

Eccentric versus concentric isotonic resistance training of quadriceps muscles for treatment of knee osteoarthritis

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Objective: To compare the effect of isotonic eccentric resistance training versus isotonic concentric resistance training for treatment of knee osteoarthritis (KOA).

Methodology: A total of 40 obese female patients with KOA (grade 2 and 3) and age between 40 to 60 years were randomized into 2 equal groups. The 1st group of 20 patients followed a physical therapy program of isotonic eccentric resistance training and the second group of 20 patients had physical therapy program of isotonic concentric resistance training for 8 weeks. We used visual analogue scale, knee range of motion, Western Ontario and McMaster University osteoarthritis

index (WOMAC) and one repetition maximum test.

Results: There was more improvement in isotonic eccentric resistance training when compared to isotonic concentric resistance training.

Conclusion: Both resistance trainings played an important role in decreasing pain and stiffness, by improving muscles strength, range of motion, and functional activities of daily living but isotonic eccentric resistance training was more effective. This study emphasizes that both exercises are essential to incorporate in treatment of KOA. (Rawal Med J 202;46:52-55).

Keywords: Isotonic, eccentric exercise, knee osteoarthritis.

INTRODUCTION

Osteoarthritis (OA) of knee is a common disorder which mainly disturbs subchondral bone and articular cartilage of joint that ultimately leads to joint failure. There is currently no identified treatment for OA. Most affected are females and incidence increases with the age peaking at about 75-80 years.¹ Obesity is a major risk factor for the progress of knee osteoarthritis (KOA). These patients show impaired physical function and muscle strength. Quadriceps muscle strength has an impact on knee pain in KOA.

KOA-related weakness and pain connect with the weak muscle strength of quadriceps femoris (loss of muscle-generating capacity).^{2,3} The two popular methods used for strengthening are isotonic eccentric resistance training (IERT) and isotonic concentric resistance training (ICRT). High-intensity IERT is associated with higher increases in strength compared to ICRT.⁴ Isotonic eccentric muscle contraction (lengthening) happens when a force applied to the muscle exceeds the momentary force created by muscle itself, resulting in the muscle system being forced to lengthen when

contracting.^{4,5} Isotonic concentric muscle contraction (shortening) happens when force created by the muscle exceeds the external force applied, resulting in the muscle-tendon system being shortened when contracting.^{4,6} The aim of this study was to compare the effect of IERT with ICRT for treatment of KOA.

METHODOLOGY

The study included 40 female obese patients of KOA into 2 groups; 20 in each IERT and ICRT group. Inclusion criteria was female gender, obese (BMI >25 kg.m⁻² and <35 kg.m⁻²), age between 40-60 years and patients having pathological KOA of grade 2 or 3. OA grade was defined by radiographs, using Kellgren–Lawrence (KL) scale. Exclusion criteria was known respiratory, metabolic and/or cardiovascular diseases, smokers, alcoholic, comorbid significant disease, conditions that would compromise the safety or limit the capability to participate in testing or interventions and significant cognitive impairment.

There was no drop out throughout the trial. Patients of both groups were first administered heating

modality (Short wave Diathermy or heat pads) before the resistance training. The IERT group was treated by program exercises of isotonic eccentric resistance training and the ICRT group was treated by exercises of isotonic concentric resistance training for eight weeks. Readings of results were taken from the most affected side only.

The 1RM of every subject was evaluated and then training for both groups was done according to the following guidelines; weeks 1–2: 3 sets by 8 reps. intensity: 60% of 1RM; weeks 3–4: 3 sets by 8 reps. intensity: 65% of 1RM; weeks 5–6: 3 sets by 6 reps. intensity: 70% of 1RM; weeks 7–8: 3 sets by 4 reps. intensity: 75% of 1RM.⁷

Both groups were instructed to do a contraction of quadriceps muscle at assigned contraction speeds so that concentric or eccentric would dominate. ICRT participants had knee extensions from 90° of flexion. The muscle contraction occurred in 3 seconds till full end ROM limit. Limb returned to its original position in 1 second. Rest between each repetition was 6 seconds and 1 minute after each set.⁸ The program continued for 8 weeks, investigated and supervised by the same physical therapist. Patients were assessed before and after 8 weeks of treatment. We used body mass index (BMI), visual analogue Scale (VAS) for pain VAS, knee range of motion (KROM) extension, Western Ontario and McMaster University Osteoarthritis Index (WOMAC), and one repetition maximum test weight.⁹⁻¹²

Statistical Analysis: Statistical analysis was performed using SPSS version 25. T-test was utilized for data analysis. $p < 0.05$ was considered significant.

RESULTS

Comparison of two groups is shown in Table 1. The pre and post-test measures in IERT group had significant value ($p \leq 0.05$) which indicated that there was significant decrease of pain on VAS (6.55 ± 1.19 to 2.2 ± 1.15), KROM flexion (86.60 ± 7.177 to 99.10 ± 5.340), extension (-13.20 ± 2.191 to -6.65 ± 1.89), WOMAC scores of pain (10.55 ± 2.28 to 5.60 ± 1.04), stiffness (4.50 ± 1.235 to 1.85 ± 0.875), functional activity (30.80 ± 5.367 to 16.80 ± 5.367), WOMAC total

scores (45.85 ± 8.19 to 24.25 ± 6.973) and 1RM (8.25 ± 0.92 to 11.17 ± 1.05).

Table 1. The comparison of base line data between IERT group and ICRT group.

| Variable | | Mean | SD | Total Mean | Total SD |
|-----------|-----|--------|--------|------------|-------------|
| Age | 1st | 50.50 | 5.916 | 51.325 | 5.427316946 |
| | 2nd | 52.15 | 4.902 | | |
| Height | 1st | 62.20 | 2.966 | 61.5 | 3.055050463 |
| | 2nd | 60.80 | 3.054 | | |
| Weight | 1st | 189.50 | 18.746 | 185.05 | 18.08236143 |
| | 2nd | 180.60 | 16.675 | | |
| BMI | 1st | 34.43 | 2.422 | 34.385 | 2.197031797 |
| | 2nd | 34.34 | 2.009 | | |
| KOA Grade | 1st | 2.40 | 0.503 | 2.4 | 0.496138938 |
| | 2nd | 2.40 | 0.503 | | |

Table 2. Post scores comparison of IERT vs ICRT group.

| Variable | | Mean | SD | T-test | p-value |
|---------------------------------|-----|--------|--------|--------|---------|
| Pain VAS | 1st | 2.20 | 1.152 | -4.375 | 0.000 |
| | 2nd | 3.65 | 0.933 | | |
| KROM Flexion (degrees) | 1st | 99.10 | 5.340 | 3.947 | 0.000 |
| | 2nd | 92.30 | 5.555 | | |
| KROM Extension (degrees) | 1st | 6.65 | 1.899 | 1.899 | 0.001 |
| | 2nd | 9.15 | 2.434 | | |
| WOMAC pain score | 1st | 5.60 | 1.046 | -7.251 | 0.000 |
| | 2nd | 8.80 | 1.673 | | |
| WOMAC stiffness score | 1st | 1.85 | 0.875 | -2.829 | 0.007 |
| | 2nd | 2.90 | 1.410 | | |
| WOMAC functional activity score | 1st | 16.80 | 5.672 | -4.795 | 0.000 |
| | 2nd | 26.20 | 6.685 | | |
| WOMAC total score | 1st | 24.25 | 6.973 | -5.316 | 0.000 |
| | 2nd | 37.90 | 9.124 | | |
| 1 RM | 1st | 11.175 | 1.0548 | 4.604 | 0.000 |
| | 2nd | 9.650 | 1.0400 | | |

The pre and post-test measures in ICRT group had significant value ($p \leq 0.05$) which indicated that there was significant decrease of pain on VAS (6.45 ± 1.099 to 3.65 ± 0.933), KROM flexion (86.50 ± 5.094 to 92.30 ± 5.555), extension (-12.20 ± 2.462 to -9.15 ± 2.434), WOMAC scores of

pain (10.85 ± 2.412 to 8.80 ± 1.673), stiffness (4.45 ± 1.276 to 2.90 ± 1.41), functional activity (30.15 ± 7.422 to 26.20 ± 6.685), WOMAC total scores (45.45 ± 10.480 to 37.90 ± 9.124) and 1RM (8.15 ± 1.43 to 9.65 ± 1.04). When compared post measurements of both groups, there was more significant improvement in IERT group ($p \leq 0.05$), when compared to ICRT group in by VAS, KROM, WOMAC scale and 1 RM (Table 2).

DISCUSSION

Both programs used in this study had a positive effect on the functional capacity of the knee and muscle strength. IERT program of muscle strengthening was more effective than a ICRT program due to the lengthening contraction that was more beneficial than shortening contraction and also the residual muscle fatigue takes place after six seconds in the IERT program as compared to the other group in which it takes place after 5 seconds. So, the force in the IERT program is more as compared to the ICRT program.

An increase in the strength of quadriceps muscles also results in the improvement of the physical health status. An increase in KROM occurs with pain reduction which is responsible for the improvement in muscle strength.^{13,16} Quadriceps muscle strength increase resulted in depletion of load on knee joint. Thus, the joint degeneration and reaction force decreased and also pain and inflammation process became less intense.

Improvement of pain was also due to a decrease in the hyper tonicity and hyperactivity of the quadriceps muscles. The weakness of quadriceps may be etiologically linked to the beginning and the development of pathological variations in persons with KOA. In KOA, the dysfunction and pain originate quadriceps femoris muscle's reflex inhibition. This arthrogenous muscle inhibition change afferent input from the affected joint and consequential reduction in quadriceps's stimulation of the efferent motor neuron.¹⁷

The weakness of quadriceps muscle could raise the risk for additional wasting changes to the knee joint, mostly in those patients with joint laxity and atypical leg alignment.¹⁸ Quadriceps action also acts as a brake, delaying the rate of descent of the leg at

the finish of the swing phase of gait, weakness of quadriceps might fast-track damage to articular cartilage in the knee.^{19,20}

CONCLUSION

IERT and ICRT exercises program are advantageous in strengthening of the quadriceps muscles and the IERT exercises program is more successful as compared to ICRT exercises program in knee osteoarthritis patients.

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