

THE EFFECTS OF ISOKINETIC AND FUNCTIONAL TRAINING ON STRENGTH AND ABILITY TO PERFORM DAILY ACTIVITIES IN KNEE OSTEOARTHRITIS PATIENTS

Abstract

Introduction: Despite the well-known fact that exercises are the effective treatment in OA, exact modalities, amount and types of exercise that would be beneficial and not destructive to the affected joint are unknown and most effective types and combinations of exercise and the amount of those are still unclear. Study objectives included assessing the effects of Isokinetic Training (IT) and Functional Task Training (FT) on the peak torque at various angular velocities, pain, ability to perform daily activities and basic functional mobility in osteoarthritis patients. **Materials and Methods:** Eligible 48 patients (considering possible dropouts) who fulfilled the criteria were selected and randomly assigned to isokinetic training (IT) functional training (FT) and control with no exercise (CG) groups to participate in an intervention program involving baseline, mid- (6 weeks) and post- intervention (12 weeks) assessment through isokinetic testing to assess patient's quadriceps peak torque at 90°/s, 120°/s and 180°/s angular velocities; WOMAC physical function questionnaire to assess patient's pain, stiffness and ability to perform daily activities; timed up and go test (TUG) to assess subjects' basic functional mobility. **Results:** Both training modalities improved patient's strength, pain, and ability to perform daily activities and basic functional mobility with significant improvements at mid- and post-tests as compared to controls. FT group has equaled IT group in strength gains at every tested angular velocity, FT group was significantly superior in physical function. **Conclusion:** Both interventions brought significant improvements in studied variables with FT group emerging superior in physical function domain.

Key words: *Isokinetic training; Functional training; knee osteoarthritis.*

Introduction

The frequency and chronicity of osteoarthritis (OA) and the lack of effective prevention or cure makes this disease a substantial economic burden for patients and major worldwide cause of economic loss^{1,2}, health care systems and social security problem to all nations^{3,4}. The physical disability arising from knee OA prevents the performance of daily life activities such as walking, squatting, climbing stairs and is increasing the risk of falls⁵. OA is the most frequent and symptomatic health problem for middle aged and older people⁶. The chronic disease has been considered as one of the major health problems in the world^{7,8}. There are no consistently effective methods for preventing OA or slowing its progression. Currently management of OA includes a combination of pharmacologic and non-pharmacologic treatments^{9,10}. Non-pharmacologic treatments of OA include education programmes, changes of life style, physical therapy and exercises programmes. Based on several previous studies, physical activities including exercises have been identified as the most effective non-pharmacological treatments in OA¹¹ and a crucial component of primary, secondary and tertiary prevention of OA. Exercises were proved to be safe and well tolerated by osteoarthritic patients¹². Osteoarthritic patients can benefit from exercises in improving their pain and physical function and other symptoms by increasing the circulation of synovial fluid in the joint, increasing strength, endurance and stability, weight reduction, improve status of other chronic disease and more accurate proprioception^{13,14}. Despite the well-known fact that exercises are the effective treatment in OA, exact amount and types of exercise that would be beneficial and not destructive to the affected joint are unknown and most effective types and combinations of exercise as well as the amount are still unclear. The current trend in rehabilitation exercise for OA is to emphasize functional types of exercises that include weight-bearing activity. The term "functional" relates to those activities that most closely resemble day-to-day activities, such as rising to stand, ascending and descending stairs, stepping, walking, squatting and lunging. This type of exercises provides axial loading to the joint, exercise more than one joint at the same time, involve both concentric and eccentric muscle contraction, simulate daily activity, enhance muscle contraction and minimize the shear forces at the knee joint¹⁵. Other projected benefits include increased proprioception and coordination of the lower extremity and increased carry over to functional activities including a quicker return to daily activities. Besides obvious potential benefits of a quick return to the non-hampered daily activities, it may be a serious potential in functional training related to its reasonable ease of execution, low cost and a

possibility of wide spread in the community settings, which in turn can boost the program adherence and motivation to stay physically active. **Objectives of the study:** Study objectives included assessing the effects of Isokinetic Training(IT) and Functional Task Training (FT) on the peak torque at various angular velocities, pain, ability to perform daily activities and basic functional mobility in osteoarthritis patients.

Materials and Methods

Subjects

The sample size was calculated using G Power software with the power of the study was set at 80% with 95% confidence interval and effect size f' was set at 0.25. The sample size calculated was 45 subjects with each group containing 15 subjects. Eligible 48 patients (considering possible dropouts) who fulfilled the criteria were selected at Orthopaedic clinic Hospital Universiti Sains Malaysia, MAHSA University Kuala Lumpur Physiotherapy Department and Heritage Physiotherapy Centre, Ampang, Kuala Lumpur. After signing the informed consent forms, subjects were randomly assigned into three groups (one control and two experimental groups) with 16 patients per group.

Inclusion criteria

- In the range of 40-65 years old
- Having a bilateral knee OA with grade one and two
- Have no contraindication from a personal physician for participation in resistance and functional exercises
- Both genders
- A history of knee pain for longer than 6 months (chronic knee osteoarthritis).

Exclusion criteria included:

- Knee surgery or intra-articular corticosteroid injection within past six months;
- Systemic arthritic conditions;
- History of hip or knee joint replacement or tibial osteotomy;
- Any other condition affecting lower limb function;
- A Vestibular disorder,
- Patients will be excluded if they had received physical therapy, acupuncture or massage therapy treatment for their knee during the preceding 3 months.
- Musculoskeletal conditions involving the knee joint (e.g., tendon/ligament tears),
- Severe uncontrolled hypertension (>160/100 mm/hg).
- Cardiorespiratory disease (ischemia, arrhythmia, chest pain, or exercise-induced bronchospasm), liver abnormalities;

Experimental variables and assessment protocol

The parameters measured in the study helped assessing patients' isokinetic strength level at various angular velocities, patients' ability to perform daily activities and daily life activities efficiency. Two intervention groups and control group performed pre-experimental test evaluation before beginning the exercise program, mid-intervention test after six weeks of intervention and post- intervention test after twelve weeks of the study.

The test conducted included:

1. Isokinetic testing with Biodex Isokinetic Dynamometer to assess patient's quadriceps peak torque at 90°/s, 120°/s and 180°/s angular velocities.
2. WOMAC physical function questionnaire to assess patient's pain, stiffness and ability to perform daily activities¹⁶.
3. Timed up and go test to assess subjects' basic functional mobility¹⁷.

Intervention Protocols

Isokinetic Training (IT)

The experimental group 1 received isokinetic training thrice a week, with 40-45 min duration of each session following modified training protocol. It included concentric contractions of knee extensors consisting of two to four sets of six repetitions at angular velocities of 90, 120 and 180°/second. A 40

seconds rest interval was given between the sets; 2 min rest was given while changing legs. Experimental protocol of this study omitted the angular velocity of 60°/second for its slow speed and due to heavily increased strength component. Rest intervals between the velocities were kept at two minutes. Exercise progression included two sets of exercises at weeks 1 to 4, three sets at weeks 5 to 8 and four sets at weeks 9 to 12. Subjects were adjusting their exercise efforts voluntarily within their exercise tolerance and safety being a priority.

Functional Task Training (FT)

Experimental group 2 received Functional Task Training thrice a week, 45 to 50 min each session for 12 weeks. Each exercise was either timed or expressed in number of repetitions. Intervention protocol in this group was divided in three phases.

Practice phase(2 weeks). Exercises in this phase consisted of short, simple tasks. Weight transported and repetition numbers were noted.

Variation phase(weeks 3 to 6) –Participants apply basic tasks to various training conditions, such as environment, attributes, and interaction.

Daily tasks phase(weeks 7 to 12) -The aim of this phase is to train situations that closely match the participants' daily activities.

The programme specifically targeted four domains:

- Movements with a vertical component like walking upstairs;
- Movements with a horizontal component like walking around;
- Transporting an object;
- Transfers, for example moving from a lying/sitting/ standing position.

Ethical clearance

Ethical clearance was granted by the Human Research Ethics Committee of Universiti Sains Malaysia (FWA Reg. No: 00007718; IRB Reg. No: 00004494), protocol USM/JEPeM/2803.(5).

Statistical Analysis: The data was analyzed using the Statistical Package for Social Science (SPSS) version 22.0 software. Normality of data was determined through histogram where the normality curve was used as an indication whether the data was normally distributed or not. Mixed-Design ANOVA (Repeated measures with a between subject factor) was used to analyze interaction between groups in all parameters and across the experimental time. A simple effect or post-hoc test was used to locate the differences when the two-way repeated measured ANOVA revealed a significant interaction between groups or across the experimental time. Difference were considered significant at $p < 0.05$.

Results: Statistical analysis of the data from 45 patients (age 53.61 ± 6.47 and weight 69.36 ± 11.87) who successfully concluded the intervention revealed some statistically significant effects of various types of training in terms of time (from pre- to mid- to post) in terms of group and in terms of time & group (various training groups differences at pre- at mid- and at posttest).

Strength

Peak torque during the left knee extension at various angular velocities

There was a significant difference across the three time points, $F(2,84) = 27.5$, $p < .001$ and non-significant differences between groups, $F(2,42) = .799$, $p > .001$, in peak torque at 90° angular velocity. There was also a significant interaction between time and group, $F(4,84) = 12.43$, $p < .001$. There was no significant difference between groups at baseline and the control group did not change over time. Both experimental groups have demonstrated steady and significant improvements (Tab 1). IT group has shown significant improvements from pre- to mid- testing with no significant improvement from pre- to post- testing. FT group has been significantly improving from pre- to mid tests, mid- to post tests and also from pre- to post-test. There was a significant difference across the three time points, $F(1.68,84) = 30.52$, $p < .001$ and non-significant differences between groups, $F(2,42) = .26$, $p > .001$, in peak torque at 120° angular velocity. There was also a significant interaction between time and group, $F(3.37,84) = 7.32$, $p < .001$. There was no significant difference between groups at baseline and the control group did not change over time. Both experimental groups have

demonstrated steady and significant improvements (Tab 1) from pre- to mid tests, mid- to post tests and also from pre- to post-test. There was a significant difference across the three time points, $F(2,84) = 35.1$, $p < .001$ and non-significant differences between groups, $F(2,42) = .502$, $p > .001$, in peak torque at 180° angular velocity. There was also a significant interaction between time and group, $F(4,84) = 15.6$, $p < .001$. There was no significant difference between groups at baseline and the control group did not change over time. Both training groups have demonstrated steady and significant improvements (Table 1). FT group have been significantly improving from pre- to mid tests, mid- to post tests and also from pre- to post-test, whereas IT group has only improved significantly from pre- to post-test.

Table 1. Peak torque (Nm) during left knee extension at tested angular velocities

Group	Angular velocity	Pre-test		Mid-test		Post-test	
		MEAN	SD	MEAN	SD	MEAN	SD
Isokinetic	90°	70.29	24.35	77.67*	25.89	81.8	26.86
	120°	68.63	20.05	75.46*	25.62	80.09**, ***	26.86
	180°	61.26	17.05	65.99	22.64	68.93**	24.41
Functional	90°	62.58	24.97	69.55*	24.37	76.44**, ***	20.87
	120°	57.95	19.17	66.04*	20.81	72.44**, ***	20.99
	180°	50.37	20.29	63.01*	23.67	71.39**, ***	23.36
Control	90°	67.52	21.14	65.65	21.75	65.08	20.55
	120°	62.76	17.16	62.77	17.58	63.14	17.47
	180°	58.00	18.89	58.21	19.25	57.44	17.9

Significant: at $p < .05$ *from pre- to mid-; **from pre- to posttest; ***from mid- to posttest

Peak torque during the right knee extension at various angular velocities

There was a significant difference across the three time points, $F(2,84) = 20.04$, $p < .001$ and non-significant differences between groups, $F(2,42) = .127$, $p > .001$, in peak torque at 90° angular velocity. There was also a significant interaction between time and group, $F(4,84) = 9.3$, $p < .001$. There was no significant difference between groups at baseline and the control group did not change over time. Both experimental groups have demonstrated steady and significant improvements (Table 2). IT group have shown significant improvements from pre- to mid and pre to post-test. FT group was significantly improving from pre- to post tests, and mid- to post-tests. At the post test, both groups were significantly superior to control. There was a significant difference across the three time points, $F(1.55,84) = 15.9$, $p < .001$ and non-significant differences between groups, $F(2,42) = .365$, $p > .001$, in peak torque at 120° angular velocity. There was also a significant interaction between time and group, $F(3.1,84) = 9.71$, $p < .001$. There was no significant difference between groups at baseline and the control group did not change over time. Both experimental groups have demonstrated steady and significant improvements (Table 2) from pre- to mid tests, and pre- to post tests. In addition, Functional training group also have improved from mid- to post-test. There was a significant difference across the three time points, $F(1.47,61.7) = 86.3$, $p < .001$ and non-significant differences between groups, $F(2,42) = .375$, $p > .001$, in peak torque at 180° angular velocity. There was also a significant interaction between time and group, $F(2.94,61.7) = 39.78$, $p < .001$. That there was no significant difference between groups at baseline and the control group did not change over time. Both training groups have demonstrated steady and significant improvements (Table 2) from pre- to mid tests, mid to post and pre- to post-tests. At the post-training FT group was significantly better than control group.

Table 2. Peak torque (Nm) during right knee extension at tested angular velocities

Group	Angular velocity	Pre-test		Mid-test		Post-test	
		MEAN	SD	MEAN	SD	MEAN	SD
Isokinetic	90°	85.4	27.46	92.9*	28.18	95.4**	31.88
	120°	83.41	22.95	90.32*	25.52	92.65**	27.15
	180°	68.25	20.22	78.94*	24.49	82**, ***	25.51
Functional	90°	80.07	23.3	87.03*	21.27	95.35**	23.09
	120°	71.25	24.22	79.31*	25.15	89.47**, ***	26.89
	180°	59.79	22.07	76.39*	22.24	87.03**, ***	22.72
Control	90°	74.6	23.05	73.28	23.31	74.49	22.53

120°	78.27	25.08	76.16	23.3	75.07	25.2
180°	67.06	22.35	65.67	21.57	64.19	20.25

Significant: at $p < .05$ *from pre- to mid- ; **from pre- to posttest; ***from mid- to posttest

Ability to perform daily activities and basic functional mobility

WOMAC questionnaire scores

There was a significant difference across the three time points, $F(2,84) = 114.24$, $p < .001$ and significant differences between groups, $F(2,42) = 3.76$, $p = .031$, in WOMAC pain scores. There was also a significant interaction between time and group, $F(4,84) = 13.59$, $p < .001$. There was no significant difference between groups at baseline and the control group did not change over time. Both experimental groups have demonstrated steady and significant improvements from the pre- to mid- and from pre- to posttests. In addition, FT group has also significantly improved from mid- to posttest. At post tests, the scores shown by the subjects of FT group were significantly better than in IT and control groups. At the post test, subjects of both intervention groups have shown significantly better scores than controls (Table3).

Table 3. WOMAC scores of the subjects of all study groups at various testing sessions

Time Group	Pain scores					
	Pre-test		Mid-test		Post-test	
	MEAN	SD	MEAN	SD	MEAN	SD
Isokinetic	8.13	0.92	6.27*	1.22	5.9**	0.88
Functional	7.87	1.3	6.6*	0.99	4.53**,***	0.91
Control	8.2	2.21	7.27	1.62	7.13	1.41
Time Group	Stiffness scores					
	Pre-test		Mid-test		Post-test	
	MEAN	SD	MEAN	SD	MEAN	SD
Isokinetic	4.8	0.94	3.87*	0.74	2.6**	0.63
Functional	4.73	0.88	4.07*	0.704	1.73**	0.88
Control	4.47	1.36	4.2	1.15	3.87	1.36
Time Group	Physical function scores					
	Pre-test		Mid-test		Post-test	
	MEAN	SD	MEAN	SD	MEAN	SD
Isokinetic	28.47	8.62	26.2*	7.49	25.6**	7.71
Functional	27.07	7.36	24.73*	5.69	19.6**,***	4.19
Control	24.67	8.78	22.6	7.3	21.87	7.19

Significant: at $p < .05$ *from pre- to mid- ; **from pre- to posttest; ***from mid- to posttest

There was a significant difference across the three time points, $F(2,84) = 136.7$, $p < .001$ and non-significant differences between groups, $F(2,42) = .095$, $p > .001$, in WOMAC stiffness scores. There was also a significant interaction between time and group, $F(4,84) = 20.33$, $p < .001$. There was no significant difference between groups at baseline and the control group did not change over time. Both experimental groups have demonstrated steady and significant improvements from the pre- to mid- mid- to post- and also from pre- to posttests. At the post test, subjects of both intervention groups have shown significantly better scores than the subjects from control group. FT group readings at the posttest were close to being significantly better than of IT, however not significant enough ($p = .068$) (Table3). There was a significant difference across the three time points, $F(1.72,72.36) = 69.37$, $p < .001$ and non-significant differences between groups, $F(2,42) = 1.135$, $p > .001$, in WOMAC physical function scores. There was also a significant interaction between time and group, $F(3.47,72.36) = 11.12$, $p < .001$. There was no significant difference between groups at baseline and the control group did not change over time. Both experimental groups have demonstrated steady and significant improvements. IT group has shown significant improvements from pre- to mid- testing and from pre- to post- testing, whereas FT group improved from pre- to mid-, mid- to post and pre- to posttests. Interestingly, FT group was significantly ($p = .048$) better than IT at the posttest (Table3).

Gait speed and the ability to go out

There was a significant difference across the three time points, $F(1.36,57.2) = 179.08$, $p < .001$ and non-significant differences between groups, $F(2,42) = 2.27$, $p > .001$, in WOMAC physical function scores. There was also a significant interaction between time and group, $F(2.7,57.2) = 23.28$, p

<.001. There was no significant difference between groups at baseline and the control group did not change over time. Both experimental groups have demonstrated steady and significant improvements from the pre- to mid- and further to posttests. Besides, at the post test, subjects of both intervention groups have shown significantly better timings than subjects from control group (Table4).

Table 4. Timed Up and Go time (s) of the subjects of all study groups at various testing sessions

Time Group	Pre-test		Mid-test		Post-test	
	MEAN	SD	MEAN	SD	MEAN	SD
Isokinetic	15.3	1.14	13.08*	1.04	12.31**	0.85
Functional	14.77	1.16	13.46*	1.15	12.14**	1.38
Control	14.77	1.76	14.17	1.69	14.11	1.53

Significant: at $p < .05$ *from pre- to mid- ; **from pre- to posttest; ***from mid- to posttest

Discussion

Although both experimental groups in this study improved in peak torque in all angular velocities involved, at no point of time (6 and 12 weeks) one group has been superior to another. Studies showed an improvement in muscle strength with an isokinetic exercise program as compared with an isometric exercise program^{18,19} with however no difference to an aerobic program²⁰. In some studies, improvement occurred after 8 weeks and 1-year post intervention²¹. However, no other significant differences between isokinetic exercises and a progressive resistance exercise (PRE) program²² or isotonic exercises or aerobic exercise were found in previous studies. The improvements in muscle strength were typically greater if isokinetic exercises were combined with other treatments, like ultrasound therapy, Chinese Traditional massage²³ and laser treatment²⁴. To the best of our knowledge there was no previous comparison done between isokinetic and functional training in terms of strength gains. Pain was ameliorated with isokinetic training as compared with a control group²⁵, progressive resistance exercise program or educational program. The impact on pain was better if the isokinetic training was associated with ultrasound therapy, especially pulsed ultrasound and Chinese Traditional massage. Pain assessed by the WOMAC sub-score 'pain' was significantly favorably affected by isokinetic training in some studies and not affected in others²⁶. Although both experimental groups in this study improved significantly in WOMAC pain and stiffness scores, none was better than another at 6 and 12 weeks of intervention. Effect on disability Functional indices were better with isokinetic training than isotonic and isometric muscle reinforcement techniques but were equivalent to a progressive resistance exercise program however less efficient than an educational program²⁷. The best results were achieved with isokinetic training and ultrasound therapy combined. Some studies indicated a significant improvement in function assessed by the WOMAC physical function score. It has been reported²⁸ that FT improves functional mobility, balance and decreases pain and stiffness in OA Knee, faster rise time and transfer to task performance and activities of daily living^{29,30}. A study found that similar results in their 12-week study of functional task exercises with an elderly population. Outcome measures were significant for the timed up and go test (TUG), standing reach, sit and reach and self-report of physical function. In current research TUG has improved in both experimental groups with no between the group differences³¹.

Conclusion

Our study corroborates that statement, whereby a FT group was improving significantly better than IT group at week 12 of intervention program. Both traditional strength training (ST) and functional training (FT) groups improved in all measures of pain, balance and functional outcomes. However, FT group benefited by significant relief in pain, achieved good balance & functional mobility than ST group³². Results of the similar study indicated that both groups improved in all measures of pain, Balance and functional outcomes (walking time). However, the effect on pain was better in the FT group³³.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the

advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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