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# Hip versus Ankle muscles strengthening in treatment of Primary Knee Osteoarthritis

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The aim of this study was to compare the effect of adding strengthening exercises of hip extensors and abductors versus ankle dorsi flexors and plantar flexors in treatment of primary knee osteoarthritis. Forty female patients with primary knee osteoarthritis participated in this study were randomly distributed into two equal experimental groups. The first experimental group consisted of 20 patients who received moist hot pack, hip adductors, hamstring and calf stretching exercises, quadriceps and hamstring strengthening exercises, in addition to hip abductors and extensors strengthening exercises. The second experimental group consisted of 20 patients who received moist hot pack, hip adductors, hamstring and calf stretching exercises, quadriceps and hamstring strengthening exercises, in addition to ankle dorsi flexors and plantar flexors strengthening exercises. All patients were treated for 12 sessions, 3 times per week each other day for 4 weeks. Patients were evaluated pretreatment and post treatment for knee pain severity, isometric muscle strength of quadriceps and hamstring, static and dynamic balance and functional ability .The results showed that both groups had significant improvement in all measured variables with P value < 0.0001. There was no significant difference between groups for all variables except for dynamic balance which had significant difference in favor of the second group. It is concluded that both strengthening exercises programs induced significant improvement in all measured variables, however adding strengthening exercises of ankle dorsi flexors and plantar flexors was more effective in improving dynamic balance.

**Keywords: Knee osteoarthritis, hip muscles, ankle muscles, strengthening exercises, stretching exercises.**

## INTRODUCTION

Osteoarthritis was reported to be the sixth leading cause of disability in worldwide, and has been estimated to rise to the fourth leading cause by 2020 (Woolf and Pfleger, 2003). Knee osteoarthritis is the most common type of arthritis and the major cause of disability (Hinman, 2002 and Iwamoto et al., 2011). Muscle impairments in patients with osteoarthritis are not limited to quadriceps but also involve hamstring and the muscles of the hip and ankle joints (Emrani 2006, Astephen et al., 2008 and Costa et al., 2010).Weakness of hip muscles is thought to contribute to knee osteoarthritis by altering the stress on the knee during locomotion, placing knee structures at risk for injury (Brindle et al., 2003; Ireland et al., 2003 and Mascal et al., 2003). Hip abductors muscle weakness has also been reported as a risk factor for development and progression of medial compartment knee

osteoarthritis as weak glueus medieus muscle leads to increased knee adduction moment (Chang et al., 2005 and Mundermann et al., 2005).

Many investigators (Bennell et al., 2007; Bennell et al., 2010; Sled et al., 2010 and Throp et al., 2010) proved that strengthening of the hip muscles is effective in treatment of knee osteoarthritis. In addition, Mousa (2012) proved that adding strengthening exercises of hip abductors and extensors to strengthening exercises of quadriceps and hamstring induced reduction of knee pain severity and knee adduction moment, as well as improved isokinetic strength and functional ability in patients with knee osteoarthritis.

Some studies (Astephen et al., 2008 and El Fiky, 2012) found that, peak ankle dorsiflexion moment is decreased in knee osteoarthritic patients. As well as, Jadlies et al. (2001) proved that ankle muscles weakness was associated with balance deficits in persons with knee osteoarthritis. Furthermore, Abd Allah (2014) proved that adding strengthening exercises of ankle dorsi flexors and plantar flexors to quadriceps and hamstring strengthening exercises was an effective method in treatment of knee osteoarthritis.

To our knowledge there are only two studies (Topp et al., 2002 and Abd Allah, 2014) who investigated the adding of ankle muscles strengthening in treatment of knee osteoarthritis and no previous studies compared between the effect of adding strengthening of hip and ankle muscles in treatment of knee osteoarthritis. Therefore, the main purpose of this work was to compare the effect of adding strengthening exercises of hip extensors and abductors versus ankle dorsi flexors and plantar flexors in treatment of primary knee osteoarthritis.

## MATERIALS AND METHODS

This study was conducted in the outpatient clinic of the Faculty of Physical Therapy, Misr University for Science and Technology, 6th of October City, Giza, Egypt. Forty female patients had primary medial tibiofemoral joint osteoarthritis of age ranged between 40-60 years and duration of illness ranged from 6 months to 2 years. They were randomly distributed into two equal experimental groups. The first group consisted of 20 patients of mean age 46.00 (± 3.87) years, mean weight 93.30 (± 16.87) kg, mean height 159.20 (± 6.70) cm, and mean duration of illness 11.60 (± 4.69) months. The second group consisted of 20 patients of mean age 46.35 (± 4.55) years, mean weight 93.95 (±20.39) kg, mean height 159.00 (± 6.03) cm, and mean duration of illness 12.55 (± 5.57) months.

Each patient was assessed pretreatment and post treatment after the 12th treatment session by measuring knee pain severity using numerical pain rating scale, isometric muscle strength of quadriceps and hamstring using hand held dynamometer, static balance by one leg standing test and dynamic balance using step test. In addition, functional ability was also assessed by using of a 15- meter walking test, ascending stairs test and descending stairs test.

The first group received moist hot pack, hip adductors, hamstring and calf stretching, quadriceps and hamstring strengthening, in addition to hip abductors and extensors strengthening. The second group received moist hot pack, hip adductors, hamstring and calf stretching, quadriceps and hamstring strengthening, in addition to ankle dorsi flexors and plantar flexors strengthening. All patients were treated for 12 sessions, 3 times per week each other day for 4 weeks.

## RESULTS

Pretreatment comparison for the demographic data of both groups was done using unpaired t-test showed that there was no significant difference between groups ($P > 0.5$). Comparison between the medians of knee pain severity of both groups was done using Mann-Whitney U test showed there was no significant difference between groups ($P > 0.5$). Comparison between the means of both groups for isometric quadriceps strength, isometric hamstring strength, static balance, dynamic balance, walking speed, ascending stairs time and descending stairs time was made by using unpaired t-test showed there was no significant difference between groups ($P > 0.5$).

### Posttreatment within groups difference

Using Wilcoxon signed ranks test showed that there was significant difference between the pretreatment median 7.5 (4.0-8.0) and the post treatment median 3.0 (2.0-5.0) of knee pain severity in the first group (hip group) with $z = 3.97$ and $P < 0.0001$, as well as between the pretreatment median 7.0 (4.0-8.0) and the post treatment median 2.5 (2.0-5.0) of knee pain severity in the second group (ankle group) with $z = 3.95$ and $P < 0.0001$.

**Table 1: Within the first group (hip group) difference**

| Variables | Pre-treatment Mean(± SD) | Post-treatment Mean(± SD) | t-value | P-value |
|---|---|---|---|---|
| Isom. Quad. Str. (Newton ) | 118.26 ( ± 30.56) | 145.17 (± 36.82) | 6.07 | <0.0001 |
| Isom. Hamst. Str. (Newton ) | 65.39 (± 20.30) | 86.74 (± 19.00) | 10.11 | <0.0001 |
| Static balance (Seconds ) | 2.48 (±1.05) | 3.03 (±1.21) | 8.50 | <0.0001 |
| Dynamic balance (Number. of steps) | 10.10 (± 2.47) | 11.70 (± 2.54) | 10.51 | <0.0001 |
| Walking speed (M/sec.) | 1.25 (± 0.18) | 1.57 (± 0.31) | 4.88 | < 0.0001 |
| Ascending stairs time (Seconds ) | 6.53 (±1.46) | 5.30 (±1.29) | 10.09 | <0.0001 |
| Descending stairs time (Seconds ) | 6.07(±1.44) | 4.86 (±1.26) | 8.99 | <0.0001 |

**Table 2: Within the second group (ankle group) difference**

| Variables | Pre-treatment Mean(± SD) | Post-treatment Mean(± SD) | t-value | P-value |
|---|---|---|---|---|
| Isom. Quad. Str. (Newton ) | 107.61 (± 27.78) | 134 (± 32.16) | 6.28 | <0.0001 |
| Isom. Hamst. Str. (Newton ) | 59.21 (± 19.36) | 80.71(± 20.99) | 8.44 | <0.0001 |
| Static balance (Seconds ) | 2.20 (± 0.91) | 3.65(± 1.06) | 10.90 | <0.0001 |
| Dynamic balance (Number. of steps) | 11.10 (± 3.31) | 13.80 (± 3.32) | 11.71 | <0.0001 |
| Walking speed (M/sec.) | 1.33 (± 0.23) | 1.52 (± 0.27) | 6.41 | < 0.0001 |
| Ascending stairs time (Seconds ) | 6.85 (± 1.98) | 5.92 (± 1.73) | 6.88 | < 0.0001 |
| Descending stairs time (Seconds ) | 6.74(± 2.10) | 5.77(± 1.70) | 5.70 | <0.0001 |

**Table 3: Post-treatment between groups difference**

| Variables | Group A (Hip Gr.) Mean(± SD) | Group B (Ankle Gr.) Mean(± SD) | t-value | P-value |
|---|---|---|---|---|
| Isom. Quad. Str. (Newton ) | 145.17 (± 36.82) | 134.25 (± 32.16) | 0.99 | 0.32 |
| Isom. Hamst. Str. (Newton ) | 86.74 (± 19.00) | 80.71(± 20.99) | 0.95 | 0.35 |
| Static balance (Seconds ) | 3.03 (± 1.21) | 3.65 (± 1.06) | 1.71 | 0.10 |
| Dynamic balance (Number. of steps) | 11.70 (± 2.54) | 13.80 (± 3.32) | 2.25 | 0.03 (Sig.) |
| Walking speed (M/sec.) | 1.57 (± 0.31) | 1.52 (± 0.27) | 0.51 | 0.61 |
| Ascending stairs time (Seconds ) | 5.30 (± 1.29) | 5.92 (± 1.73) | 1.27 | 0.21 |
| Descending stairs time (Seconds ) | 4.86 (± 1.26) | 5.77(± 1.70) | 1.92 | 0.06 |

Using paired t-test showed that there was significant difference between the pretreatment and the post-treatment means of isometric quadriceps and hamstring muscle strength, static and dynamic balance, walking speed, ascending stairs time and descending stairs time in the first group as shown in table (1) as well as in the second group as shown in table (2)

**Posttreatment between groups difference**

Using Mann-whitney U test showed that there was no significant difference between the post-treatment median of knee pain severity 3.0 (2.0-5.0) of the first group and the post-treatment median of knee pain severity 2.5 (2.0-5.0) of the second group with z = 0.35 and P =0.73.

Using unpaired t-test showed that there was no significant difference between the post-treatment means of isometric quadriceps and hamstring strength, static balance, walking speed, ascending stairs time and descending stairs time as shown in table (3). However, there was a significant difference (t = 2.25 and P= 0.03) between the post-treatment means of dynamic balance in favor of the second group as shown in table (3).

## DISCUSSION

In the current study both groups showed a significant decrease in knee pain severity, increase in isometric strength of quadriceps and hamstring, improvement in both static and dynamic balance as well as functional ability. Regarding the between groups difference, there was no significant difference between groups in all measured variables except in dynamic balance , as the second experimental group who received ankle dorsi flexors and plantar flexors strengthening exercises showed more significant increase in dynamic balance than the first experimental group who received hip extensors and abductors strengthening exercises.

The results of our study are consistent with the findings of Baker et al., (2001) who demonstrated that progressive strength training program of knee extensors and flexors, hip extensors, abductors and adductors improved muscle strength, physical function, and pain in patients with knee osteoarthritis. We are also in agreement with Topp et al., (2002) who used strengthening exercises for 6 muscle groups of the lower limb; these were ankle dorsi flexors and plantar flexors, knee extensors and flexors, hip flexors and extensors. They reported that isotonic resistance training improved functional ability and reduced knee joint pain of patients with knee osteoarthritis.

Our results are also consistent with the findings of many investigators (Bennell et al., 2007; Bennell et al., 2010; Sled et al., 2010, Throp et al., 2010 and Mousa, 2012) who proved that strengthening the hip muscles is effective in treatment of knee osteoarthritis. Bennell et al. (2007) reported that strengthening hip abductors and adductors could lead to slow osteoarthritis progression through reduction of knee adduction moment. In addition, Bennell et al. (2010) proved that strengthening of the hip abductor and adductor muscles improved symptoms and function in patients with knee osteoarthritis. Sled et al., (2010) reported that an 8 week home strengthening program for the hip abductor muscles in patients with knee osteoarthritis resulted in significant improvement in hip abductor strength, improved functional performance and decreased knee pain.

Throp et al., (2010) proved that muscle training focused on the hip abductors in addition to quadriceps and hamstring training would beneficially reduce the dynamic loading of the knees during gait in patients with symptomatic knee osteoarthritis through reduction of knee adduction moment which considered as a risk factor for progression of knee osteoarthritis. Finally, Mousa (2012) concluded that adding strengthening exercises of hip abductors and extensors to quadriceps and hamstring strengthening induced reduction of knee pain severity and knee adduction moment, as well as improved isokinetic strength and functional ability in patients with knee osteoarthritis.

Furthermore our results are consistent with the findings of several previous studies (Jadelis et al., 2001, Topp et al., 2002, Hsieh et al. , 2008, and Abd Allah , 2014) who proved that strengthening of ankle muscles were effective in treatment of knee osteoarthritis. Jadelis et al., (2001) as well as Hsieh et al., (2008) recommended that improving ankle strength may be an alternative way for maintaining dynamic balance for osteoarthritic patients whose pain often limits knee strengthening exercises. Abd Allah (2014) investigated the effect of adding strengthening exercises of ankle dorsi flexors and plantar flexors to quadriceps and hamstring strengthening exercises in treatment of patients with primary knee osteoarthritis. It was reported that adding strengthening exercises of ankle dorsi flexors and plantar flexors was effective method in

treatment of primary knee osteoarthritis as it results in a more significant improvement in knee pain severity and isometric ankle dorsi flexors strength as well as dynamic balance. The significant improvement in dynamic balance may be attributed to increased ankle dorsi flexors isometric strength.

## CONCLUSION

From the findings of this current study and the support of the previous investigations which mentioned earlier, it might be concluded that both hip abductors and extensors strengthening and ankle dorsi flexors and plantar flexors strengthening had a significant effect in treatment of primary knee osteoarthritis for knee pain severity, isometric knee strength, static and dynamic balance, as well as functional ability. Therefore, we can conclude that adding of both hip abductors and extensors and ankle dorsi flexors and plantar flexors strengthening exercises is an effective method in treatment of knee osteoarthritis. Furthermore, strengthening exercises of ankle dorsi flexors and plantar flexors induced more significant improvement in dynamic balance than strengthening exercises of hip abductors and extensors. We recommend the use strengthening exercises of both hip and ankle muscles in addition to knee muscles as an integrated kinetic unit in treatment of primary knee osteoarthritis.

### Ethical Approval

The study was approved by ethical committee of Faculty of Physical Therapy, Cairo University.

## CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

## ACKNOWLEGEMENT

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## AUTHOR CONTRIBUTIONS

All authors contributed equally in all parts of this study.



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