

# Prevention of quadriceps inhibition is the key to achieve movement of the knee joint after total knee replacement and lower end of femur surgery

**Kundu ZS<sup>1</sup>, Vandana<sup>2</sup>, Verma Vishal<sup>3</sup> and Verma Bhawna<sup>4</sup>**

<sup>1</sup>Director and senior orthopaedic surgeon of Positron Multispecialty Hospital  
Rohtak, Haryana, India

<sup>2</sup>Final year student of Department of Physiotherapy, Guru Nanak Dev University  
Amritsar, Punjab, India

<sup>3</sup>Consultant Orthopaedic Surgeon of Positron Multispecialty Hospital, Rohtak, Haryana, India

<sup>4</sup>Assistant professor, PT.B.D.Sharma institute of health sciences, Rohtak, Haryana, India

\*Corresponding Author: Vandana; [drvandana978@gmail.com](mailto:drvandana978@gmail.com)

## ABSTRACT

**Background:** Knee stiffness and weakness of quadriceps is common after surgeries around knee and even after total knee replacement. Swelling and inflammation in the early phases after surgery may contribute to stiffness and arthrogenic muscle inhibition. Aggressive physiotherapy to regain range of motion and early isometric and isotonic exercises are indicated for prevention of complications.

**Material and method:** This were a descriptive, cross-sectional study which included hundred patients (without any limit of age range) attending the orthopaedic physical therapy outpatient department of Positron Hospital were selected for this study. The subjects were assessed for quadriceps inhibition and knee range of motion. The patients were assessed one week, six weeks and 12 weeks post surgery. The patients underwent supervised physiotherapy till 6 weeks and were put on home exercise program for next 6 weeks.

**Results:** The quadriceps inhibition in initial phase was about 25% and quadriceps inhibition in recovery phase remained only 5%. There was zero flexion deficit in 30%, 59% and 76% of patients in first week, sixth week and twelfth week respectively. Mean of flexion deficit in hundred patients were 15% in first week, 6.5% flexion deficit remained in sixth week and only 2.9% flexion deficit left in twelfth week.

**Conclusion:** Quadriceps inhibition was seen in 25% patients. Quadriceps inhibition was not associated with gender or age. There was moderate to strong correlation between flexion deficit and quadriceps inhibition

**Keywords:** knee stiffness; total knee replacement; isotonic; isometric exercise

## INTRODUCTION

<sup>1</sup>The knee joint is a complex hinge type and synovial joint that lined by hyaline cartilage connects three bones: the femur, tibia and patella and composed of two articulations: the tibiofemoral joint and patellofemoral joint. The knee joint is the largest and feasibly the most weight bearing joint in the body. The arrangement of the bones is such that the joint act as a fulcrum that express the actions of the flexor and extensor muscles of the knee. The primary extensor of the knee joint is quadriceps femoris, assisted commonly known as the quad muscle. Quadriceps muscle is the strongest muscle of the human body. It is located in the anterior compartment of the thigh, together with the Sartorius. Quadriceps femoris of four muscle bellies; rectus femoris, vastus lateralis, vastus medialis and vastus intermedius. All these four muscles innervated by the femoral nerve. <sup>2</sup>Total knee arthroplasty (TKA) has manifested to be an exceedingly successful procedure for the relief of draining pain associated with degenerative joint disease or trauma or surgery. <sup>3</sup>Stiffness due to soft tissue tightness and intra articular adhesions in extension is most common complication which result in restriction of range of motion of joint after trauma or surgery. <sup>4</sup>Patients experience persistent weakness and atrophy of the quadriceps muscle after knee injury, knee surgery or in patients with knee joint arthritis which is partly caused by an ongoing neural activation deficit of the quadriceps, a process known as arthrogenic muscle inhibition (AMI) in the operated leg after surgery. If it does not improve then total knee replacement or lower end of femur surgery is indicated. <sup>5</sup>Stiffness is the most common complication after trauma or surgery and can be reduced by vigorous physiotherapy. <sup>6</sup>Quadriceps strength and endurance are of vital importance for normal knee joint function. Quadriceps strength restoring for normal quadriceps function after knee joint injuries is an essential component of rehabilitation. Consequently, <sup>7</sup>exercise-based rehabilitation encompassing isometric and isotonic exercise of quadriceps and hamstring is common practice after TKR.

**METHODOLOGY**

The study was a cross-sectional study including 100 patients who underwent knee surgery and attended orthopaedic physical therapy outpatient department of Positron Hospital were recruited in the study. The patient who underwent surgeries for fracture shaft of femur, intercondylar tibial fracture and total knee replacement were included. Fracture shaft of femur were managed surgically by an open reduction and internal fixation with closed interlocking nailing, plate and screw fixation. Fracture at intercondylar region of tibia managed by an open reduction with plate and screw fixation. The subjects were excluded if they had Osteoporosis, bone infections (osteomyelitis), Osteochondritis dissecans (loose bodies), traumatic effusion, bone tumors, fractures treated with closed reductions, Chondromalacia patella, traumatic synovitis, psychiatric problems and were unwilling to participate. The patients who were willing to participate signed an informed consent and attended outpatient physical therapy department. Quadriceps activation, muscle strength and knee range of motion was recorded at one week after surgery and at 6 weeks and 12 weeks follow up. The range of motion was recorded and flexion deficit was calculated. Muscle strength was assessed using manual muscle testing. Marked weakness of quadriceps muscle at one week post surgery was marked as presence of quadriceps inhibition. Quadriceps inhibition was also noted at 6 weeks follow up. The patients were given supervised physiotherapy sessions as per standard protocol for 6 weeks followed by home exercise plan for another 6 weeks.



**POST: TKR knee extension**



**POST: TKR knee flexion (first week)**

## RESULTS

The study included 100 patients out of which 68 were males. The mean age of the patients was 38.13±15.92 years. Quadriceps inhibition was seen in 25% of patients one week after surgery. 19 males and 6 females had quadriceps inhibition. Chi square test showed no association of quadriceps inhibition with gender. Also, no significant relationship was seen between age and quadriceps inhibition ( $r = -.113$ ).

Flexion deficit was recorded from range of motion. There was zero flexion deficit in 30%, 59% and 76% of patients in first week, sixth week and twelfth week respectively. Mean flexion deficits recorded at first, sixth and twelfth week are presented in TABLE 1.

Flexion Deficit	Mean	Standard deviation
First week	14.65	14.68
Sixth week	6.5	9.91
Twelfth week	2.9	5.95

Significant correlations were seen between quadriceps inhibition and flexion deficit at first and twelfth weeks. TABLE 2 shows correlation coefficients between quadriceps inhibition and flexion deficit.

	Correlation coefficient	p value
Quadriceps inhibition and flexion deficit (first week)	.820	< 0.01
Quadriceps inhibition and flexion deficit (twelfth week)	.585	< 0.01

## DISCUSSION

<sup>8</sup>Total knee replacement (TKR) is considered an effective intervention for the treatment of chronic knee pain and disability especially in end-stage knee osteoarthritis. Stiff knee is a common complication of surgeries around knee. <sup>9</sup>The post traumatic knee stiffness can impose a severe handicap and disability that can severely threaten the occupational and leisure activities of the patient.

<sup>10</sup> It is widely accepted that an aggressive rehabilitation protocol is mandatory for a proper ROM recovery and to avoid the onset of arthrofibrosis and heterotrophic ossifications. <sup>11</sup>Knee osteoarthritis in advanced stages can also lead to limited range of motion which is disabling for the patients.

<sup>12</sup>Results of this study demonstrated that more intensive exercise combined with physical activity promotion and health education delivered at least 3 months after TKR is safe and well tolerated by patients. Patients were also supported by low nutrition, high exercise adherence, and no adverse events. It is widely accepted that an aggressive rehabilitation protocol is mandatory for a proper ROM recovery and to avoid the onset of arthrofibrosis and heterotrophic ossifications, as said "NO PAIN NO GAIN".

<sup>13</sup>Stiffness caused by soft tissue tightness and intra articular adhesions in extension is more common that restrict range of motion of joint after trauma or surgery and can be reduced by vigorous physiotherapy.

<sup>14</sup>Supervised physiotherapy after knee replacement and internal fixation aims to regain early range of motion in knee.

<sup>15</sup>The Total Knee Replacement is a major surgical operation, which play a vital role in successfully achieving knee flexion and extension range depends both on the surgeon as well as the patient. <sup>22</sup>To achieve a successful outcome, preparation begins in the preoperative period with patient education on knee exercises and is followed up postoperatively by adhering to a strict postoperative vigorous physiotherapy protocol. This would help patient to prevent quadriceps inhibition and allow toning and strengthening of the quadriceps and hamstring muscles. The patient must be checked for any mild extensor lag which he may have on follow-up.

There is profound quadriceps weakness in early stages after the surgery. Arthrogenic muscle inhibition appears to be most severe in the acute stages of joint damage and post-surgery (17,18) Quadriceps inhibition is a barrier to effective rehabilitation after knee surgeries. Inhibition prevents full activation of the muscles and may delay strengthening. Quadriceps inhibition is caused by change in the discharge of sensory receptors around knee due to factors like swelling, inflammation, joint laxity and damage to articular receptors (19). Arthrogenic muscle inhibition is not associated with age and pain (16, 18).

## CONCLUSION

Quadriceps inhibition was seen in 25% patients at first week and 5% at 12 weeks. Quadriceps inhibition was not associated with gender or age. There was moderate to strong correlation between flexion deficit and quadriceps inhibition.

## REFERENCES

- [1] Abulhasan, J.F.; Grey, M.J. Anatomy and Physiology of Knee Stability. *J. Funct. Morphol. Kinesiol.* 2017, 2, 34.
- [2] Bong, M. R., & Di Cesare, P. E. (2004). Stiffness after total knee arthroplasty. *The Journal of the American Academy of Orthopaedic Surgeons*, 12(3), 164–171. <https://doi.org/10.5435/00124635-200405000-00004>
- [3] Kundu, Z., Sangwan, S., Guliani, G., Siwach, R., Kamboj, P., & Singh, R. (2007). Thompson's quadricepsplasty for stiff knee. *Indian journal of orthopaedics*, 41(4), 390–394. <https://doi.org/10.4103/0019-5413.3700>

- [4] Jakobsen, T. L., Jakobsen, M. D., Andersen, L. L., Husted, H., Kehlet, H., & Bandholm, T. (2019). Quadriceps muscle activity during commonly used strength training exercises shortly after total knee arthroplasty: implications for home-based exercise-selection. *Journal of experimental orthopaedics*, 6(1), 29. <https://doi.org/10.1186/s40634-019-0193-5>
- [5] Bong, M. R., & Di Cesare, P. E. (2004). Stiffness after total knee arthroplasty. *The Journal of the American Academy of Orthopaedic Surgeons*, 12(3), 164–171. <https://doi.org/10.5435/00124635-200405000-00004>
- [6] Hurley, M. V., Jones, D. W., & Newham, D. J. (1994). Arthrogenic quadriceps inhibition and rehabilitation of patients with extensive traumatic knee injuries. *Clinical science (London, England: 1979)*, 86(3), 305–310. <https://doi.org/10.1042/cs0860305>
- [7] Meier, W., Mizner, R. L., Marcus, R. L., Dibble, L. E., Peters, C., & Lastayo, P. C. (2008). Total knee arthroplasty: muscle impairments, functional limitations, and recommended rehabilitation approaches. *The Journal of orthopaedic and sports physical therapy*, 38(5), 246–256. <https://doi.org/10.2519/jospt.2008.2715>
- [8] Rasnick, Robert & Standifird, Tyler & Reinbolt, Jeffrey & Cates, Harold (Hal) & Zhang, Songning. (2016). Knee Joint Loads and Surrounding Muscle Forces during Stair Ascent in Patients with Total Knee Replacement. PLOS ONE. 11. E 0156282. 10.1371/journal.pone.0156282.
- [9] Kundu, Z., Sangwan, S., Guliani, G., Siwach, R., Kamboj, P., & Singh, R. (2007). Thompson's quadricepsplasty for stiff knee. *Indian journal of orthopaedics*, 41(4), 390–394. <https://doi.org/10.4103/0019-5413.37004>
- [10] Wylde, V., Beswick, A., Bruce, J., Blom, A., Howells, N., & Gooberman-Hill, R. (2018). Chronic pain after total knee arthroplasty. *EFORT open reviews*, 3(8), 461–470. <https://doi.org/10.1302/2058-5241.3.180004>
- [11] [https://www.physiopeadia.com/index.php?title=Flexion\\_Deformity\\_of\\_the\\_Knee&oldid=240091](https://www.physiopeadia.com/index.php?title=Flexion_Deformity_of_the_Knee&oldid=240091).
- [12] Varacallo M, Luo TD, Johanson NA. Total Knee Arthroplasty (TKA) Techniques. [Updated 2020 Jul 31]. In: StatPearls [Internet] Sattler, L. N., Hing, W. A., & Vertullo, C. J. (2019). What is the evidence to support early supervised exercise therapy after primary total knee replacement? A systematic review and meta-analysis. *BMC musculoskeletal disorders*, 20(1), 42. <https://doi.org/10.1186/s12891-019-2415-5>
- [13] Luo TD, Hubbard JB. Arthroplasty Knee Unicompartamental. [Updated 2020 Jul 8]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2020 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK538267/>
- [14] [https://www.physiopeadia.com/index.php?title=Total\\_Knee\\_Joint\\_Replacement\\_Revision\\_Surgery&oldid=222372](https://www.physiopeadia.com/index.php?title=Total_Knee_Joint_Replacement_Revision_Surgery&oldid=222372)
- [15] Bade, M. J., Kohrt, W. M., & Stevens-Lapsley, J. E. (2010). Outcomes before and after total knee arthroplasty compared to healthy adults. *The Journal of orthopaedic and sports physical therapy*, 40(9), 559–567. <https://doi.org/10.2519/jospt.2010.3317>
- [16] Urbach, D., & Awiszus, F. (2002). Impaired ability of voluntary quadriceps activation bilaterally interferes with function testing after knee injuries. A twitch interpolation study. *International journal of sports medicine*, 23(4), 231–236. <https://doi.org/10.1055/s-2002-29074>
- [17] Machner, A., Pap, G., & Awiszus, F. (2002). Evaluation of quadriceps strength and voluntary activation after unicompartamental arthroplasty for medial osteoarthritis of the knee. *Journal of orthopaedic research: official publication of the Orthopaedic Research Society*, 20(1), 108–111. [https://doi.org/10.1016/S0736-0266\(01\)00068-7](https://doi.org/10.1016/S0736-0266(01)00068-7)
- [18] Mizner, R. L., Petterson, S. C., Stevens, J. E., Vandenborne, K., & Snyder-Mackler, L. (2005). Early quadriceps strength loss after total knee arthroplasty. The contributions of muscle atrophy and failure of voluntary muscle activation. *The Journal of bone and joint surgery. American volume*, 87(5), 1047–1053. <https://doi.org/10.2106/JBJS.D.01992>
- [19] Bampouras, T. M., Reeves, N. D., Baltzopoulos, V., & Maganaris, C. N. (2006). Muscle activation assessment: effects of method, stimulus number, and joint angle. *Muscle & nerve*, 34(6), 740–746. <https://doi.org/10.1002/mus.20610>