



Compression of Hamstring and Quadriceps Muscles Strength in Patients with Osteoarthritis of Knee and Normal individual

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JPRI/2021/v33i43A32458

Editor(s):

(1) Dr. Asmaa Fathi Moustafa Hamouda, Jazan University, Saudi Arabia.

Reviewers:

(1) Nurudeen Amusat, St. Joseph General Hospital, Canada.

(2) Ibidunni Alonge, University of Ibadan, Nigeria.

Complete Peer review History: <https://www.sdiarticle4.com/review-history/70418>

Original Research Article

Received 15 May 2021
Accepted 11 July 2021
Published 03 September 2021

ABSTRACT

Objectives: 1. To assess the strength of hamstring and quadriceps in patients with knee OA with 1 RM.

2. To compare the strength of hamstring and quadriceps with normal individuals.

Research Design: Observational study.

Introduction: Quadriceps and hamstring muscle weakness is commonly found in knee OA which may alter normal Quadriceps/Hamstrings ratio i.e. (2:1). So the purpose of the study was to check the strength of the quadriceps and hamstring muscle in OA knee patients and compare it with normal individual.

Method: 20 diagnosed knee OA patients and 21 normal individuals were recruited. Quadriceps and hamstring muscle strength was measured in both case and normal group by using 1 RM method. Q/H ratio was obtained from the muscle strength and both were compared between two groups by using T test.

Materials: Quadriceps table, Metal weight plate, Plinth, Sand bag.

Results & Discussion: Quadriceps and hamstring strength were reduced significantly ($p < 0.001$) in patients with knee OA compare to normal individual. There was negative co relation between pain and muscle strength seen. No alteration in Q/H ratio (Rt knee $p = 0.130$; Lt knee $p = 0.722$) between the case & control found because both the muscle strength reduced similarly.

Conclusion: Quadriceps and hamstring muscle strength is significantly reduced in OA knee. Patients compare to normal individuals but no alteration in Q/H ratio seen in both groups.

Keywords: Osteoarthritis knee; quadriceps strength; hamstring strength; hamstring quadriceps ratio.

1. INTRODUCTION

Osteoarthritis (OA) is degenerative joint disease [1,2,3]. worldwide It is most common chronic musculoskeletal condition [2]. and leading cause of disability among elders [4] resulting in pain, fatigue, functional limitations [4,5,6,7], increased healthcare utilization and high economic costs to society and impact on quality of life [2,5,6]. Worldwide estimates reported 9.6% of men and 18.0% of women aged ≥ 60 years have symptomatic osteoarthritis [8]. Indian Council of Medical Research sponsored multi-centre study on, 'epidemiology of musculoskeletal conditions in India' in 2012 reported that percentage of OA patients are in the category of moderate severity and they varied from 40.5% to 66.5% [9].

OA knee cause remains unknown [5]; obesity, age, joint trauma, and heavy work load are the major risk factors [10]. Risk of OA is increasing with age [5,8]. According to the author Behzad Heidari et al the prevalence of OA is increased significantly with age and in woman mostly after menopause [11]. Occupational activities that physically load the joint like squatting and kneeling, regular heavy weight lifting, climbing and high physical workload contribute in occurrence and or progress the disease [11,12]. Obesity one of the major risk factor for the incidence of bilateral knee OA. It increased mechanical loading of the knee and hip. This would lead to cartilage damage in these weight-bearing joints [5].

Two major muscles of the thigh that inserted around knee joint are hamstrings and quadriceps which play important role in knee flexion and extension⁶. These muscles provide dynamic stability to the knee joint [5,6,13].

A numbers of studies supported that individual with OA knee markedly appears with weaker quadriceps [1,4,6,7,13,14,15,16]. Quadriceps and hamstring weakness is clinically important because in individuals with OA quadriceps and

hamstring weakness is associated with impaired dynamic knee stability and physical function, as both hamstring and quadriceps muscle works concentrically and eccentrically in walking, standing, stair climbing squatting, getting up from the chair, toileting [4,17]. Quadriceps muscle weakness can increased loading on joint which may initiate knee OA or increased existing disease [4,16].

Apart from quadriceps other lower limb muscles including the hip abductors and adductors are also weaker and these muscles may play a role in disease pathogenesis and people with a lower external hip adduction moment (possibly from weaker hip abductor muscles) demonstrated more rapid knee OA progression [18,19].

Many studies found that quadriceps strength reduced by between 25% to 60% [16,17,20,21] and Hamstring strength was reduced by between 20 % to 30% in cases with knee OA. Main cause of muscle weakness is arthrogenic muscle inhibition (AMI); continuing neural inhibition prevents the quadriceps muscles from being fully activated [2,3,4,16,21,22,23]. Quadriceps weakness due to AMI leads muscle atrophy [16,22].

A number of studies have been done in different countries to assess the quadriceps and hamstrings strength in knee OA patients and compare it with normal individual [15,16,17,20,22]. Healthy age –sex matched individuals are more functional as compared to OA knee patients. In OA knee patients the quadriceps and hamstrings muscles Isometric peak torque of the affected leg is lower than healthy age matched controls [15,17,20].

In normal individual the ratio of the quadriceps and hamstring muscles strength are (Q/H) 2:1 [5,15,20]. In people without knee OA, the average Q/H ratio was reported to be about 1.67 (range 1.11–2.32) [5,20]. Normal ratio is altered in knee OA due to alteration in hamstring and

quadriceps muscle strength [5,15,20], but the reduction of quadriceps and hamstring muscles strength in the alteration of the Q/H ratio is still controversial [20].

The present study was planned to assess hamstring and quadriceps strength of subjects with knee osteoarthritis and compare with their age matched healthy control, and to see whether the differential reduction in the strength of these two muscle groups would result in a significant difference in the Q/H ratio.

2. MATERIALS AND METHODS

2.1 Inclusion Criteria

Patients with knee OA unilateral / bilateral were included for the study.

2.2 Exclusion Criteria

Patients with surgeries around the knee, internal fixation / implants in lower limb, Spinal and lower limb pathologies, Secondary OA were excluded.

Information about the study was provided to all the patients, those who satisfy the inclusion criteria were recruited. Total 41 patients were recruited in that 20 patients had OA and 21 people were self-reported healthy individual. After recruiting patients; quadriceps and hamstring muscle strength was measured with 1 RM (procedure describe below) and ratio of quadriceps and hamstrings (Q/H) was calculated. Same method was used to check normal (self-reported healthy) and the strength and ratio of quadriceps and hamstring was compared with the normal same age, sex & BMI group.

2.3 Procedure for Checking Quadriceps Strength [24]

1RM -The 1-repetition maximum (1-RM) refers to the maximum weight that a person can lift through a prescribed range of motion once only.

Patient was in high sitting position with back rested in 120° on quadriceps Table. Patient set with back supported to the backrest and both arms was on arm rest. Metal Weights could be added to the weight stack, when required during testing, the shin pad of the apparatus was positioned just proximal to the lateral malleolus. The starting position of measured knee was 90degree flexion from where patients were asked

to straighten the knee fully. After making patient familiar to the procedure, a load was selected that the subject might lift over 2 to 5 repetitions initially, following a 2-3 minute rest period, the load was increased 5 to 15% according to the perceived level of patient's exertion and a 1-RM was attempted.

If at any point patients were not able to complete full repetition, load was decreased by 5% to 10%. This process continued until the maximum load that the subject could lift with proper technique. During straightening of the knee trick movement should be avoided. The maximum weight was recorded as 1 RM, which was lifted by patient without getting fatigue and trick movement.

2.4 Procedure for Checking Hamstring Strength

Patient was in prone lying position on the plinth. Both feet are kept outside the bed. Sand bag was tied above the malleolus of the leg which is being tested than ask the patient to bend the knee from the full extension to 90degree flexion. After making patient familiar to the procedure, a load was selected that the subject might lift over 2 to 5 repetitions initially, following a 2-3 minute rest period, the load was increased gradually according to perceived level of patient's excursion and a 1-RM was attempted. This process continued until the maximum load that the subject could lift with proper technique. Maximum weight which was lifted by patients without any trick movement and fatigue considerable as 1RM.

Outcome measures

- 1) Isotonic hamstring strength and isotonic quadriceps strength

Repetition Maximum = 1 RM

- 2) The isotonic quadriceps/hamstring strength ratio

Q/H ratio = $\frac{\text{Isotonic quadriceps strength value}}{\text{Isotonic hamstring strength value}}$

All statistical analyses were performed with SPSS (Statistical Package for Social Science) version16 software and Descriptive statistics including Mean, Standard Deviation were calculated. Pearson chi – Square test was applied to check difference basic parameter that is age, weight, height aand BMI of two groups. Independent t – test was applied to compare

intergroup difference in quadriceps strength, hamstring strength, Q/H ratio, and NPRS Mean values, Standard Deviation and Mean Difference.

3. RESULT AND DISCUSSION

Total patients with OA knee (Case group) are 20 and total Normal individuals are 21 for this study. Normal individuals are those who are not diagnosed with any knee OA changes.

A number of studies have reported significant reduction in strength of muscles surrounding the knee joints of patients with OA [4,7,19]. The present study was planned also to check the strength of hamstring and quadriceps muscles in OA knee patients to compare it with normal individual especially because squatting is common activity amongst Indians. In the present study there were 20 OA knee patients and 21 normal individual and both group were homogenous. (Table 1) In present study strength of quadriceps and hamstrings muscles were measured by 1 RM method, and we found reduction in strength of quadriceps and hamstrings muscle compare to normal individual.

The prevalence of OA increases with age [5,11]. recent US data demonstrated that half of people with symptomatic knee OA are diagnosed by age 55 years [5,11]. There is growing recognition that OA affects people at younger ages [5]. In the present study the age range of the patients with knee OA was 30 to 70 years (mean 50.25 ± 10.76), number of patients <45 were 9.

In present study (mainly patients from out of state) there was 75% of male and 25% of female in case group. Worldwide estimates are that 9.6% of men and 18.0% of women aged >60 years have symptomatic osteoarthritis. Radiographic studies of US and European populations aged >45 years show higher rates for osteoarthritis of the knee: 14.1% for men and 22.8% for women [8].

In this study the patients who were recruited with knee OA the mean BMI was $25.35 \text{ kg/m}^2 \pm 6.38$ and in normal group it was $22.65 \text{ kg/m}^2 \pm 4.72$. In present study BMI was higher in case group compare to normal group but statistically there was no significant difference in BMI between two group ($p = 0.135$). Many authors [5,13,14,11] have reported that Knee OA is more common in obese subject than in subjects of normal weight.

The results of the present study aligned with findings in, that both hamstring and quadriceps muscles strength are less in patients with knee OA compare to healthy individuals. Cheing and Hui-Chan [20] (2000), Adegoke B.O.A et al. [15] (2007), and Tamika Heiden et al. [17] have reported that knee OA weakened both the quadriceps and hamstring muscle groups.

A number of studies [4,12,16,17,22,23,25] state that quadriceps weakness to be due to arthrogenic muscle inhibition, which lead consequence of joint such as pain, effusion, and joint damage, decreased motivation, or fear of further joint injury or pain in knee OA [25].

Quadriceps weakness may result from the pain of osteoarthritis [2,10]. In present study we found there is a strong negative correlation between NPRS (pain) and muscle strength. We found that as pain is increasing the strength of quadriceps and hamstring muscles are decreasing (Table 2).

Paula et al. [2] 2012 the data analysis revealed a strong negative correlation between the concentric knee extensor torque and the responses to the pain section of the WOMAC questionnaire. These results indicate that the greater knee extensor torque is, the lower the level of pain that is self-reported by these individuals [2].

Michael D. Lewek et al (2004) [22] studied the quadriceps strength and demonstrated 24% average quadriceps strength deficit compared to the asymptomatic, healthy age matched control group [22]. The author also have reported about other studies which have shown 22-36% decrease in isokinetic quadriceps strength relative to body weight in a group of patients with knee osteoarthritis compared to healthy age matched controls and another which found isometric quadriceps strength 20% weaker than an age matched control group [22].

David A Rice (2011) [16] study reported 20% to 45% marked weakness of the quadriceps muscles strength compared with age and gender-matched controls [16].

Meta analysis by Ali H. Alnahdi et al. [4] (2012) stated 10% to 56% isometric quadriceps strength deficits and 11% and 56% concentric isokinetic muscle strength deficit in patients with OA compared with healthy controls [4].

In the present study the strength of the Quadriceps & Hamstrings was studied by

method of 1 RM. As per Table 3 quadriceps muscle strength is reduce in knee OA patient compare to normal individuals and that is clinically significant. In knee OA patients right side quadriceps strength was 1.55 kg (mean) and left side quadriceps strength was 1.55 kg (mean), and in normal individuals right and left side quadriceps muscle strength was following 4.07 kg (mean) and 4.01 kg (mean) which is more than OA knee patients.

Patients with OA knee also have Isometric strength deficits range from 4% to 35% and concentric isokinetic tests, deficits ranged from 7% to 38% of hamstrings [4]. Tamika L. Heiden [17]. (2009) reported hamstring muscle strength reducing up to 19 % to 25% [17]. As per Table 4 quadriceps muscle strength is reduce in knee OA patient compare to normal individuals and that is clinically significant. In knee OA patients right side hamstring strength was 0.80 kg (mean) and left side quadriceps strength was 0.7 kg (mean), and in normal individuals right and left side quadriceps muscle strength was following 1.7 kg (mean) and 1.7 kg (mean) which is more than OA knee patients. One of the reason of reduction in strength is due to pain.

There are many studies reporting that abductors and adductors weakness is seen in patients with

OA knee [18,19,26]. In present study we also found hip abductors muscles weakness in patients with OA knee, as our objective was to check hamstrings and quadriceps muscles strength we did not check hip abductors strength by 1RM method.

Many studies have reported that in people without knee OA, the average Q/H ratio was found to be about 1.67 (range 1.11–2.32), and there was more reduction in the quadriceps peak torque than in the hamstrings [5,15,20]. Cheing and Hui-Chan et al. [20] 2001 reported that there was a greater loss in the peak torque of knee extensors than in that of flexors, and no significant difference in the Q/H ratio between the more affected and the less affected side among the patients with OA, or between the patients with OA and people without OA [20].

In present study we found there was no significance difference in Q/H ratio of right knee (p =0.130) and left knee (p=0.72) between the case & control (Table 5). The Q/H in the control group was seen to be 2.4071&2.4476 of Rt & Lt resp. Similarly the Q/H of the case group was seen to be 1.9889& 2.3500 of Rt & Lt. Resp. Thus due to equal reduction found in quadriceps and hamstring muscles strength the present study shows no difference (Table 5).

Table 1. Compare basic parameters of two groups

Variables	Case group (n=20)		Normal group (n=21)		t value	p value
	Mean	SD	Mean	SD		
Age (year)	50.25	10.765	48.67	10.919	0.467	0.64
Weight	65.85	11.554	65.00	7.211	0.284	0.778
Height	159.30	8.287	162.23	20.368	-0.597	0.554
BMI	25.3515	6.38464	22.6790	4.72822	1.528	0.135

Table 2. Correlation of numerical pain rating scale (NPRS) and (Q- Quadriceps) &(H- Hamstring) strength of Rt. And left Knee in case group

No.	NPRS Mean (SD)	Strength Mean (SD)	Pearson correlation	p value
17(right)	4.95±1.24	Q-1.55±1.08	-0.956	<0.001
		H-0.80±0.45	-0.65	0.004
20(left)	4.80±1.05	Q-1.55±0.93	-0.889	<0.001
		H-0.70±0.37	-0.58	0.007

Table 3. Comparison of quadriceps muscle strength between two groups

	Group	N	Mean	Std. Deviation	Std. Error Mean	t-value	p-value
Quadriceps_Rt	Case	18	1.5556	1.08314	.25530	-8.545	<0.001
	Normal	21	4.0714	.74642	.16288		
Quardiceps_Lt	Case	20	1.5500	.93048	.20806	-9.302	<0.001
	Normal	21	4.1667	.87082	.19003		

Table 4. Comparison of hamstring muscle strength between two groups

	Group	N	Mean	Std. Deviation	Std. Error Mean	t-value	p-value
Hamstrings_Rt	Case	18	.8056	.45822	.10800	-7.112	<0.001
	Normal	21	1.7143	.33806	.07377		
Hamstrings_Lt	Case	20	.7000	.37697	.08429	-8.464	<0.001
	Normal	21	1.7381	.40679	.08877		

Table 5. Comparison of Q/H ratio between case and normal groups

	Group	N	Mean	Std. Deviation	Std. Error Mean	t-value	p-value
QH_Ratio_Rt	Case	18	1.9889	1.18415	.27911	-1.549	0.130
	Normal	21	2.4071	.33850	.07387		
QH_Ratio_Lt	Case	20	2.3500	1.20416	.26926	-0.358	0.722
	Normal	21	2.4476	.33035	.07209		

4. CONCLUSION

Thus present study found significant reduction in quadriceps and hamstring strength in knee OA patients compare to normal individuals. There is no significant difference in Q/H ratio in both the groups.

ETHICAL APPROVAL AND CONSENT

Ethical approval was granted by the Sumandeep Vidyapeeth Institutional Ethical Committee (SVIEC) and patients with knee OA unilateral / bilateral was taken for this study. And informed consent was obtained from participants who were willing to participate Patient information sheet was provided to participants /relatives (which was explaining about assessment. Subjects were assessed in detail as per the format by the researcher, following their consent.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:

The peer review history for this paper can be accessed here:
<https://www.sdiarticle4.com/review-history/70418>