ISOKINETIC STRENGTH MEASUREMENTS IN EARLY KNEE OSTEOARTHRITIS

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Abstract

Objectives: One of the most important reasons for locomotor dysfunction and disability in patients with knee osteoarthritis (OA) is muscle weakness in the lower extremity. The aim of this study was to compare the isokinetic knee muscle strength of patients with early knee OA with those of healthy people.

Patients and Methods: Fifty-one patients with bilateral knee osteoarthritis who were radiologically graded as stage I or II and forty-three healthy subjects were enrolled. Western Ontario and McMaster Universities Osteoarthritis Index and 100 mm VAS were used to assess patients with knee OA. Manual muscle strength testing for quadriceps muscle and circumference measurements 10 cm above the midpatellar line were performed. Bilateral isokinetic (concentric/concentric) knee flexion and extension with the protocol of 60 degrees/sec (four repetitions), 180 degrees/sec (four repetitions) and 240 degrees/sec (20 repetitions) were performed.

Results: Regarding manual muscle testing of knee OA group, quadriceps muscle strength in six knees were 4/5 and in 96 knees were 5/5; whereas in the control group only two knees had 4/5 and the rest 84 knees had 5/5 muscle strengths (p=0.22). Thigh circumference measurements were statistically similar in this regard (all p values > 0.05). In all velocities knee flexor and extensor isokinetic muscle strength values were found to be significantly lower in patients with knee OA compared to healthy subjects (p<0.05). Patients with stage I OA had greater muscle strength than those of stage II (p<0.05).

Conclusions: Whether being a cause or a consequence of knee OA, muscle strength loss which cannot be detected during clinical examination appears to be present during isokinetic measurements.

Keywords: Osteoarthritis; Knee; Muscle strength; Isokinetic testing.

Introduction

Osteoarthritis (OA) is the most commonly seen joint disease throughout the world.[1] The knee joint is often involved and locomotor dysfunction and disability in these patients ensue due to muscle weakness of the lower extremity.[2]

Stability of the knee joint is achieved through two ways, first of which is the active neuromuscular control provided by muscle strength and proprioceptive sense. The second is the passive resistance formed by surrounding ligaments and joint capsule. Any problem arising from these factors may disturb the stability of the joint, thereby rendering it susceptible to degenerative processes.[3] Previously, isokinetic muscle strength of the knee muscles has been shown to decrease significantly in elderly patients with chronic knee OA.[4-9] However, it is still controversial whether muscular weakness is also present in early stages of OA.

Objectives

The aim of this study was to compare the manual and isokinetic knee muscle strength of patients with early knee OA with those of subjects without clinical or radiological evidence of knee OA.

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Patients and Methods

Fifty-one female subjects who were diagnosed with bilateral knee osteoarthritis according to *American College of Rheumatology* (ACR) criteria[10] and whose X-rays were graded as stage I or II according to Kellgren & Lawrence Scale[11] were enrolled. Forty-three female subjects without clinical or radiological evidence of knee OA who volunteered to participate were also recruited (from hospital staff and their relatives) as a control group. Patients were excluded if they had any of the following: active synovitis, arthroscopic/surgical intervention or intraarticular injection within the last six months, any pathology (e.g. lumbar nerve root compression, polyneuropathy, myopathy) that would cause muscle weakness and inability to perform isokinetic testing.

Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) (5-point Likert 3.0) questionnaire which had been validated in our language[12] was performed and pain levels were measured with 100 mm VAS in patients with knee OA. Manual muscle strength testing for quadriceps muscle (Lovett scale; 0-5)[13] and circumference measurements 10 cm above the midpatellar line were performed by the same physician at baseline. Informed consent was taken before subjects agreed to participate.

Isokinetic testing

In both groups, isokinetic quadriceps/hamstring strengths were measured by using the Biodex System 3-Pro (*Biodex Medical Systems, Inc, New York, USA*) dynamometer with the knee attachment. Orientation of the dynamometer was kept at 0°, tilt at 0°, seat orientation at 0°.The patients were seated and secured to the apparatus with chest and thigh straps. The attachments of the dynamometer were adjusted so that the centre of motion of the lever arm was aligned as accurately as possible with the slightly changing flexion-extension axis of the joint. The resistance pad was placed on the distal tibia. The range of motion of the knee joint was kept at 0-90°. Bilateral isokinetic (concentric/concentric) knee flexion and extension with the protocol of 60 degrees/sec (four repetitions), 180 degrees/ /sec (four repetitions) and 240 degrees/sec (20 repetitions) were performed. Enough resting was provided between the sessions and vocal encouragement was standardized.

Statistical Analysis

SPSS 13.0 software was utilized for statistical assessment. Student's t test was used for comparison of the mean values regarding isokinetic test results and Mann Whitney U test was used to compare isokinetic test results between different radiological stages. Chi-square test was used for comparison of manual muscle test results. Pearson coefficients were used for correlation analysis. Statistical significance was set at $p<0.05$.

Results

Demographic and clinical features of the subjects are summarized in Table I. The two groups were found to be statistically indifferent with regard to age and BMI values (p=0.11 and p=0.32, respectively).

Thigh circumference measurements were 47.41±4.57 (right) and 47.44±4.47 (left) in the OA group, and 49.20±4.84 (right) and 48.86±4.85 (left) in the control group. The groups were found to be statistically similar in this regard (all p values > 0.05). Regarding manual muscle testing of knee OA group, quadriceps muscle strength in six knees were 4/5 and in 96 knees were 5/5; whereas in the control group only two knees had 4/5 and the rest 84 knees had 5/5 muscle strengths (p=0.22).

Table II lists isokinetic muscle strength values of

Table I. Demographic and clinical features of the subjects

	Osteoarthritis (n=51)	Control (n=43)
Age	55.6±9.7	52.4±9.6
Sex	Female	Female
Body Mass Index	23.7±5.3	28.6±4.8
WOMAC		
Pain	5.9±0.92	–
Stiffness	5.1±1.3	–
Physical function	6.2±0.7	–
Total	17.2±2.4	–
VAS activity (100 mm)	58.8±9.9	–
K-L radiologic stage		
Stage I	18	–
Stage II	33	–
Dominant leg		
Right	49	40
Left	2	3

VAS: Visual Analogue Scale, K-L: Kellgren-Lawrence

Table II. Isokinetic strength measurements of the subjects

	Osteoarthritis (n=102) mean±SD peak torque/body weight (N-m)/kg	Control (n=86) mean ±SD peak torque/body weight (N-m)/kg	P
60°/s Ext	114.13±39.76	142.85±29.98	<0.001
60°/s Flex	49.48±18.01	69.91±19.66	<0.001
180°/s Ext	80.91±23.13	100.67±20.57	<0.001
180°/s Flex	50.29±13.01	59.50±17.25	<0.001
240°/s Ext	77.05±20.73	87.41±19.50	0.01
240°/s Flex	50.69±16.86	61.68±17.82	<0.001

Ext: Extension, Flex: Flexion

both groups. In all velocities knee flexor and extensor isokinetic muscle strength values were found to be significantly lower in patients with knee OA compared to healthy subjects. When the right and left knee strengths were compared separately, the two groups were again found to be statistically different (Figures 1 and 2).

Isokinetic strength measurements regarding stage I and II (knees) are given in Table III. Patients with stage I had greater knee muscle strength when compared with stage II. There were negative correlations between isokinetic strength values and WOMAC-pain and VAS scores but the correlations were only significant for measurements at 60°/s velocity, both during extension (p values being 0.04 and 0.03 respectively) and flexion (p values being 0.02 and 0.01 respectively).

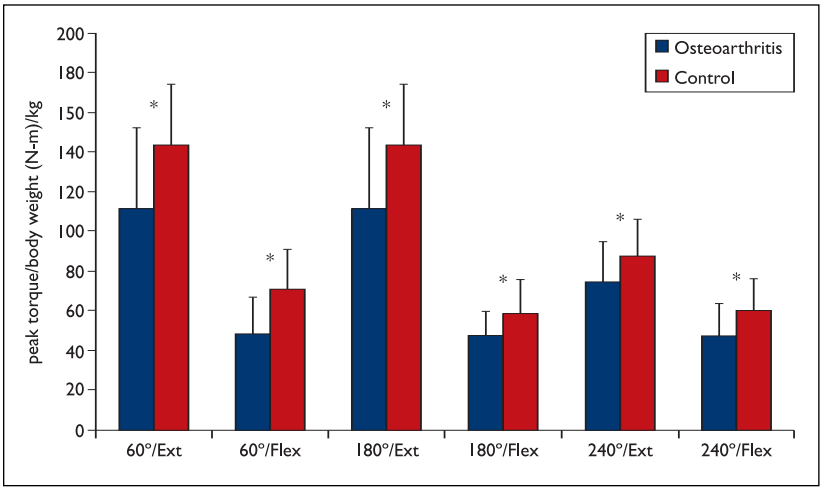

Figure 1. Comparative isokinetic muscle strength measurements of the right extremity (OA vs healthy).
Ext: Extension; Flex: Flexion; (*: p<0,001)

Discussion

In this study, manual and isokinetic knee muscle strength testing of female subjects with early OA were compared with other females without any evidence of knee OA. Although manual muscle testing were similar between the groups, patients with OA were found to have significantly lower flexor and extensor isokinetic knee strength. Further, stage I patients had greater muscle strength when compared with stage II patients.

Regarding OA, a close association was established between dynamic isokinetic muscle strength measurements and the progression level of disease and clinical signs.[14] It is known that isokinetic muscle strength measurements in patients with knee OA is a validated and reliable method in a repeatable manner.[15,16] Many deficits rarely detectable through manual muscle measurement can be revealed using isokinetic measurement.

There might be many reasons for muscle weakness in knee OA. Young et al[17] reported that "arthrogenic muscle inhibition" of quadriceps muscles in patients with knee OA might lead to weakness. This term refers to inhibition of motor neurons due to afferent signals from affected joint or periarticular tissues, i.e. inhibition of muscular contraction. This reflex inhibition may also be detected following joint surgery[18] or with joint effusions.[19] It has been recently shown that in early OA muscle weakness was related with changes in motor unit physiology.[20]

Impaired neuromuscular control, decreased muscle strength and muscle atrophy are related to less muscle use due to pain and dysfunction consequent to the degenerative process. On the other hand, Slemenda et al[5] found significantly lower isokinetic muscle strength in 462 pati-

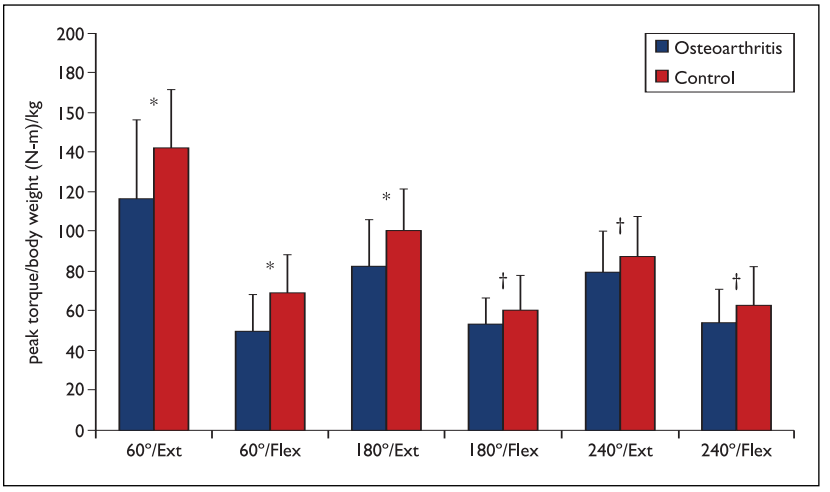

Figure 2. Comparative isokinetic muscle strength measurements of the left extremity (OA vs healthy).
Ext: Extension; Flex: Flexion; (*: p<0,001; †: p<0,05)

Table III. Isokinetic strength measurements of the subjects

	Stage I (n=36) mean±SD peak torque (N-m)	Stage II (n=66) mean ±SD peak torque (N-m)	P
60°/s Ext	103.0±25.7	70.3±18.4	<0.001
60°/s Flex	44.8±12.8	30.6±8.6	<0.001
180°/s Ext	70.1±15.0	51.7±9.0	<0.001
180°/s Flex	39.4±10.0	35.0±8.9	0.02
240°/s Ext	64.3±12.5	50.5±9.1	<0.001
240°/s Flex	42.9±11.0	33.0±9.0	<0.001

Ext: Extension, Flex: Flexion

ents without knee pain or muscular atrophy though having radiological signs of knee OA. Accordingly, they suggested that quadriceps weakness was the primary risk factor for the progression of joint damage, disability and pain. Similarly, our study also showed that while people with early stage knee OA had isokinetic muscle strength loss, they had no significant change in their muscle mass.

Most important factors impairing the function of periarticular muscles in degenerative processes are advanced age, increased fatigue, delayed muscle reaction time, previous minor trauma, abnormal articular sensory input, impaired neuromuscular protective reflexes, and abnormal loads on the joint due to deterioration of shock absorption during walking.[9] There is a complex relationship between disability and cartilage degeneration, and sensorimotor dysfunction originating from muscles around the joint.

The increase of load on the joint accelerates the progression of knee OA, especially in medial compartment.[21] van der Esch et al have shown that isokinetic muscular weakness had more influences on the limitation of functional ability in knee OA patients with poorer proprioception.[6] Their isokinetic testing protocol comprised only 60º/sec measurements; in our study, we have measured at three velocities and found that both in low and high speeds the muscle strength loss was significant. Brandt et al detected that people with knee pain but without radiological signs of OA, had more weakness in quadriceps and hamstring muscles when compared to subjects with pain and radiological signs.[8] In clinical practice, severity of the disease is frequently assessed according to the radiological signs. Nonetheless, mainly in knee OA, the correlation between radiological scores, clinical findings and pain is poor.[22] In our study, although being in the early stage, we have observed muscle weakness in the OA group. However, since the muscle strengths of Stage 1 patients were greater than Stage 2 patients; we may not definitely propose that muscle weakness is a primary factor that has an adverse effect in the disease process.

On the other hand, concerning the negative correlations between pain scores and muscle strength, it would rather be wise to relate these results to some technical features of isokinetic testing. Yet, the correlations were statistically significant only at the velocity of 60°/s and values regarding flexion measurements were more significant than those of extension. During isokinetic testing, a patient may exert less force when it is painful. Considering the

fact that knee flexion is generally more painful than extension and these patients need to apply greater forces during isokinetic measurements at low velocities, our findings seem to be reasonable.

One possible drawback of our study would be related with the difficulties of isokinetic testing. While providing accurate and objective data concerning muscle weakness, isokinetic devices may not be available at every clinic. The required time and manpower further challenge the routine use of this method. Regarding some confounding factors for isokinetic measurements, the absence of pain and stiffness measurements (WOMAC and pain VAS) in control subjects could be another limitation of our study.

To summarize, in the light of our results, we may conclude that muscle strength loss which cannot be detected during clinical examination appears to be present in female subjects with early stage knee OA; moreover, isokinetic measurements seem to uncover such muscle weakness. It should be therefore emphasized that knee strengthening exercises should be given to patients as soon as they are diagnosed to have knee OA. Further studies concerning the effect of exercise therapy on strength measurements are warranted.

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