

A Modified Thompson Quadricepsplasty for Extension Contracture Resulting From Femoral and Periarticular Knee Fractures

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Background: The lack of knee flexion is an increasingly recognized complication of femoral and periarticular knee fractures. This is a significant challenge for both surgeon and patients.

Methods: This article reports the clinical outcomes of 40 knees in 40 patients who underwent a modified Thompson quadricepsplasty. They were 36 men and 4 women. We performed a modified Thompson quadricepsplasty for all patients without excision of vastus intermedius even in scarred cases. The definitive flexion gain was classified recording to Judet criteria; excellent defined as >100 degrees, good when >80 degrees and <99 degrees, fair when >50 degrees and <79 degrees, and poor when <50 degrees.

Results: Patients were operated on average 6.9 months \pm 3.6 months (range, 4–24 months) after first initial surgery. Average follow-up was 17.5 months (range, 12–24 months). According to Judet criteria, 9 patients (22.5%) achieved excellent, 27 patients (67.5%) good, 2 patients (5%) fair, and 2 patients (5%) poor. Final average flexion arc improvement was 65 degrees \pm 25.99 degrees with a range between 5 degrees and 100 degrees. Our complications included two cases (5%) of superficial infection and one case (2.5%) with patellar fracture. In patients who had preoperative extension lag, we did not achieve a significant improvement of the extension lag ($p = 0.062$).

Conclusion: Modified Thompson quadricepsplasty is a promising procedure with satisfactory results. It provides significantly results if it is performed earlier and in more severe extension contracture.

Key Words: Knee stiffness, Quadricepsplasty, Knee extension contracture, Knee surgery, Thompson quadricepsplasty, Knee fracture, Distal femoral fracture, Iran.

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Knee stiffness is a commonly recognized complication of high-energy complex fracture of the lower limbs. Extension contracture of the knee is much less common than flexion contracture,¹ but a more disabling problem especially in Asian countries where as a result of social and religious customs, kneeling is an important part of daily living.^{2,3}

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Quadricepsplasty was first described by Thompson in 1944 and from then it has been the most frequently used technique for the management of knee extension contracture.⁴ However, despite being widely used, there is not an agreement among surgeons as how early the surgical intervention, the preoperative mobility as measured by the flexion arch, and the patient age predict clinical outcome of this procedure.^{5,6}

The purpose of this study was to answer the following questions:

1. Does earlier surgical intervention (quadricepsplasty) results in better final range of motion?
2. Does flexion arcs of motion before quadricepsplasty influence final achieved flexion arcs of motion?
3. Does patient age influence the achieved postoperative flexion arcs of motion?

PATIENTS AND METHODS

The present retrospective study consisted of 40 knees in 40 patients who were admitted to our clinic at Mashad University of Medical Science, Mashad, Iran, with postoperative knee stiffness resulting from femoral and periarticular knee fractures, in the period between 2000 and 2005. The study was approved by the research committee of our institute.

Inclusion criteria consisted of patients who failed a controlled nonoperative regimen for a period of 8 weeks to 18 weeks despite an intensive physiotherapy program and who did not gain any improvement by manipulation under anesthesia. Patients excluded from our study included those with a history of infection, hip or ankle deformity, and neurovascular impairment. A goniometer was used for knee range of motion before, during, and after surgery.

Causative factors for knee stiffness included distal femoral fracture in 23 patients (57.5%), mid-shaft femoral fracture in 8 patients (20%), proximal femoral fracture in 2 patients (2%), proximal tibial fractures in 5 patients (12.5%), and both femur and tibial fractures in 2 patients (5%). Five patients (12.5%) had already undergone manipulation under anesthesia and 35 patients (87.5%) had no history of manipulation.

Surgical Technique and Aftercare

A modification of Thompson quadricepsplasty was performed for all patients in this study by using a standard anterior longitudinal incision in 31 patients and on the previous scar in 9 patients.

The principle of Thompson’s quadricepsplasty is to isolate the rectus femoris completely from the vasti and to develop it to such an extent that it takes over the action of knee extension contracture.

The operation was performed without a tourniquet, so the anterior incision may be extended proximally for adequate release of the rectus femoris if needed.

The rectus femoris was freed from the vastus lateralis, medialis, and intermedius. The vastus intermedius was never excised even when found scarred and fibrosed. Instead, the rectus femoris, vastus lateralis, and medialis were released from the vastus intermedius. For more knee flexion range and intra-articular release, an incision was extended to the medial and lateral patellar retinaculum.

Occasionally, the rectus femoris must be lengthened because of fibrosis of the muscle and failure to achieve flexion. This, however, was not performed on any of the patients in this study. The wound was hemostated by electrocautery and closed with suction drainage.

Continuous Passive Motion (CPM) was used for immediate postoperative rehabilitation while patients stayed in the hospital. The CPM range was started from 0 to 70 flexion and gradually increased until maximum flexion was achieved.

Measurement of Clinical Outcome

The Judet classification was adopted in this study. “Excellent” was achieved when >100 degrees, “good” when >80 degrees, <99 degrees, “fair” when >50 degrees, <79 degrees, and “poor” when <50 degrees.⁷⁻⁹ The flexion and extension strengths were graded from 0 to 5 according to the Daniel’s scale. The patients were followed-up by the attending surgeons (M.H.E., A.B.N.) at intervals of every 2 weeks for first 3 months and then every month for the next 6 months regularly. The patients were examined at 8, 10, and 12 months postoperatively.

Data Collection and Static Analysis

The data were collected during hospital stay and at follow-up visits. It was analyzed by χ^2 and independent Student’s *t* tests by using SPSS (version 11.5; Chicago, IL) software.

RESULTS

This study included 40 knees in 40 patients, who underwent a modified Thompson quadricepsplasty. Thirty-six patients (90%) were men and 4 patients (10%) were women. The age of patients ranged between 17 years and 65 years, with an average of 30.52 years. Most patients were between 20 years and 29 years (19 patients, 47%; Fig. 1).

We used a modified Thompson quadricepsplasty technique for all patients and our incision was anterior longitudinal in 31 knees (77.5%) and on the previous scar in 9 cases (22.5%). Patients were operated for quadricepsplasty between 4 months and 24 months posttrauma surgery with an average of 6.9 months \pm 3.6 months (Fig. 2).

Interval between primary trauma surgeries to quadricepsplasty was <10 months in 35 cases (87.5%) and >10 months in 5 cases (12.5%). Average of follow-up was 17.5 months with a range of 12 months to 48 months.

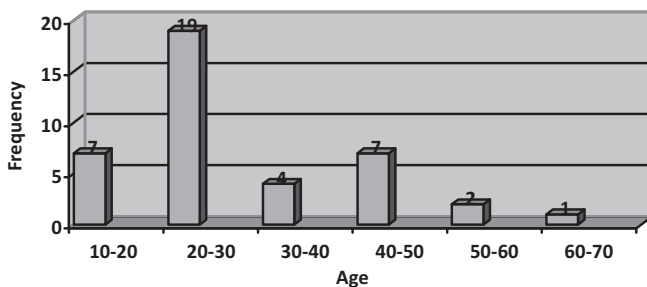


Figure 1. Distribution of patients into 10-year age groups.

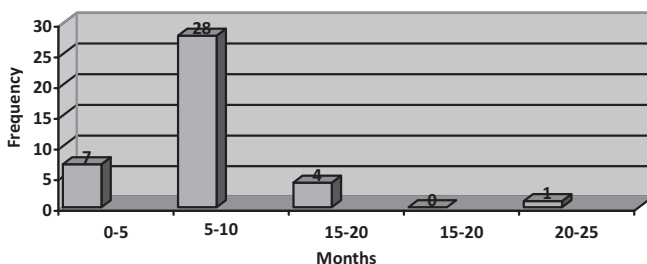


Figure 2. Incidence of patients interval between primary trauma surgery and quadricepsplasty.

TABLE 1. Flexion Range Before, During Surgery, and at Follow-Up in 40 Patients Who Undergone Quadricepsplasty

	Maximum	Minimum	Average
Preoperative	90	0	30.75 \pm 28.54
During surgery	140	100	124 \pm 15.15
Follow-up	140	40	95.75 \pm 20.74

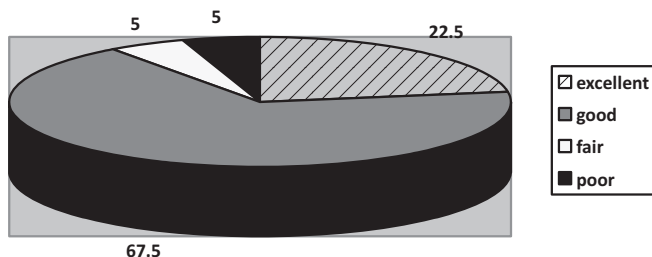


Figure 3. Frequency of patients outcome according to Judet criteria.

Knee flexion was assessed with a goniometer before, during, and after surgery (Table 1). Using the Judet criteria, 9 patients achieved excellent (22.5%), 27 patients (67.5%) good, 2 patients (5%) fair, and 2 patients (5%) poor (Fig. 3).

A significant improvement was appreciated when comparing preoperative and follow-up flexion arch (*p* = 0.002). In patients who had preoperative extension lag, a significant improvement of extension lag was not achieved (*p* = 0.062; Table 2). Final average flexion arc improvement was 65 degrees \pm 25.99 degrees with a range between 5 degrees and 100 degrees. The patients were then divided into two groups

TABLE 2. Extension Lag Preoperative and Postoperative

	Maximum	Minimum	Average
Preoperative	30	5	10.45 ± 7.89
Follow-up	20	5	10 ± 5.77

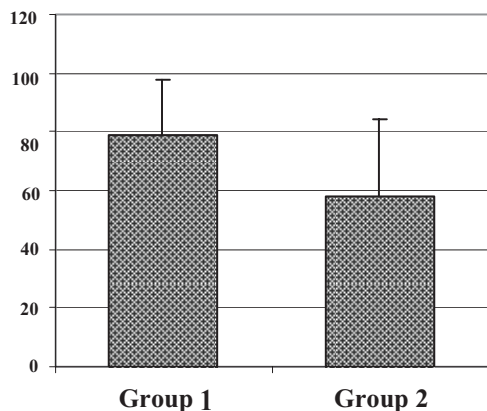


Figure 4. Average flexion arch achieved by group 1 (preoperative flexion <20) and group 2 (preoperative flexion >20).

TABLE 3. Incidence of Patients Outcome According to Judet Criteria Regarding Preoperative Flexion Arch of <20 Degrees (Group 1) and 20 and More (Group 2)

Judet Criteria	Incidence (%)	
	Group 1 (Flexion <20)	Group 2 (Flexion ≥20)
Excellent	1 (7.1)	8 (30.8)
Good	10 (71.4)	17 (65.4)
Fair	1 (7.1)	1 (3.8)
Poor	2 (14.3)	0 (0)

based on preoperative flexion range, age and interval time between trauma surgery, and quadricepsplasty.

Preoperative Flexion

Group 1 had <20 degrees flexion range, whereas group 2 had 20 degrees or more. Fourteen patients (35%) were categorized as group 1 and 26 patients (65%) in group 2. Final average flexion ranges in groups 1 and 2 were 78.57 ± 19.5 and 57.69 ± 26.57, respectively. Therefore, better results were achieved in patients who had <20 degrees of preoperative flexion range ($p = 0.013$; Fig. 4). When using Judet's criteria, there was no significant difference between group 1 and 2 ($p = 0.101$; Table 3).

Age

Group A consisted of patients younger than 25 years, whereas group B were ≥25 years. The final flexion range in group A was 63.92 ± 30.26 and in group B was 65.57 ± 24.1. This was not significant ($p = 0.851$).

Interval Time of Last Trauma Surgery to Quadricepsplasty

Patients who had been undergone quadricepsplasty in the first 6 months after last surgery achieved average 74.70 ± 15.18 flexion and patients in whom quadricepsplasty was performed after 6 months after initial surgery achieved 57.82 ± 29.80. There was a significant difference between these two groups ($p = 0.041$).

The definitive flexion gain did not correlate with patient age ($p > 0.05$), whereas it was inversely correlated with the preoperative flexion range ($p = 0.013$) and directly correlated with preoperative interval ($p = 0.041$).

Surgical complications included two cases (5%) of superficial infection that treated with irrigation and antibiotic and one case (2.5%) of patellar fracture.

DISCUSSION

Knee stiffness continues to be a challenge to address after periarticular knee fractures. Despite advances in fracture fixation and injury management, inadequate application of these techniques, improper rehabilitation techniques, and inavailability of expert medical help at the right time still leaves many people with stiff knees in many countries. Loss of extension is labeled more debilitating in Western cultures because small extension deficits impede normal walking. Restricted flexion, however, is a serious problem in Asian countries where social and religious mores make sitting on the ground an essential requirement of everyday life.^{3,10}

Flexion loss is mostly due to intra-articular fibrosis and scarring in the quadriceps femoral mechanism. Anterior adhesions involve the quadriceps expansion in the lateral and medial recesses, suprapatellar bursa, muscle adhesions to the femur, patella infera, or even shortening of the rectus femoris.¹¹

The first description of the pathologic anatomy of knee extension contracture was provided by Bennett in 1922.¹² The patella was described as the intrinsic component and the quadriceps tendon as the extrinsic component of knee flexion. These two components move in series and anything that anchors one will affect the excursion of the other.

Nicoll⁴ identified four ways in which normal distal excursion of the patella may be blocked in flexion: (1) extrinsic fibrosis of the vastus intermedius tying down the deep surface of the rectus femoris tendon to the front of the femur and suprapatellar pouch; (2) intrinsic adhesions from the deep surface of the patella to the femoral condyles and adhesions of the tibia or femoral joint surfaces; (3) extrinsic fibrosis and shortening of the lateral expansions of the vasti and their adherence to the lateral aspect of the femoral condyles with obliteration of the smooth, gliding mechanism of the paracondylar gutters; and (4) extrinsic actual shortening of the rectus femoris.

In Thompson technique of the quadricepsplasty with a longitudinal anterior incision, vastus muscles are released from each other and from rectus femoris. One may also excise necrotic and fibrotic vastus intermedius.¹³

Patients in this study did not have the vastus intermedius excised because excision of this scared muscle can increase the likelihood of the development of further adhe-

sion. Therefore, the patients of this study had the intermedius released from other vastus muscles and the rectus. Lengthening the rectus femoris was not required for any of the patients.

One of the questions regarding quadricepsplasty is when is the best time for doing this surgery. In previous studies, it was found that time between initiation of the inflammatory process and appropriate treatment was considered to be a major factor influencing improvement.^{11,14}

The patients of this study were operated between 4 months and 24 months after primary surgery with an average of 6.9 months. Most of our excellent/good results were patients who had quadricepsplasty in the first 10 months after initial surgery. Twenty-nine patients of 36 excellent/good results were patients who had surgery before 10 months of primary surgery.

Operative treatment 1 year or more after initial procedure has been less successful in improving range of motion.³ In comparing with other reports, we have performed earlier surgical intervention and results were better. Hahn et al., in a study of 20 stiff knee operated with Thompson quadricepsplasty, recently reported 90% excellent, 10% good, and 10% fair and poor results.¹⁵

Another question addressed by this study is the effect of preoperative knee flexion on the final range achieved by quadricepsplasty. A total of 80.96% of the patients we examined had definite flexion of >80 degrees and were classified either as excellent, 38.10% or good, 42.86% according to the Judet scale. The average definitive flexion gain among this the patient population of the study was 72.14 degrees.

Of importance to note was the fact that definitive flexion gain measured was significantly greater in those patients who had the worse preoperative flexion ($p = 0.013$). This would imply that the strongest indication for this surgical procedure is patients with a severe lack of flexion.

Finally, how age affects clinical outcome of quadricepsplasty was addressed in this study. Massa et al., in a report of 21 cases of long-term outcome of 21 cases of just quadricepsplasty, concluded that definitive flexion gain did not correlate with either patient age or with preoperative interval but reversibly correlated with the preoperative flexion.¹⁶

In this study, Thompson quadricepsplasty did not significantly correlate to the patient's age ($p = 0.851$). Average final flexion gain in the group of patients younger than 25 years was approximately the same as what was achieved by patients aged 25 years or older.

Moore et al.,¹⁷ reviewed nine patients and found that six developed a mean lag of 10 degrees and eight had an average flexion of 78 degrees, 16.4 months postoperatively. Nicoll⁴ reported 30 patients with an average flexion of 68 degrees. In 21 patients, there was full active flexion, whereas three had an extension lag of 5 degrees. Six patients required lengthening of the rectus femoris muscle and these had permanent significant extension lag ranging from 20 degrees to 40 degrees. Pick¹⁸ noted that two of his three patients had a significant extension lag and an average final flexion of 90 degrees. Hesketh performed Thompson's quadricepsplasty on 10 patients, and in all patients, 100 degrees of flexion was achieved. Two patients had an extension lag of 5 degrees.¹⁹ In

TABLE 4. Published Reported on Thompson Quadricepsplasty

Authors	Publication Date	Number of Patient	Operative Technique
Thompson ¹³	1944	14	Thompson
Hesketh ¹⁹	1963	10	Thompson
Nicoll ⁴	1963	30	Thompson
Jeffery ²⁰	1972	7	Thompson
Pick ¹⁸	1976	4	Thompson
Moore ¹⁷	1987	9	Thompson
Ikpeme ⁶	1993	12	Thompson
Hahn ¹⁵	2000	20	Thompson
Jovanovic et al. ²¹	2000	10	Thompson

this study, there was an average extension lag of 10 ± 5.77 (range: 5–20) on follow-up (Table 2).

Postoperative management is an integral part of the quadricepsplasty because postoperative motion should be maintained with continuous active and passive exercise to minimize loss of final range of movement. This requires adequate pain control to allow continuous exercise and an experienced physiotherapist. It should be started long before the wound has healed, which may increase the risk of wound complication.²⁰

Limitation of this study is that the results were scored according to Judet criteria because there is not an outcome instrument available for a Thompson quadricepsplasty. It would be better to use a validate instrument for our clinical results.

Conversely, when compared with other published reports of Thompson quadricepsplasty, this study involved a larger number of patients than other studies reported in the literature thus far^{3–6,13–15,18–21} (Table 4).

Finally, quadricepsplasty although a major procedure with demanding rehabilitation regiment should be considered when attempting to correct knees extension contractures. An earlier intervention would produce a better outcome especially in more severe cases.

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