ± 6.58	27.68 ± 6.00

SD = Standard deviation

Postural Stability (PS), Limits of Stability (LOS), Visual Analog Scale (VAS), 30-Second Chair Stand Test (30CST), Timed Up and Go Test (TUG), and 6 Minute Walk Test (6MWT)

An ANCOVA was run to determine the effect of conventional treatment (CG) and core strengthening plus conventional treatment (IG) on post-intervention PS, LOS, VAS, 30CST, TUG, and 6MWT after controlling the baseline PS, LOS, VAS, 30CST, TUG, and 6MWT values, respectively.

Participants were classified into two groups: CG (n = 10) and IG (n = 10). Standardized residuals for the interventions and the overall model were normally distributed, as assessed by Shapiro-Wilk's test (P-value, $p > 0.05$). There was homogeneity of variances, as assessed by Levene's test. There were no outliers in the data, as assessed by no cases with standardized residuals greater than ± 3 standard deviations.

Postural stability (PS) and limits of stability (LOS)

After adjustment for baseline PS, there was no statistically significant mean difference in post-intervention PS between the CG and IG, $F(1,17) = 0.038$, $p = 0.847$ (Table 2). However, post-intervention PS were lower in the IG (M = 0.533, SE = 0.049) compared with the CG (M = 0.547, SE = 0.049) (Table 3).

After adjustment for baseline LOS, there was no statistically significant mean difference in post-intervention LOS between the CG and IG, $F(1,17) = 0.509$, $p = 0.485$ (Table 2). However, Post-intervention LOS was better in the IG (M = 46.006, SE = 3.12) compared to the CG (M = 42.794, SE = 3.12) (Table 3).

Table 2: Post-Intervention effect in between groups. ANCOVA was run to determine the effect of conventional treatment (CG) and core strengthening plus conventional treatment (IG) after controlling baseline values

	F value	P-value	Partial Eta Squared
Postural Stability	0.038	0.847	0.002
Limits of Stability	0.509	0.485	0.029
Visual Analog Scale	4.237	0.055	0.200
30 Second Chair Stand Test	0.115	0.738	0.007
Timed Up and Go Test	0.144	0.709	0.008
6-Minute Walk Test	2.516	0.131	0.129

Table 3: Post-intervention mean values for Postural Stability, Limits of Stability, Visual Analog Scale, 30 Second Chair Stand Test, Timed Up and Go Test, and 6-Minute Walk Test after controlling baseline values

	Groups	Mean (SE)	95% CI
Postural Stability			
Overall stability index	Control	0.547 (0.049)	(0.444, 0.650)
	Intervention	0.533 (0.049)	(0.430, 0.636)
Limits of Stability			
Overall score	Control	42.794 (3.120)	(36.211, 49.377)
	Intervention	46.006 (3.120)	(39.423, 52.589)
Visual Analog Scale			
Measurement in millimetres	Control	34.611 (4.060)	(26.045, 43.178)
	Intervention	22.789 (4.060)	(14.222, 31.355)
30 Second Chair Stand Test			
Number of repetitions	Control	13.703 (0.611)	(12.413, 14.993)
	Intervention	13.997 (0.611)	(12.707, 15.287)
Timed Up and Go Test			
Time in seconds	Control	6.539 (0.202)	(6.112, 6.966)
	Intervention	6.647 (0.202)	(6.220, 7.074)
6-Minute Walk Test			
Distance in metres	Control	460.594 (11.049)	(437.283, 483.905)
	Intervention	485.406 (11.049)	(462.095, 508.717)

SE: Standard error
CI: Confidence interval

Visual Analog Scale (VAS)

After adjustment for baseline VAS, there was a marginally statistically significant mean difference in post-intervention VAS between the groups, $F(1,17) = 4.237$, $p = 0.055$, partial $\eta^2 = 0.200$ (Table 2). Post-intervention Visual Analog Scale (VAS) was statistically significantly lower in the IG (M = 22.789 mm, SE = 4.06) compared with the CG (M = 34.611 mm, SE = 4.06) (Table 3).

30-Second Chair Stand Test (30CST), Timed Up and Go Test (TUG), and 6-Minute Walk Test (6MWT)

After adjustment for baseline 30CST, there was no statistically significant mean difference in post-intervention 30CST between the groups, $F(1,17) = 0.115$, $p = 0.738$ (Table 2). However, post-intervention 30CST were greater in the IG (M = 13.997, SE = 0.611) compared to the CG (M = 13.703, SE = 0.611) (Table 3). After adjustment for baseline TUG, there was no statistically significant mean difference in post-intervention TUG between the groups, $F(1,17) = 0.144$, $p = 0.709$ (Table 2). The CG fared better post-intervention however, with higher TUG times in the IG (M = 6.647 s, SE = 0.202) compared with the CG (M = 6.539 s, SE = 0.202) (Table 3).

After adjustment for baseline 6MWT there was no statistically significant mean difference in post-intervention 6MWT between the groups, $F(1,17) = 2.516$, $p = 0.131$ (Table 2). However, Post-intervention 6MWT was greater in the IG (M = 485.406 m, SE = 11.049) compared with the CG (M = 460.594 m, SE = 11.049) (Table 3).

KOOS Pain

For KOOS Pain and ADL, there were no outliers, as assessed by the boxplot. The data were normally distributed, as assessed by Shapiro-Wilk's test of normality ($p > 0.05$). There was homogeneity of variances ($p > 0.05$) and covariances ($p > 0.001$), as assessed by Levene's test of homogeneity of variances and Box's M test, respectively. Mauchly's test of sphericity indicated that the assumption of sphericity was met for the two-way interaction. Within subjects, there was no statistically significant interaction between the intervention and time on KOOS Pain, $F(2,36) = 1.089$, $p = 0.347$, partial $\eta^2 = 0.057$.

The main effect of time showed a statistically significant difference in mean KOOS Pain at the different time points, $F(2,36) = 10.071$, $p < 0.001$, and partial $\eta^2 = 0.359$ indicates the large effect size, with KOOS Pain increasing from (M = 62.6%, SE = 3.391) at baseline to (M = 72.25%, SE = 3.069) at post-intervention and to (M = 74.85%, SE = 3.236) at 12 weeks. Post hoc analysis with a Bonferroni adjustment revealed that KOOS Pain was statistically significantly increased from baseline to post-intervention [-9.65% (95% CI = -16.43 to -2.87%), p = 0.004], and from baseline to 12 weeks [-12.25% (95% CI = -21.00 to -3.50%), p = 0.005]. (Table 4 and 5).

The main effect of the group showed that there was no statistically significant difference in mean KOOS Pain between the groups $F(1,18) = 1.809$, $p = 0.195$ (Table 6).

Table 4: KOOS scores at baseline, post-intervention, and 12 weeks post-intervention

	KOOS scores	
	Mean (SE)	**95% CI**
Pain		
Baseline	62.6000 (3.391)	(55.476, 69.724)
Post-intervention	72.2500 (3.069)	(65.801, 78.699)
12 weeks post-intervention	74.8500 (3.236)	(68.052, 81.648)
Activities of Daily Living (ADL)		
Baseline	65.0000 (3.571)	(57.497, 72.503)
Post-intervention	74.0500 (3.544)	(66.604, 81.496)
12 weeks post-intervention	80.7500 (3.118)	(74.200, 87.300)

SE: Standard error
CI: Confidence interval

KOOS Activities of Daily Living (ADL)

Within subjects, there was no statistically significant interaction between the intervention and time on ADL, $F(2,36) = 2.492$, $p = 0.097$, partial $\eta^2 = 0.122$. The main effect of time showed a statistically significant difference in mean Activities of Daily Living (ADL) at the different time points, $F(2,36) = 13.857$, $p < 0.001$, and partial $\eta^2 = 0.435$ indicates the large effect size, with ADL score increasing from (M = 65%, SE = 3.571) at baseline to (M = 74.05%, SE = 3.544) at post-intervention and to (M = 80.75%, SE = 3.118) at 12 weeks.

Post hoc analysis with a Bonferroni adjustment revealed that ADL was statistically significantly increased from baseline to post-intervention [-9.05% (95% CI = -15.989% to -2.11%), p = 0.009], and from baseline to 12 weeks [-15.75% (95% CI = -25.16% to -6.34%), p = 0.001] (Tables 4 and 5). The main effect of the group showed that there was no statistically significant difference in mean ADL between the groups $F(1,18) = 1.907$, $p = 0.184$ (Table 6). No adverse events or complications were reported by participants throughout the 12 weeks the trial was conducted.

Table 5: Main effect of time, pairwise comparison of mean KOOS scores at different time points. ANOVA applied to investigate the main effect of time within groups

	Timepoint 1	Timepoint 2	Mean Difference	Standard Error	P-value[b]	95% CI for Difference[b]
KOOS Pain	Baseline	Post-intervention	-9.650*	2.568	0.004	(-16.427, -2.873)
		12 weeks post-intervention	-12.250*	3.314	0.005	(-20.996, -3.504)
KOOS ADL	Baseline	Post- intervention	-9.050*	2.629	0.009	(-15.989, -2.111)
		12 weeks post-intervention	-15.750*	3.564	0.001	(-25.157, -6.343)

ADL: Activities of Daily Living
* The mean difference is significant at the 0.05 level
[b] Adjustment for multiple comparisons: Bonferroni

Table 6: Main effect of group, difference of mean KOOS scores between intervention and control groups. ANOVA applied to investigate main effect of intervention between groups

	Mean difference (SE)	95% CI for difference[a]	F(1, 18)	P-value[a]
Pain	7.467 (5.552)	(-4.198, 19.131)	1.809	0.195
ADL	8.133 (5.890)	(-4.241, 20.508)	1.907	0.184

ADL: Activities of Daily Living
[a] Adjustment for multiple comparisons: Bonferroni
CI: Confidence interval
SE: Standard error

Discussion

Core strengthening exercises have been touted to have various benefits. Among patients who are suffering from KOA, it can bring improvements in pain and function (13, 27). It is easy to perform, requires little or no equipment, and is an economical choice (10). A structured exercise program has the potential to empower a patient to confidently perform home-based exercises. Our study aimed to educate and enable patients to exercise at home to the best of their ability, while also reducing the risk of contracting infections. Home-based exercise has gained more traction during the era of the COVID-19 pandemic, when exercise in confined, crowded areas such as gymnasiums and public areas such as parks, or even hospital-based settings are discouraged (28). Our study was conducted from January 2021 till July 2021, during which a Movement Control Order was enforced in Malaysia to curb the pandemic. Unnecessary travel and social outings, including exercise and sporting activities in public were banned, hence highlighting the importance of advocating a consistent home-based exercise program (29).

This study was primarily aimed at studying the potential effect of core strengthening in addition to conventional KOA treatment, which focused more on lower limb strengthening across several parameters. This pilot study has shown that it is feasible to conduct a short-term home-based exercise program, and the exercise protocol designed was appropriate and simple to perform (30). Participants from both groups could perform the exercises at home without supervision, reporting no problems. They could perform the field tests (PS, LOS, 6MWT, TUG, 30CST) during the initial assessment, and during clinic follow-up after 6 weeks. No statistically significant results in the parameters of pain, balance, and function were found. However, positive clinical change was detected, which will be discussed in more detail below.

Static and dynamic balance testing using the Biodex Balance System to test for PS and LOS respectively both showed improvement in the IG but did not attain statistical significance. Despite that, it is an encouraging finding, as a better balance is associated with reduced fall risk (31). Balance results from coordinated efforts involving the sensory systems (visual, vestibular, and proprioceptive) and motor systems (upper and lower extremity muscle strength and joint flexibility) (32). Our exercise intervention only targeted the motor system's influence on balance but did not take into account other confounding factors.

Changes in pain were assessed using a VAS and KOOS Pain subscale. VAS showed a marginally significant improvement in pain in the intervention group. This improvement echoes similar findings from previous trials (13, 27). For KOOS Pain, the main effect of time revealed significant improvement after 6 weeks and at 12 weeks. The main effect group showed no significant difference between the control and intervention groups.

Performance-based tests of physical function after 6 weeks by the intervention group showed improvements in 6MWT distances and the number of repetitions in the 30CST. However, there was a slight deterioration in the TUG times. None of the differences were statistically significant. For the KOOS ADL subscale for function, the main effect of time showed statistically significant improvement at 6 weeks and 12 weeks. There is no significant difference between groups.

Our pilot study did not manage to delineate the potential meaningful change that may be brought about by the inclusion of core strengthening exercises on balance, pain and function due to its small sample size. However, it should be emphasized that, any form of exercise intervention, if consistently performed in a structured manner, can bring about improvements in terms of pain, and an improvement in function in patients with knee OA after at least 6 weeks, as highlighted in our results. This concept has been re-emphasized across all management guidelines for KOA (33).

In this new era of heightened vigilance, brought about by the COVID-19 pandemic, it has become paramount that physicians adopt a new approach, employing the use of technology for patient monitoring, detecting, and addressing adverse events from treatment, and to increase compliance and adherence to therapy (34). We have strived to adapt, by employing an approach using regular communication using phone calls, text messages, and sharing information when needed, as a form of telemedicine with our group of patients, with good response. Telemedicine proved to be an important communication avenue in our study in between physical encounters to achieve the above-mentioned goals. All participants in this study were only required to physically attend the baseline assessment, and after 6 weeks to reduce their hospital visits.

Limitations

The main limitation of our pilot study was the small sample size, which we attribute to being the reason no statistically significant change was detected across all studied parameters. Despite that, reassuring findings of positive clinical improvement were detected in almost all tests. Further clinical research involving a larger sample size is needed in the future to fully appreciate the effect and significance of core strengthening in KOA patients.

The second limitation is the short interval between baseline and post-intervention testing. Although 6 weeks has been proposed as the minimum time frame for physiological changes, it is desirable to allow a longer duration of exercise intervention (35). Another component that was not focused on was the element progression. Progression is one of the keys to improving muscular strength and endurance (36). As our patients were not required to attend supervised sessions, and unnecessary physical presence in the hospital was at that point discouraged, their exercises could not be progressed especially in the components such as volume and intensity. Techniques could also not be observed and corrected if needed. That may have led to poorer test outcomes which would affect the overall results. Ideally, participants should be seen on a more frequent basis, to optimize their outcomes.

Ensuring patient adherence is also another limitation. We relied on patients' self-reporting of adherence via exercise diaries and phone communication rather than mandating compulsory observed sessions. This could have reduced their motivation and commitment to the program.

Conclusion

This study has shown that core strengthening when combined with conventional treatment did not significantly affect balance, pain and function for KOA patients when compared to stand-alone conventional treatment. However, this treatment strategy is a safe, practical, and feasible non-surgical option and should be routinely advocated in this population.

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Competing interests

The authors declare that they have no competing interests.

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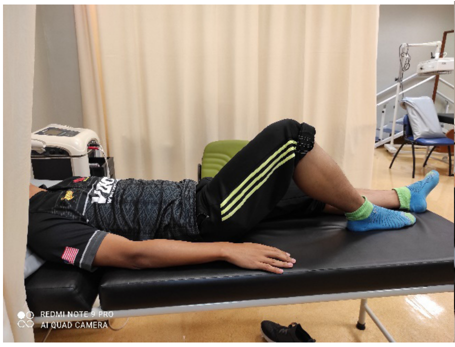
APPENDIX 1
EXERCISE INFORMATION SHEET

KNEE STRENGTHENING EXERCISES

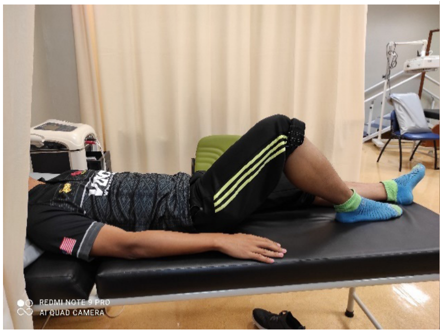
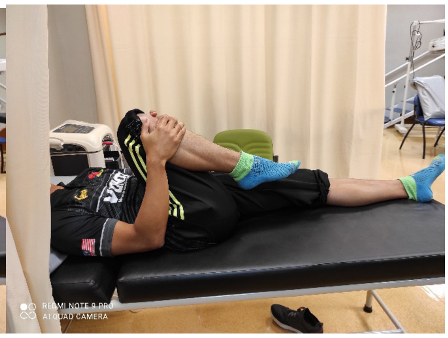
<u>Range of motion exercises</u>

Perform daily. 2 sets of 10 repetitions, hold position for 3 seconds at the end of motion range.

1. **Knee extension**: Supine position, knee flexed at 45° with foot on supporting surface. Extend knee by contracting quadriceps.




2. **Knee flexion** : Supine position with knee flexed at 45°, flex knee fully with arms or band.

<u>Strengthening exercises</u>

Perform daily. 2 sets of 10 repetitions, hold for 6 seconds. Rest for 10 seconds between repetitions.

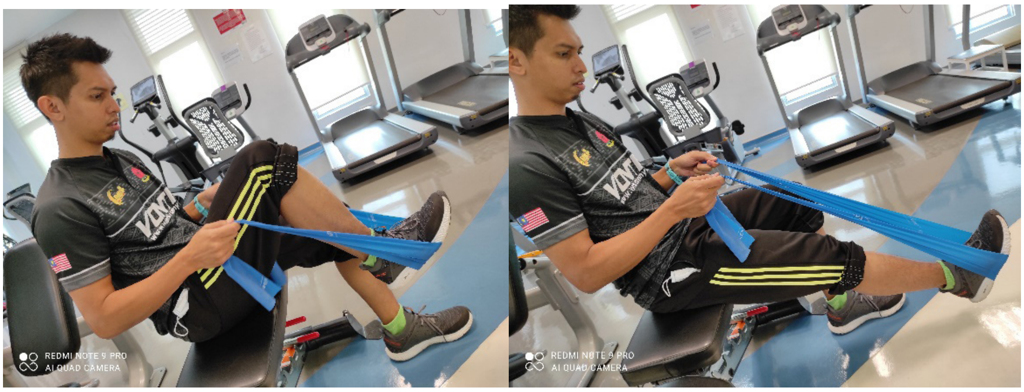
1. **Isometric quadriceps exercise with knee extension**: Supine position, with knee straight and ankle dorsiflexed. Contract quadriceps and push down the knee against pillow.

Perform 3 times a week. 2 sets of 10 repetitions, hold for 3 seconds.

2. **Leg press**: Supine with hip and knee flexed at 90°. Place foot on pillow against the wall. Extend knee by pushing down on pillow, contracting gluteal and quadriceps.

OR

Seated leg press : Seated position, holding resistance band in both hands. Place foot on band, straighten knee by pushing foot down and forward by contracting gluteal and quadriceps.



Perform 3 times a week. 2 sets of 10 repetitions, hold for 3 seconds.

3. **Semi squats with partial weight bearing**: Stand with back against the wall. Half squat to 90° of knee flexion, with knees properly aligned.

Perform 3 times a week. 2 sets of 10 slow repetitions.

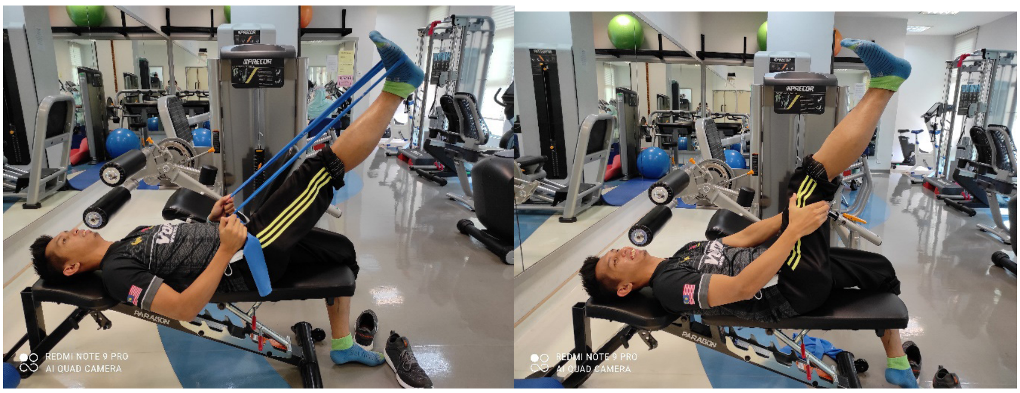
4. **Step-ups**: Step up a low step (10 cm) with affected leg with as little push-off assistance from contralateral foot as possible. Step down with contralateral foot.

__Stretching exercises__

Perform daily. Hold for 30 seconds, repeat 3 times.

1. **Standing calf stretch**: Stand facing a wall with both hands on the wall. Position leg to be stretched behind with straight knee and heel on the ground. Lean body forward till a stretch is felt in the calf.

2. **Hamstring stretch** : Supine position. Flex hip with straight knee, and ankle in dorsiflexion with a band until a pull is felt in the posterior thigh and calf **OR** straighten knee with proximal lower leg supported with hands.



3. **Quadriceps stretch** : Prone position. Both hips and knees straight, place a band around ankle. Bend the knee by pulling on the band with both hands, until a stretch is felt over the anterior thigh **OR** stand facing a wall, bend knee towards the buttocks and hold with one hand, using the other hand as support.


<u>CORE STRENGTHENING EXERCISES</u>

Perform 3 times a week. 2 sets of 8 repetitions, hold for 5 seconds.

Rest 10 seconds between repetitions.

Rest 30 seconds between sets, rest 1 minute between exercises.

Repeat exercises for both sides.

Perform only <u>ONE</u> of the options according to your own ability.

1. A) **Back bridge**: Supine position. Feet flat on the ground, with knees bent to 90° , arms alongside the body, with hands on the floor (palms down). Lift pelvis to align thighs and spine.

B**) Unilateral bridge**: In back-bridge position with pelvis lifted and neutral spine position, extend one knee by lifting foot off the ground.

2. A) **Quadruped arm lift**: Hips and knees flexed to 90°, arms and thighs perpendicular to floor. Pelvis, spine and head aligned. Lift one arm until parallel to ground, keeping pelvis in neutral position.

B) **Quadruped lower extremity lift**: Extend one leg until parallel to ground.

C) **Quadruped arm and lower extremity lift**: Extend one leg and lift opposite arm until both parallel to the ground.

Perform 3 times a week. 2 sets of 10 repetitions. Rest 30 seconds between sets.

3. **Curl-up**: Supine position, with hands behind the head and the knees flexed to approximately 90°. Lift head and shoulders until scapulae lift off the floor.

All images in this document are posed by a model.