

Modified Thompson Quadricepsplasty to Treat Extension Contracture of the Knee after Surgical Treatment of Patellar Fractures

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Background: This retrospective study reported on the treatment of extension contracture of the knee after surgical treatment of patellar fractures.

Methods: Twenty-eight patients who sustained extension contractures of the knee after surgical treatment of patellar fractures 8-14 months previously (mean, 12 months) were treated. A midline longitudinal approach was made. After implants were removed, adhesions between the vastus intermedius and the femur, and in the patellofemoral joint were released completely. The knee was flexed up to 110 degrees. Postoperatively, a continuous passive motion (CPM) machine was used to assist knee flexion. Physical therapy was continued at local clinics. No aids were necessary for ambulation.

Results: Twenty-four patients were followed-up for at least 2 years (range, 2.1-7.6 years; mean, 4.6 years). The mean arc of motion of the knee improved from 72 degrees preoperatively to 123 degrees ($p < 0.001$). Knee function improved from an unsatisfactory grade in all 24 patients preoperatively to a satisfactory grade in 21 patients ($p < 0.001$). There were no significant surgical complications.

Conclusion: This surgical technique has a high success rate with few complications. Above all, the surgical procedure is relatively simple. Therefore, it can be considered for indicated cases.

(*Chang Gung Med J* 2007;30:263-9)

Key words: quadricepsplasty, extension contracture, patellar fracture

Patellar fractures are common, and can be caused by either high or low energy injuries.^(1,2) Although treatment methods are numerous, tension band wiring has achieved the most support.⁽²⁻⁴⁾ The greatest advantage of this technique is that there is normally no need for immobilization of the knee postoperatively.^(2,5) Exercise of the knee's arc of motion (AOM) can be implemented early. Therefore, the AOM of the knee is usually satisfactory.

However, under some situations, the AOM may be restricted, such as when it is associated with refractory knee pain or when the knee requires a period of immobilization due to associated surrounding injuries.^(3,4) The reduced AOM may severely hinder the patients' daily activities. After fractures heal, patients normally ask for removal of implants and correction of the knee's AOM concomitantly.

Extension contractures of the knee are often

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Received: Jun. 6, 2006; Accepted: Dec. 12, 2006

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successfully treated with quadricepsplasty of Thompson or Judet.^(6,7) The original indications of both techniques were for extension contractures of the knee caused by femoral shaft fractures. To the best of our knowledge, neither technique has been reported for extension contractures of the knee caused by patellar fractures. The goal of this retrospective study was to develop a better surgical technique to treat combined extra- and intra-articular knee lesions which caused extension contractures of the knee after surgical treatment of patellar fracture.

METHODS

From March 1995 to March 2001, 28 consecutive adults (> 15 years) who sustained extension contracture of the knee after surgical treatment of patellar fractures underwent the described technique at the authors' institution. Patients were from 29- 62 years old (mean, 42 years) with a male to female ratio of 5 to 1. The causes of patellar fractures included 14 motorcycle accidents, 8 car accidents, 4 falls from heights, and 2 simple falls on the ground. There were few associated knee injuries (intercondylar fracture, prepatellar bursitis and soft tissue conditions around the knee) and they were not complicated. All fractures were immediately treated with various wiring techniques at various hospitals. Although the patellar surgery was performed only once, all patellar fractures healed uneventfully. The period from the injury to our treatment was 8-14 months (mean, 12 months) and the maximal flexion of the knee was 5-100 degrees (mean, 74 degrees). Knee pain was mild to negligible and all patients could ambulate without aids. Eight patients who had associated extensive quadriceps muscle injuries due to femoral shaft fractures and had undergone Judet quadricepsplasty were excluded. Four patients who had associated tibial plateau fractures were also excluded because severe destruction of the femotibial joint might have hindered evaluation of knee function.

In the outpatient department (OPD), histories of the wound healing process and radiographs of the knee in the anteroposterior, lateral and Merchant's tangential view, were checked carefully. There was no evident patellofemoral degeneration in these patients. The indications for the described technique included an interval of at least 8 months after patellar fractures, patellar fractures that had completely

healed, and less than full flexion of the knee (140 degrees).⁽⁸⁾

Surgical technique

Under spinal anesthesia, patients were placed on the operating table in the supine position. A pneumatic tourniquet was used routinely.

With a midline longitudinal skin incision, the quadriceps tendon and the patella were exposed. All implants in the patella were removed. If there were other small implants in the distal femur, they were removed concomitantly. Then, the quadriceps tendon was incised longitudinally with a scalpel. The anterior aspect of the femur was exposed with a retractor. Adhesions between the vastus intermedius and the femur were released with cauterization and a tissue scissors. Adhesions between the patella and the femur were released with a tissue scissors. With finger palpation, all adhesive bands were released completely. Consequently, the knee was gradually flexed. All knees were bent up to 110 degrees.

Finally, the quadriceps tendon was approximated with absorbable sutures and the wound was closed with absorbable sutures layer by layer. A closed drain was inserted.

The next day, a continuous passive motion (CPM) machine was used to assist knee flexion. Initially, knee flexion was started at 50 degrees and increased 20 degrees each day for 3 days. There was no need for ambulation aids. Patients were then discharged and they continued physical therapy at local clinics. Full flexion of the knee was encouraged for all patients.

Patients were followed-up at the authors' OPD at one month, three months, one year, and whenever necessary afterwards. In addition to the wound healing process, knee pain, the knee's AOM, and gait types were recorded.

Knee function was evaluated by modified Ma's criteria and four grades were described.⁽⁹⁾ An excellent grade included no pain, knee flexion > 130 degrees, and a normal gait. A good grade included mild pain, knee flexion > 110 degrees, and a normal gait. A fair grade included moderate pain, knee flexion > 90 degrees and slight difficulty in walking. A poor grade included severe pain, knee flexion < 90 degrees or a limp. A satisfactory grade was defined as an excellent or good grade. This criteria was used because it is relatively simple and practical.

McNemar's test or paired Student's *t*-test was used for statistical analysis. Statistical significance was set at $p < 0.05$.

RESULTS

Twenty-four patients were followed-up for at least 2 years (range, 2.1- 7.6 years; mean, 4.6 years). Four patients were lost to follow-up despite our best efforts to contact them (Table 1).

Before the operation, all 24 patients had no complaints of knee pain and only 3 patients had a limp. At the latest follow-up, all 24 patients had no knee pain and none had a limp ($p = 0.2482$, McNemar's test).

Before the operation, the maximal flexion of the knee in 24 patients was 5-100 degrees (mean, 72 degrees). At the latest follow-up, the maximal flexion of the knee was 100-140 degrees (mean, 123 degrees; $p < 0.001$, paired Student's test). The mean difference of maximal flexion of the knee was 50.6 degrees. The 95% confidence interval was 43.9~57.4 degrees. Before the operation, knee function in all 24 patients was unsatisfactory. At the latest follow-up, 21 patients had a satisfactory grade and 3 patients had a fair grade ($p < 0.001$, McNemar's test). Subjectively, all 24 patients were satisfied with the described surgery (Figs. 1, 2).

There were no wound infections, neurovascular injuries or patellar tendon avulsion.

Table 1. Clinical Data for 28 Patients with Extension Contracture of the Knee after Surgical Treatment of Patellar Fractures

Case	Age (yr)	Sex	Interval from injury (mo)	Associated knee injuries	Prior operative techniques	Preoperative knee AOM (degree)	Latest knee AOM (degree)	Functional outcome	Follow-up (yr)
1	52	M	12	N	T	0-60	0-130	E	7.6
2	32	M	10	N	T	0-90	0-140	E	7.2
3	29	M	12	N	C	0-100	L	L	L
4	38	M	9	I	T	0-5	0-110	G	6.5
5	44	M	14	N	C	0-70	0-120	G	6.3
6	42	W	11	N	T	0-50	0-100	F	6.2
7	62	M	12	N	T	0-80	L	L	L
8	58	M	14	I	T	0-70	0-120	G	5.8
9	35	W	12	N	T	0-100	0-140	E	5.7
10	29	M	11	I	T	0-90	0-130	E	5.5
11	56	M	8	N	T	0-90	0-120	G	5.2
12	38	M	12	N	C	0-80	0-130	G	5.0
13	47	W	12	N	T	0-70	0-120	G	4.9
14	36	M	11	N	T	0-100	0-140	E	4.7
15	32	M	14	N	T	0-80	0-130	G	4.6
16	49	M	10	N	T	0-90	L	L	L
17	39	M	12	N	T	0-60	0-100	F	4.3
18	34	M	11	N	T	0-60	0-120	G	4.2
19	60	M	8	N	T	0-80	0-120	G	4.0
20	36	W	10	N	T	0-90	0-140	E	3.8
21	31	W	10	N	T	0-80	0-130	E	3.6
22	41	M	13	I	T	0-70	0-120	G	3.5
23	32	M	14	N	T	0-70	L	L	L
24	35	M	13	N	T	0-70	0-100	F	2.9
25	45	M	13	N	T	0-80	0-130	G	2.7
26	51	M	10	N	T	0-80	0-120	G	2.4
27	44	M	13	N	T	0-60	0-130	G	2.2
28	38	M	14	N	T	0-50	0-110	G	2.1

Abbreviations: C: circumferential wire; E: excellent; F: fair; G: good; I: intercondylar fracture; L: lost; M: man; N: no; T: tension band wire; W: woman; AOM: arc of motion.



Fig. 1 Case 1. A 52-year-old man sustained a right patellar fracture, and the fracture was treated with tension band wiring. Chafing from the proximal Kirschner wires caused knee pain and the arc of motion (AOM) of the knee was 0-60 degrees 12 months after surgery. The knee was treated with the described technique and the AOM of the knee improved to 0-130 degrees. The outcome was excellent.

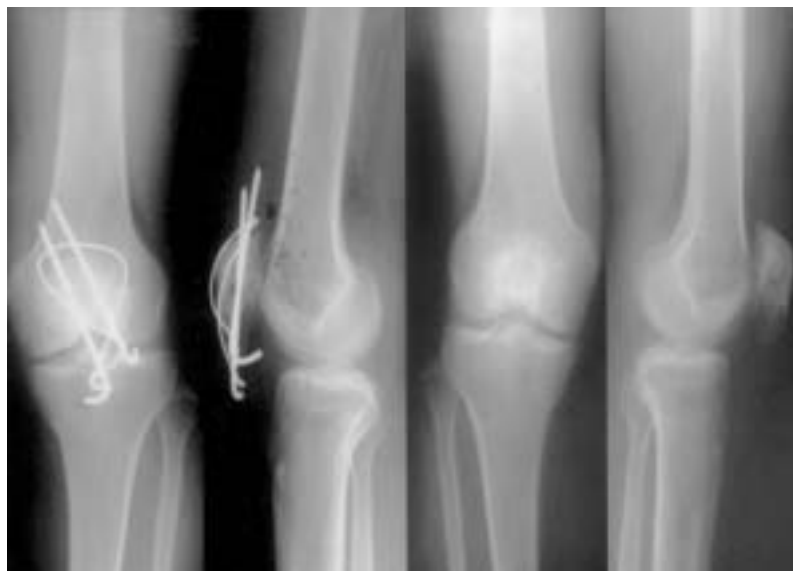


Fig. 2 Case 2. A 32-year-old man sustained a right patellar fracture, and the fracture was treated with tension band wiring. The proximal piercing ends of the Kirschner wires caused knee pain and the arc of motion (AOM) of the knee was 0-90 degrees 10 months after surgery. The knee was treated with the described technique and the AOM of the knee improved to 0-140 degrees. The outcome was excellent.

DISCUSSION

Extension contracture of the knee can be caused by a large number of disorders. The main pathology

is due to adhesion between the extensor mechanism and the femur.^(6,7) Clinically, it may occur inside or outside the knee joint or both. Common situations include femoral shaft fractures associated with quadriceps femoris injury, long-term immobilization

of the knee by casting or external fixation or pain in the knee due to fractures around the knee.^(6,7,10) When extension contracture of the knee occurs, knee pain normally subsides gradually and patients can ambulate without aids. However, bending the knee causes pain and the effects of corrective surgery are reduced. This situation is even more common when the femoral or tibial articular surface is injured.

Judet quadricepsplasty is favored over Thompson quadricepsplasty in the treatment of extension contractures of the knee secondary to adhesion between the quadriceps femoris and the femur.⁽⁶⁾ The advocated advantage is avoidance of repeated substantial injury to the quadriceps femoris.^(11,12) This is helpful later when the patient has physical therapy. However, the present study showed that with the one-incision procedure of the modified Thompson technique, implants can be removed and adhesions released concomitantly. This procedure is effective because adhesions between the quadriceps femoris and the femur in patellar fractures are normally not severe. Furthermore, the tension band technique avoids immobilization of the knee.^(2,5) Therefore, once adhesions between the patella and the femur are released, gradual flexion of the knee is normally effective.

Longitudinal incisions on the tendon of the quadriceps femoris have been used in the traditional approach in total knee arthroplasty for a long period.⁽¹³⁻¹⁵⁾ The knee's AOM normally is not hindered. Postoperatively, a CPM machine can be used early. Thus, in the present study a similar principle was applied and knee flexion exercise was begun the first day postoperatively. With continuous physical therapy at local clinics, a satisfactory outcome is predictable.

It is reported that Judet quadricepsplasty results in some loss of flexion after the operation and correction of more 15 degrees is recommended.⁽⁶⁾ This can improve the knee's AOM about 53-90 degrees.^(6,11,12) However, Thompson quadricepsplasty can only improve flexion 50-68 degrees.^(7,16) In the present study, 50 degrees of improvement was achieved. The cause of the preoperative sub-normal AOM in these patients was moderate knee pain. Immediate postoperative knee flexion improved to 110 degrees. Continuous physical therapy might further improve knee flexion. The latest knee flexion was 120 degrees. The main reason that the described

technique achieved an improvement of only 51 degrees was that the preoperative extension contractures of the knee were not as severe as that in patients in previous reports.

Since immobilization of the knee is not necessary with the tension band technique,^(2,5) a single patellar fracture very rarely causes limitation in knee flexion. Commonly, knee stiffness occurs when patellar fractures are associated with ipsilateral femur or tibial fractures. Severe knee pain forces patients to reduce flexion. Patients are advised to walk carefully on the injured extremity, and the knee is almost always in the extension position. Knee stiffness is normal with extension contracture of the knee, not flexion contracture of the knee. This is contrary to observations reported in the literature.⁽⁶⁾

The tension band technique has some configurations which may result in complications and affect the outcome. In the present study, a high percentage of extension contractures of the knee were simply caused by skin irritation due to chafing from the piercing ends of Kirschner wires (Figs. 1, 2). This can be prevented by bending both ends of the wires.⁽¹⁷⁾

With a long period of knee extension, muscle fibers of the quadriceps femoris become shortened. Forceful flexion of the knee may cause avulsion of the patellar tendon from the patellar or tibial insertion. Consequently, reattachment and immobilization of the patellar tendon must be done and extension contracture of the knee recurs.^(18,19) In the present series, initial flexion of the knee up to 110 degrees was normally safe and not difficult. Further flexion to the maximum can be achieved with continuous physical therapy, resulting in a good outcome is normally predictable.⁽²⁰⁾

Because we could find no similar studies in the literature, the outcome of the present study could not be compared. However, the described surgical technique can provide a high success rate with a low complication rate. Above all, the surgical procedure is relatively simple. Therefore, it can be considered for indicated cases.

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以修改型湯姆遜股四頭肌成型術治療臏骨骨折術後 引起的膝部伸直攣縮

黃毓智 吳基銓

- 背景：** 本回溯性研究，在報告治療臏骨骨折，術後引起的膝部伸直攣縮的經驗。
- 方法：** 28 位罹患臏骨骨折，術後引起膝部伸直攣縮的患者（期間 8-14 個月，平均 12 個月）接受治療。在正中線垂直切開，內固定植入物取出後，股中間肌與股骨間，以及臏股骨關節間的沾粘，完全解除。膝關節以徒手折彎至 110 度。術後，以被動式彎曲儀器 (CPM) 協助膝關節彎曲。出院後，並繼續在住家附近診所復健。並不須使用助行器。
- 結果：** 24 位患者接受至少兩年以上的複查（期間 2.1-7.6 年，平均 4.6 年）。膝關節的活動範圍，從術前的平均 72 度，改善至最後的 123 度 ($p < 0.001$)。膝關節功能從術前的 24 位不滿意狀況，改善至最後的 21 位滿意狀況 ($p < 0.001$)。並沒有明顯的手術併發症發生。
- 結論：** 本研究所報告的手術方法，可提供很高的成功率及很低的併發症率。很重要的一點，手術過程相當單純。因此，它可被考慮應用在所有具適應症的患者身上。
(長庚醫誌 2007;30:263-9)

關鍵詞： 股四頭肌成型術，伸直攣縮，臏骨骨折

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受文日期：民國95年6月6日；接受刊載：民國95年12月12日

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