

Evaluation of Thompson's quadricepsplasty results in patients with knee stiffness resulted from femoral fracture

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Background: Posttraumatic and/or postsurgical knee stiffness is one of the orthopedic complications which is difficult to be treated and can affect individual's life negatively. The aim of this study is to investigate the results of quadricepsplasty in patients with knee stiffness resulted from femoral fracture. **Materials and Methods:** This is a cross-sectional study on all patients with femoral fracture which has caused knee flexion limitation referred to Kashani and Al-Zahra Hospitals in Isfahan from January 2010 to March 2013. The type and site of fracture, joint extension, and fracture fixation technique were recorded. Moreover, the range of motion (ROM) before surgery, under general anesthesia, and 3- and 6-month postoperation were measured. **Results:** Among the patients, 13 had a simple fracture (48%) and 14 had a segmental fracture (51.9%). Considering the fracture site, 11, 10, and 6 patients had femoral (40.74%), supracondylar (37.3%), and femoral supracondylar (22.2%) fractures, respectively. The fracture fixation was performed by the plate, external, and Wagner fixation techniques for 24 (88.9%), 2 (7.4%), and 1 (3.7%) patients, respectively. The mean ROM before operation, under general anesthesia, and 3- and 6-month postoperation were determined to be $33.15^\circ \pm 24.73^\circ$, $122.60^\circ \pm 10.22^\circ$, $99.63^\circ \pm 16.52^\circ$, and $100.74^\circ \pm 15.67^\circ$, respectively. The mean ROM value at various stages was not similar ($P < 0.001$). The mean changes in the ROM were $79.2^\circ \pm 24.6^\circ$ and $62.1^\circ \pm 19.7^\circ$ in the cases with simple and segmental fractures, respectively. The mean changes in the knee ROM were significantly higher in simple fractures in comparison with the segmental femoral fracture ($P = 0.03$). **Conclusion:** We found Thompson's quadricepsplasty may successfully increase the range of knee flexion in knee fracture and also regardless of quadriceps time.

Key words: Flexion contracture, knee stiffness, Thompson's quadricepsplasty

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INTRODUCTION

Posttraumatic and/or postsurgical knee stiffness is one of the orthopedic complications which is difficult to be treated.^[1]

The influence of joint stiffness on individual's function varies in different joints. For instance, good function is observed in stiffness of ankle and wrist, whereas knee stiffness affects occupational, daily, and leisure activities in negatively, especially in youth.^[2]

Intra- or extramedullary fixation of distal femoral fractures can cause knee stiffness and under 70° flexion can pose gait problems and also limping. Underlying mechanism of knee stiffness as an adverse effect of femoral shaft fracture is fibrosis and contracture of quadriceps muscle. A major site for fibrosis is vastus intermedius, which passes directly anterior surface of femur. This makes the muscle prone to damage. Fibrosis of this region interferes with normal mechanism of knee flexion.^[1,3]

Before the 1970s, nonoperative treatment was the choice for knee stiffness.^[4] Operation success is significantly dependent on distal femoral fixation effectiveness.^[4-6]

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One of the surgical procedures is quadricepsplasty, in which the quadriceps muscle is released for knee flexion improving. The most popular surgical method for knee stiffness is Thompson and Judet quadricepsplasty.^[1]

This study was carried out to investigate the results of quadricepsplasty in patients with knee stiffness resulted from femoral fracture.

MATERIALS AND METHODS

The current study was a cross-sectional experiment performed on all patients with femoral fracture which has caused knee flexion limitation referred to Kashani and Al-Zahra Hospitals (affiliated to Isfahan University of Medical Sciences), from January 2010 to March 2013 [Table 1].

The experimental protocol was approved by the Research and Ethics Committee of Isfahan University of Medical Sciences (Research Project Number: 391351). The patients signed an informed written consent before the study.

Inclusion criteria were being in the age range of 18–60, having knee stiffness following femoral fracture, knee flexion limitation of $<90^\circ$, and lacking underlying systemic diseases.

The exclusion criteria were positive history for neuromuscular diseases, previous disorders of knee joint, unwillingness to participate in the study, or to attend follow-up visits for any reason.

Thirty-four patients met the inclusion criteria, among whom seven patients were not willing to participate in the study. Thus, the study was conducted on 27 remained patients.

Table 1: Frequency of characteristics of the fracture in patients

Fracture related information	Number(%)
Type of fracture (%)	
Simple	13 (48)
Segmental	14 (51.9)
Site of fracture (%)	
Femoral shaft	11 (40.74)
Supracondylar	10 (37.03)
Supracondylar-shaft	6 (22.2)
Joint extension (%)	
Positive	9 (33.3)
Negative	18 (66.7)
Fracture fixation technique (%)	
Plate	19 (70.37)
Intramedullary nail	5 (18.51)
External fixation	2 (7.4)
Wagner	1 (3.7)

First, the researcher explained the disease, its course, expected results, and surgical methodology for the patients. Then, history taking and physical examinations were performed.

Type and site of fracture, joint extension, and fracture fixation technique were recorded in patients' profile.

The patients underwent general anesthesia. This was achieved by propofol (2–3 mg/kg/min) or isoflurane (1.2 mac). Then, patients underwent quadricepsplasty according to the Thompson's method.

In this method, a midline incision was done from distal femur or on previous incision (from anterolateral side of thigh between rectus femoris and vastus intermedius muscles) to tibial tuberosity. The rectus femoris muscle was released from vastus intermedius. Vastus intermedius was also freed from anterior side of femur. Knee extensors were freed in medial and lateral surfaces of patella. Furthermore, the medial and lateral retinaculum and adhesions of suprapatellar gutter and those between patella and femoral condyles were released. Finally, the knee was gently flexed up to 90° to release the intra-articular fibrotic bands. After complete release of quadriceps muscle, the wound was washed, a drain was fixed, and fascia, subcutaneous, and cutaneous tissues were repaired and underwent sterile dressing. Finally, the knee was immobilized by casting in relative flexion (50° less than the flexion achieved under general anesthesia).^[1]

After fulfillment of the operation, pain was controlled by narcotic injection for 3 days (during hospitalization) and then managed conservatively using nonsteroidal anti-inflammatory analgesics. On fourth postoperative day, the cast was removed, and the knee was placed in a night splint at full extension for 2 weeks. In this step, active range of motion (ROM) of knee was maintained two to three times a day (flexion up to 60° since the 1st day) and gradually increased in 2 weeks. Physiotherapy was initiated from the 3rd week and continued until 3rd month. If knee flexion of up to 90° was not achieved, gentle manipulation was performed under general anesthesia. This was performed after the release of all suprapatellar and thigh soft tissues to release the intra-articular fibrotic bands. The manipulation should be gentle to avoid the rupture of thigh muscles or femoral fracture. The preoperative and 3- and 6-month postoperative ROM were measured and compared. The knee ROM was measured using an orthopedic scale when the patient was on operating room bed.

Another variable is quadriceps time (QT) that means the interval between management of the primary fracture and quadricepsplasty operation.

Finally, the data were analyzed using mean ± standard deviation for descriptive data and repeated measure and Bonferroni *post hoc* for analytics by the SPSS software version 22 (IBM SPSS Statistics 22, United States).

RESULTS

In the current study, 27 patients with a mean age of 27.85 years (age range of 18–60) were evaluated. Among the participants, 26 (96.3%) were males.

Two patients were complaining from extension contracture, and other 25 ones had flexion contracture.

The data related to fractures are given in Table 1.

Moreover, mean ROM values achieved under general anesthesia as well as measured ROM after 3 and 6 months were significantly higher than that measured before the operation ($P < 0.001$ for all mentioned measurements) [Table 2].

The ROM values 3 and 6 months after operation were not significantly different ($P = 0.542$) [Table 2]. However, both values were less than ROM achieved under general anesthesia ($P < 0.001$).

The mean changes in knee ROM were significantly higher in simple fractures in comparison with segmental femoral fracture ($P = 0.03$) [Chart 1 and Figure 1].

Figure 1 shows a comparison of simple and comminuted femoral fracture (Fx).

The results indicated that the ROM changes did not have a statistically significant relationship with age ($r = 0.16$, $P = 0.42$). Furthermore, the QT value and changes in knee ROM were not significantly related ($r=0.159$, $P = 0.43$).

The complications of the surgery were observed only in two cases; one case experienced patellar bone fracture and one had septic arthritis of knee.

DISCUSSION

Quadricepsplasty is a procedure for treating severe knee extension, as knee stiffness influences individual's life negatively and $<70^\circ$ of knee flexion can cause limping.^[7] Knee flexion limitation is caused by fibrosis, parapatellar retinaculum shortening, vastus intermedius fibrosis, and rectus femoris shortening.^[1,3]

Thompson's quadricepsplasty method is a procedure which resolves knee movements' limitation by isolating rectus femoris from the vasti.^[1]

In the current study, the mean preoperation ROM was 33° (10° – 90°) and the mean ROM under general anesthesia was 123° (100° – 140°). This is while the mean postoperation ROM values after 3 and 6 months were 100 and 101° (both in the range of 70° – 120°), respectively. Considering the results, the knee ROM under general anesthesia and 3 and 6 months after operation were significantly higher than preoperation ROM. The values obtained in 3 and 6 months after operation were not significantly different, but both were less than the

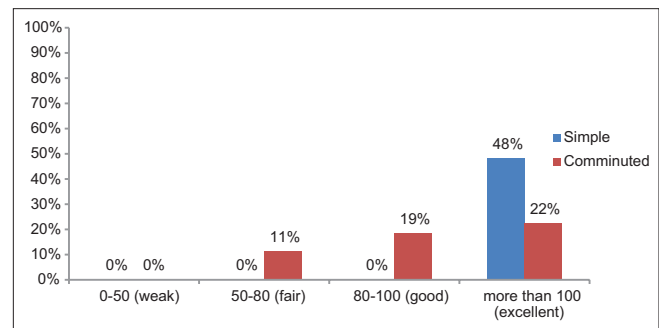


Chart 1: Comparison of simple and comminuted femoral Fx (after 6 months)

Table 2: Descriptive data on the range of motion by time and type of fracture

ROM (°)	Type of fracture	Mean±SD	Minimum	Maximum	n
Before operation	Simple	31.54±26.95	10	90	13
	Segmental	34.64±23.41	10	90	14
	Total	33.15±24.73	10	90	27
Under general anesthesia	Simple	128.46±6.90	120	140	13
	Segmental	117.14±9.94	100	130	14
	Total	122.60±10.22	100	140	27
3-month postoperation	Simple	111.54±9.87	90	120	13
	Segmental	88.57±13.51	70	110	14
	Total	99.63±16.52	70	120	27
6-month postoperation	Simple	110.77±10.38	90	120	13
	Segmental	91.43±14.06	70	110	14
	Total	100.74±15.67	70	120	27

SD = Standard deviation; ROM = Range of motion

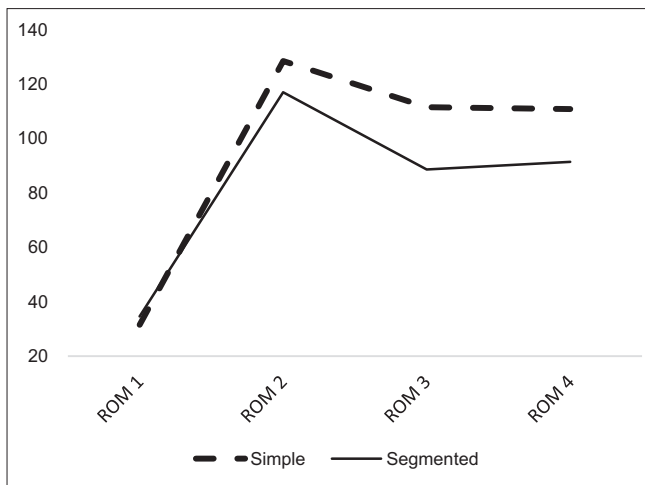


Figure 1: Changes in range of motion by time and type of fracture. ROM1 = Range of motion before operation, ROM2 = Range of motion under general anesthesia, ROM3 = Range of motion after 3 months, ROM4 = Range of motion after 6 months

achieved ROM during the operation under general anesthesia.

In a study of Kundu *et al.*, the results of 22 cases undergone quadricepsplasty according to the Thompson's method were in accordance with ours. Twenty out of 22 patients achieved $\geq 90^\circ$ of knee flexion with a range of $90\text{--}120$.^[11] In the other study that patients underwent Judet quadricepsplasty, preoperation ROM of $5^\circ\text{--}80^\circ$ changed to $45^\circ\text{--}160^\circ$ with a mean of 105° . However, their operation method was different from that in the current study. Thus, the results could suggest the effect of quadricepsplasty operation, rather than operation method, on performance improvement in patients.^[8] In this regard, some other studies with different operation methods can be considered. For instance, 33% of patients in Nicoll study who underwent Judet quadricepsplasty method achieved $> 80^\circ$ of knee flexion.^[9]

Considering the results obtained from quadricepsplasty with other techniques, it seems that other techniques are probably less effective than Thompson's quadricepsplasty. However, there is no study available about the comparison of various techniques of quadricepsplasty in terms of effectiveness.

Ali *et al.* studied ten patients who underwent Judet quadricepsplasty because of severe extraction contracture of knee following femoral fracture and treatment by external fixation. The patients had preoperative knee flexion range of 33° on average and the flexion range of 88° was achieved in 24-month follow-up.^[7]

In the study of Alici *et al.*, 11 patients who underwent Judet quadricepsplasty were followed up for 49 months and

mean improvement in knee flexion range was 70° , with a maximal movement range of 130° .^[10] In another study, the clinical outcomes of 21 cases of Judet quadricepsplasty were investigated in follow-up of up to 101 months. Among patients participated in this study, 8 (38.10%), 9 (42.86%), and 4 (19.05%) patients achieved knee flexion range of $>100^\circ$, $80^\circ\text{--}90^\circ$, and $50^\circ\text{--}80^\circ$, respectively.^[11] As can be observed, our findings are in accordance with the results of three studies mentioned above. Nevertheless, the follow-up period was 24, 22, and 101 months, while the follow-up period for our study was 6 months. Hence, short follow-up period can be considered as a limitation of the current study.

The complications of the surgery were observed only in two cases; one case experienced patellar bone fracture and one had septic arthritis of knee. It seems that the complications were not related to surgical technique and were similar in different surgical methods. Complications can be attributed to various factors such as the surgeon's skillfulness and postoperation delivered care.

A small number of studies have been performed in this field, and no similar studies have been carried out in Iran. Moreover, in the current study, the relationship between the knee ROM and the fracture type and post-quadricepsplasty follow-ups were investigated.

Considering the results obtained in this study, it is suggested to conduct further studies to compare the results of various quadricepsplasty methods.

CONCLUSION

We found Thompson's quadricepsplasty may successfully increase the range of knee flexion in knee fracture and also regardless of QT.

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Conflicts of interest

There are no conflicts of interest.

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