

Quadriceps Avoidance after total Knee Arthroplasty: Descriptive Study

MUHAMMAD NAUMAN JAMAL^{1*}, ANS HANIF², SAMEEN SAEED¹, SIDRA SHABBIR¹, ISHRAT FATIMA¹, SHAH SALMAN³

¹Department of Physio-Therapy, Akhtar Saeed College of Rehabilitation Sciences, Lahore-Pakistan

²Department of Physio-Therapy, Al-Sheikh Welfare Hospital, Sialkot-Pakistan

³Department of Physio-Therapy, Jinnah Hospital, Lahore-Pakistan

Correspondence to Dr. Muhammad Nauman Jamal, Email: noumanjamal335@gmail.com Tel:+92-321-8330725.

ABSTRACT

Background: Quadriceps avoidance is a reflex deficit disorder of quadriceps activation after total knee arthroplasty (TKA) that can lead to abnormal gait kinematics. It is patient apprehension due to pain, to prevent quadriceps activation that induces deforming forces at the knee joint.

Aim: To describe the frequency of 'quadriceps avoidance' among patients after total knee arthroplasty.

Study Design: Descriptive case series.

Methodology: The study sample size comprised of 55 post-TKA patients (Male: 16; Female: 39), who were the ages of 40-80 years. Participants were recruited who had undergone unilateral total knee replacement and attended an outpatient physiotherapy clinic of Ghurki trust teaching hospital and Surgimed hospital Lahore. Participants were undergone 'quadriceps avoidance gait' testing at approximately 02 weeks and 01 month postoperatively by using a diagnostic observational questionnaire, designed according to the observational gait analysis. Data was evaluated by using SPSS version 23. All qualitative data was presented in frequency form and quantitative data was in the form of mean±SD.

Results: Mean age of patients was 58.98 with range minimum of 40 years to a maximum of 80 years. Out of a sample size of 55, 25 (45.5%) patients were diagnosed with quadriceps avoidance after TKA, 11(20%) were male patients out of 16 and 14 (25.5%) were female patients out of 39 which showed 'stiff knee gait' pattern.

Conclusion: It was concluded that quadriceps avoidance after total knee arthroplasty was one of major complication of abnormal gait pattern which can lead to knee joint deformities if left uncorrected.

Keywords: Total knee arthroplasty, Quadriceps avoidance, Gait kinematics, Gait kinetic

INTRODUCTION

Quadriceps avoidance is a leading cause of abnormal gait kinematics and kinetics among posttraumatic, end-stage knee osteoarthritis, and postoperative patients worldwide due to reflex inhibition. Decrease in total knee range of motion and reduced knee flexion angle during quadriceps eccentric contraction in loading response of stance phase observed¹. Total knee arthroplasty (TKR) is a surgical procedure that improves function and reduces pain, a patient demonstrates with asymmetrical gait pattern 'stiff knee gait' that may affect joint loading pattern and muscle activation².

Quadriceps avoidance examined on the basis of observation of gait pattern. The total knee arthroplasty patients demonstrate a 'quadriceps avoidance' gait pattern, in which the quadriceps activating significantly less to the extension moment eccentrically developed about the knee during loading response (weight acceptance) in early stance phase. A significant decrease in the activation of the quadriceps occurs concentrically to the acceleration (initial swing) phase and eccentrically to the forward deceleration of the center of mass COM (terminal swing) phase. The TKA patients compensate this deficiency by flexing the trunk forward at early midstance to conserve the line of gravity that falls anterior to the knee joint^{3,4}.

The prevalence of TKA in older adults of fifty years of age or above estimated 4.2% population in the united states, about half of them diagnosed with preoperative knee osteoarthritis⁵. The prevalence of quadriceps avoidance among patients after total knee arthroplasty contains about 17% per year⁶.

A Gap that exists in recent research is that quadriceps avoidance is as similar to extensor lag. Extensor lag is a clinical sign that develops in a case of postoperative knee stiffness with hamstring contractures due to immobilization, while quadriceps avoidance is patient apprehension to prevent anterior tibial translation by avoidance of activation of the quadriceps in postoperative knee arthroplasty without phenomena of knee stiffness and hamstring contractures⁷. The rationale of the study was to help physical therapists to educate the patients about the

adverse effects of quadriceps avoidance at the early stages of gait training, in order to prevent the gait abnormalities caused by quadriceps activation deficits.

The objective of the study was to describe the frequency of quadriceps avoidance' among patients after total knee arthroplasty.

METHODOLOGY

The study was conducted at Ghurki trust teaching Hospital (GTTH) and Surgimed Hospital, Lahore-Pakistan following approval from ethical committee. Subjects (n=55) were enrolled in present study through non-probability convenience sampling technique.

All participants were radiographically and in combination with clinical history diagnosed with end stage knee osteoarthritis from an experienced group of orthopedic surgeons. Under supervision of physiotherapists of Ghurki trust teaching hospital and Surgimed Hospital, Participants were undergone 'quadriceps avoidance gait' testing at two different time periods: 1) approximately 4 weeks postoperatively; 2) 6 weeks postoperatively. When patients were able to walk 10 meters along corridors, turn round and then walk 10 meters back. Assessment tool was a diagnostic observational questionnaire, designed according to the observational gait analysis and variables were used in previous studies, to assess quadriceps avoidance at affected steps of stance and swing phase of gait cycle after total knee arthroplasty. Validation of questionnaire was done according to 'content validation of questionnaire' criteria by university of Health Sciences (UHS). All Post-operative total knee arthroplasty patients (males and females) having age (40-80 years) and ability to walk 20 meters without assistance were enrolled. Patients with preoperative 3rd or 4th grade knee osteoarthritis were also included. Patients with pre-operative traumatic ACL history, walking with frame or stick, postoperative active infections, DVT, vascular and neuromuscular conditions that affect gait pattern were excluded.

Statistical analysis: All data collected were analyzed through statistical package for social sciences (SPSS) version 23. The study variables were presented in the form of descriptive statistics (tables, graphs, bar charts and bar graphs). The numeric data like age was presented in the form of Mean ± SD and qualitative data like gender, quadriceps avoidance etc, were presented in the form of frequency and percentages.

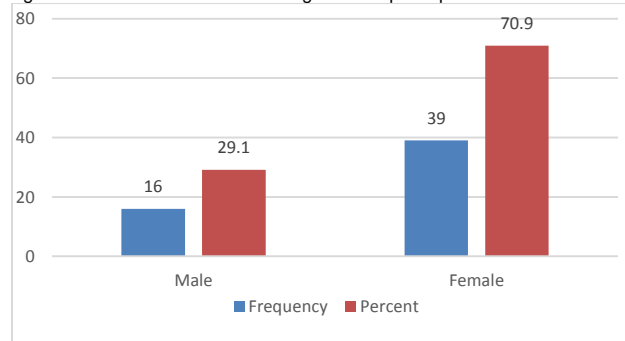
Received on 13-05-2022

Accepted on 27-09-2022

RESULTS

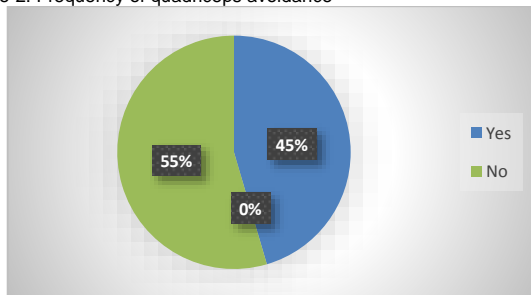
Mean age and Standard Deviation of the sample size (n=55) was 58.9818 ± 9.348 and Range of the age was 40-80 years. According to gender discrimination, in the sample of 55 TKA patients, 16 (29.1%) were male patients who underwent TKA, whereas 39 (70.9%) were female patients who underwent TKA. So, in this study majority of female patients had undergone a total knee arthroplasty procedure having a previous history of end stage osteoarthritis as shown in figure-1.

Figure-1: Gender distribution among enrolled participants



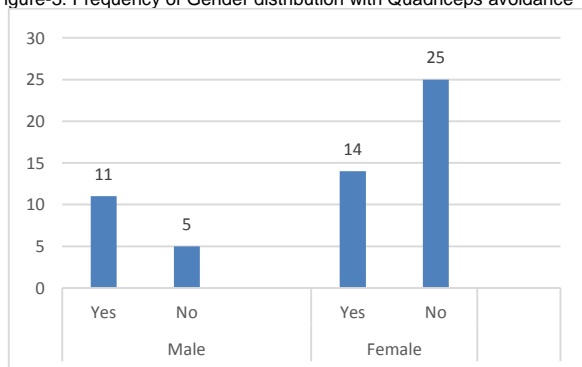
To find the frequency of quadriceps avoidance after TKA, In sample of total n=55 patients, 25(45.5%) patients were diagnosed with quadriceps avoidance gait pattern and 30 (54.5%) did not showed quadriceps activation deficits and had normal gait pattern as shown in figure-2.

Figure-2: Frequency of quadriceps avoidance



Out of Sample size (55 patients), 16 were male patients, out of which 11(20%) showed quadriceps avoidance gait pattern and 5(9%) had normal gait pattern. And 39 were female patients, out of which 14(25.5%) showed quadriceps avoidance gait pattern and 25(45.5%) had normal gait pattern. So, according to results of study males exhibited two times greater chances of quadriceps activation deficits after TKA as compare to females (Fig. 3)

Figure-3: Frequency of Gender distribution with Quadriceps avoidance



DISCUSSION

This research was conducted to find the frequency of quadriceps avoidance among patients after total knee arthroplasty having preoperative history of end stage knee osteoarthritis. Quadriceps weakness had directly association with knee osteoarthritis (OA) of tibio-femoral and patella-femoral joints. Quadriceps strength prevents the abnormal loading at both tibio-femoral and patella-femoral joints and acts as shock absorber resemble with⁸ which discuss that quadriceps strength prevents patellofemoral syndrome, anterior knee pain and knee varus malalignment. The study indicated that the patients include both males and females were belonging to the age group (40-80) years and the majority of them were males. A diagnostic observational questionnaire used in previous researches⁹⁻¹¹ to observe quadriceps avoidance gait at affected steps of stance and swing phase.

The quadriceps avoidance gait pattern were tested after 04 weeks and 06 weeks, when patients started to perform knee bending after opening of knee stitches. The study revealed that in postoperative TKA patients, out of sample size of n= 55, 05 patients showed quadriceps avoidance gait pattern after 04 weeks and 20 patients after 06 weeks. By using a diagnostic observational questionnaire, patients exhibited quadriceps avoidance at stance phase more than swing phase of gait pattern. Co-activation in stance phase after TKA stabilize the knee joint. Patients showed decreased loading response (double leg support) and increase knee extension during flat foot (weight acceptance) instead of normal 20 degrees of knee flexion due to apprehension of increase anterior tibial translation. In swing phase, patients showed increase knee flexion during the initial swing (acceleration phase) of swing phase and increased knee extension during terminal swing (deceleration phase), in order to prevent the quadriceps activation and directly enter into a stance phase. In past research it is clear that patients has impaired loading response, small knee extensor moment and low quadriceps muscle recruitment after 02 to 03 months followed by TKA^{9,10}.

This result confirmed present study as patients showed decrease stance phase (loading response) and weight acceptance phase (knee extensor moment) after 04 weeks and 06 weeks. The past research shows that knee range of motion, peak knee flexion angle and velocity at swing phase increased after pre terminal (toe off) of stance phase after total knee arthroplasty^{12,13}.

Limitations: Limitations were that cooperation of patients after TKA to attend an out-patient clinic of hospital due to multiple restricting factors and problems. The study was conducted only in Lahore, Pakistan because total knee arthroplasty is an advance surgical procedure and shortage of time faced.

CONCLUSION

It is concluded that frequency of quadriceps avoidance after total knee arthroplasty was 45.5%. During gait pattern, patient's stance phase was more affected by quadriceps activation deficits than swing phase. Male patients were affected twice by quadriceps avoidance as compared to female patients after total knee arthroplasty. So, it concludes that quadriceps avoidance is a major complication after TKA that leads to abnormal gait pattern and induced stress on patient's both knees.

Author's contribution: NMJ& AH: Conceptualized the study, analyzed the data, and formulated the initial draft, SS&SS: Contributed to the proof reading, IF&SS: Analyzed data.

Conflict of interest: None

Funding: None

REFERENCES

- Hart JM, Pietrosimone B, Hertel J, Ingersoll CD. Quadriceps activation following knee injuries: a systematic review. Journal of athletic training. 2010;45(1):87-97.

2. McGinnis K, Snyder-Mackler L, Flowers P, Zeni J. Dynamic joint stiffness and co-contraction in subjects after total knee arthroplasty. *Clinical Biomechanics*. 2013;28(2):205-10.
3. Li K, Ackland DC, McClelland JA, Webster KE, Feller JA, de Steiger R, et al. Trunk muscle action compensates for reduced quadriceps force during walking after total knee arthroplasty. *Gait & posture*. 2013;38(1):79-85.
4. Rahman J, Tang Q, Monda M, Miles J, McCarthy I. Gait assessment as a functional outcome measure in total knee arthroplasty: a cross-sectional study. *BMC musculoskeletal disorders*. 2015;16(1):1.
5. Weinstein AM, Rome BN, Reichmann WM, Collins JE, Burbine SA, Thornhill TS, et al. Estimating the burden of total knee replacement in the United States. *J Bone Joint Surg Am*. 2013;95(5):385-92.
6. Yoshida Y, Zeni Jr J, Snyder-Mackler L. Do patients achieve normal gait patterns 3 years after total knee arthroplasty? *journal of orthopaedic & sports physical therapy*. 2012;42(12):1039-49.
7. Jerosch J, Aldawoudy AM. Arthroscopic treatment of patients with moderate arthrofibrosis after total knee replacement. *Knee Surgery, Sports Traumatology, Arthroscopy*. 2007;15(1):71-7.
8. Amin S, Baker K, Niu J, Clancy M, Goggins J, Guermazi A, et al. Quadriceps strength and the risk of cartilage loss and symptom progression in knee osteoarthritis. *Arthritis & Rheumatism*. 2009;60(1):189-98.
9. Yoshida Y, Mizner RL, Snyder-Mackler L. Association between long-term quadriceps weakness and early walking muscle co-contraction after total knee arthroplasty. *The Knee*. 2013;20(6):426-31.
10. Rahman J, Tang Q, Monda M, Miles J, McCarthy I. Gait assessment as a functional outcome measure in total knee arthroplasty: a cross-sectional study. *BMC musculoskeletal disorders*. 2015;16(1):1-9.
11. Zhang HH, Yan SH, Fang C, Guo XY, Zhang K. Clinical evaluation and gait characteristics before and after total knee arthroplasty based on a portable gait analyzer. *Orthopaedic Surgery*. 2016;8(3):360-6.
12. Kiss RM, Bejek Z, Szendrői M. Variability of gait parameters in patients with total knee arthroplasty. *Knee Surgery, Sports Traumatology, Arthroscopy*. 2012 ;20(7):1252-60.
13. Fransen BL, Mathijssen NM, Slot K, de Esch NH, Verburg H, Temmerman OP, Hoozemans MJ, van Dieën JH. Gait quality assessed by trunk accelerometry after total knee arthroplasty and its association with patient related outcome measures. *Clinical Biomechanics*. 2019 1;70:192-6.