Knee Surg, Sports Traumatol, Arthroscopy
(1996) 4:92–96

J.-Y. Jenny
Z. Sader
A. Henry
G. Jenny
J.-H. Jaeger

Elevation of the tibial tubercle for patellofemoral pain syndrome

An 8- to 15-year follow-up

Received: 15 January 1996
Accepted: 27 June 1996

J.-Y. Jenny (✉) · Z. Sader · A. Henry
G. Jenny
Centre de Traumatologie et d'Orthopédie,
10 avenue Baumann,
F-67400 Illkirch Graffenstaden, France

J.-H. Jaeger
Department of Orthopaedics
and Traumatology, University Hospital,
Strasbourg, France

Abstract One hundred patients were operated on by the Maquet procedure for chondromalacia patellae. All of them were first re-examined after a mean follow-up of 4 years, and 65 of them re-examined after a mean follow-up of 11 years (range, 8–15 years). The pain score improved significantly after the operation and remained unchanged with longer follow-up. The success rate was only 62% at both follow-ups. Outerbridge grade IV chondral lesions at the time of surgery were associated with a significant improvement of the pain score at the 4-year follow-up and a success rate of 69%. The Maquet procedure should only be proposed for chronic retropatellar pain with grade IV chondral lesions, after conservative treatment has proven unsuccessful, as the expected failure rate is about 30%.

Key words Patellofemoral pain · Maquet procedure

Resumé 100 patients opérés d'un avancement de la tubérosité tibiale antérieure selon Maquet ont été réexaminés avec un recul moyen de quatre ans, et 65 d'entre eux ont pu être réexaminés ultérieurement avec un recul moyen de onze ans (extrêmes de huit à quinze ans). L'intensité de la douleur a été significativement diminuée après l'intervention et cette amélioration est restée stable dans le temps. Mais globalement le taux de succès n'était que de 62% à chacun des deux examens. La présence à l'intervention d'une mise à nu de l'os sous-chondral était significativement associée à un meilleur résultat antalgique, avec un taux de succès de 69%. L'intervention de Maquet ne doit être proposée que pour un syndrome douloureux fémoropatellaire avec mise à nu de l'os sous-chondral, mais l'indication doit être prudente car le taux d'échec est élevé.

Introduction

Elevation of the patellar tendon has been proposed by Maquet [10, 11] in the treatment of patellofemoral arthrosis. He assumed that the chondral lesions were due to mechanical overload; advancement of the patellar tendon or the tibial tubercle, while opening the angle between the quadriceps and patellar tendons, should decrease the patellofemoral contact forces. However, the clinical efficiency of this procedure remains questionable, in particular its long-term outcome. The present study reports the long-term results (8–15 years) of 65 among 100 surgically treated patients.

Materials and methods

One hundred patients were consecutively operated on by the senior authors (G. J. and J. H. J.) between 1978 and 1985. There were 46 men and 54 women, with a mean age of 43 years (range 17–64 years). The indication for operation was chronic retropatellar pain without femorotibial pain, with a permanent impairment during ac-

tivities of daily life for older patients or during sports activities for younger ones. The decision to undergo surgery was only taken after 6 months of unsuccessful conservative treatment (rest, physiotherapy, non-steroidal antiinflammatory drugs, wearing of a patellar brace) if the initial impairment remained, even if there was partial pain improvement.

The following preoperative data were recorded: age, sex, body weight, duration of symptoms, pain scoring and global objective assessment according to Bandi [1], standard anteroposterior and lateral X-rays and comparative axial views at 30°, 45° and 60° of flexion. All but 10 patients felt pain upon normal activity (Table 1). No patient achieved a good global objective assessment (Table 2). Twenty-four patients evidenced narrowing of the patellofemoral joint space of 50% compared with the normal contralateral one, and two had complete narrowing of this joint.

The operative technique used was a modified Maquet procedure, as described by Bandi [1]. After an anterior skin incision, the patellar tendon and tibial tubercle were prepared. A medial arthrotomy allowed assessment of the grade of chondral patellofemoral lesions according to the Outerbridge classification [14]: 15 grade I, 16 grade II, 21 grade III and 48 grade IV lesions were recorded. One surgeon (J. H. J.) never used an intra-articular chondral procedure, while the other (G. J.) performed local chondral treatment: no treatment for grade I lesions, peeling of grade II ($n = 7$) and III ($n = 10$) lesions in order to obtain a flat chondral surface, and drilling of grade IV lesions in order to obtain bone bleeding ($n = 34$). The joint cavity was closed, and osteotomy of the tibial tubercle was performed in order to obtain a long shingle, which was elevated with a 1–1.5 cm thick bone graft from the medial tibial plateau. The tubercle was fixed in the elevated position with one or two screws. The wound was closed around suction drainage.

The knee was placed in a splint, and rehabilitation began on the first postoperative day, with full weight-bearing with crutches on request, active quadriceps and hamstrings exercises and mobilization. Flexion was restricted to 90° for 3 weeks. Then the splint was definitely removed, and progressively free activity and free range of motion were encouraged, as far as the pain relief allowed.

Complications were seen in nine patients: five superficial infections, two thrombophlebitis and two Südeck's syndrome. All healed successfully, and they did not appear to influence the further outcome. No knee was reoperated on during the follow-up period.

All patients were reviewed for a first check after a mean follow-up time of 4 years (range 2–8 years). Sixty-five of them were reviewed for a second check 7 years later, giving a mean follow-up time of 11 years (range 8–15 years).

Early (4-year) and late (11-year) results were evaluated according to Bandi [1], emphasizing the pain score and the global objective assessment as a combination of pain, range of motion and working ability (Table 1). These results were compared with each other and the preoperative status, and several possible predictive factors were studied: age, sex, body weight, duration of preoperative symptoms, preoperative pain score, preoperative patellofemoral arthrosis and grade of patellofemoral chondral lesions. Paired X^2-test and paired Wilcoxon t-test were used for comparison of preoperative, early and late results by case; X^2-test, Mann-Whitney U-test and analysis of variance (ANOVA) test for the influence of possible predictive factors; all tests employed a 0.05 level of significance.

Results

Results on pain are given in Table 2. The paired difference between the preoperative and early postoperative score is significant ($P < 0.0001$ by paired Wilcoxon t-test). The paired difference between the early and late postoperative score is not significant ($P = 0.62$ by paired Wilcoxon t-test).

The global objective assessment is reproduced in Table 3. The paired difference between the preoperative and early postoperative assessment is significant ($P < 0.0001$ by paired X^2-test). The paired difference between the early and late postoperative assessment is not significant ($P = 0.49$ by paired X^2 test).

None of the 24 patients with preoperative incomplete narrowing of the patellofemoral joint space showed progressive narrowing at the first follow-up, while a patellofemoral joint space partially reappeared in the 2 patients with complete preoperative narrowing. Between the first and second follow-up, complete narrowing appeared in one patient with preoperative incomplete narrowing, and

Table 1 Classification of pain score and gobal objective assessment according to Bandi

Pain score:	0	No pain
	1	Occasional pain
	2	Pain with strenuous activity
	3	Pain with normal activity
	4	Pain at rest
	5	Permanent pain
Global objective assessment		
	Good	Pain score ≤ 2
		Flexion loss ≤ 10°
		Normal or moderately
		Decreased sports activity
		Normal working ability
	Poor	Pain score > 2
		Flexion loss > 10°
		No sports activity
		Decreased working ability

Table 2 Results of pain score (preoperative and 4-year follow-up: $n = 100$ cases; 11-year follow-up: $n = 65$ cases)

	Pain score					
	0	1	2	3	4	5
Preoperative	0	1	9	55	30	5
4-year follow-up	38	23	23	11	2	3
11-year follow-up	24	19	15	6	0	1

Table 3 Global objective assessment (preoperative and 4-year follow-up: $n = 100$ cases; 11-year follow-up: $n = 65$ cases)

	Global objective assessment	
	Good	Poor
Preoperative	0	100
4-year follow-up	62	38
11-year follow-up	40	25

incomplete narrowing was noted in 4 patients without preoperative narrowing.

There was no influence of age on either the early or late results (Table 4), nor of sex, body weight, duration of preoperative symptoms, preoperative pain score or preoperative patellofemoral joint space narrowing. Early or late patellofemoral joint space narrowing did not affect the early or late results.

Only the grade of preoperative patellofemoral chondral lesions had a significant predictive value (Table 5). The mean early pain score was better for the 48 patients with grade IV lesions ($P = 0.05$ by ANOVA). The late global objective assessment and late pain score were also improved for patients with grade IV lesions, but not significantly so.

Table 4 Influence of age at operation (preoperative and 4-year follow-up: $n = 100$ cases; 11-year follow-up: $n = 65$ cases)

	Age at operation		
	≤ 50 years	> 50 years	Significance
Preoperative	$n = 62$	$n = 38$	
Pain score (Mean ± SD)	3.10 ± 0.72	3.61 ± 0.68	
Global assessment (Good/poor)	0/62	0/38	
4-year follow-up	$n = 62$	$n = 38$	
Pain score (Mean ± SD)	1.18 ± 1.08	1.37 ± 1.58	$P = 0.51$
Global assessment (Good/poor)	41/21	21/17	$P = 0.28$
11-year follow-up	$n = 38$	$n = 27$	
Pain score (Mean ± SD)	1.11 ± 1.09	1.07 ± 1.04	$P = 0.91$
Global assessment (Good/poor)	23/15	17/10	$P = 0.84$

There was no influence of associated chondral treatments on the early and late results, whether considered alone or in association with the grade of chondral lesions (Table 6).

Discussion

The theoretical work by Maquet [10–12] has now been experimentally confirmed. Ferguson et al. [6] found a 80% decrease of patellofemoral pressure after a 0.5 inch elevation of the tibial tubercle in gross specimens. Wagner et al. [19] found only a 50% decrease in a similar experiment. Retaillaud et al. [16] assumed that such a decrease is only effective in cases of actual patellofemoral arthrosis and must be accompanied by a simultaneous medial and lateral patellar release.

The clinical relevance remains controversial. Only one randomized prospective study has compared the Maquet procedure plus patellar shaving to patellar shaving alone [7]: it concluded that there was a significant improvement of the results after the former treatment. Many non-comparative studies have been published, but because the grading of the results varies widely, comparison is difficult. However, several authors [5, 8, 11, 13, 15, 18] found about 80% success, while others [2–4] reported up to 66% failure. It has to be noted that most series concerned only a few cases, with just Bandi [1] and Ferguson et al. [5] describing more than 100 cases, with a success rate of 80% and 87%, respectively. Moreover, all these series reported short to mid-term follow-up, while only Schmid [17] reported a 80% success rate for 33 patients with a follow-up of over 10 years. The present study appears to have the greatest number of patients and long-term follow-up. Significantly, the early result remained in most cases unchanged with longer follow-up.

We chose the Bandi technique with an elevation of only 1–1.5 cm because we wanted to avoid any skin com-

Table 5 Influence of the grade of initial chondral lesions (Outerbridge classification) (preoperative and 4-year follow-up: $n = 100$ cases; 11-year follow-up: $n = 65$ cases)

	Grade of initial chondral lesions				
	I	II	III	IV	Significance
Preoperative	$n = 15$	$n = 16$	$n = 21$	$n = 48$	
Pain score (Mean ± SD)	3.13 ± 0.74	3.40 ± 0.82	3.43 ± 0.77	3.23 ± 0.72	
Global assessment (Good/poor)	0/15	0/16	0/21	0/48	
4-year follow-up	$n = 15$	$n = 16$	$n = 21$	$n = 48$	
Pain score (Mean ± SD)	1.47 ± 1.19	1.72 ± 1.53	1.65 ± 1.44	0.85 ± 0.99	$P = 0.01$
Global assessment (Good/poor)	8/7	9/7	12/9	33/15	$P = 0.40$
11-year follow-up	$n = 6$	$n = 10$	$n = 11$	$n = 38$	
Pain score (Mean ± SD)	1.50 ± 1.22	1.14 ± 1.06	1.22 ± 1.03	1.00 ± 1.04	$P = 0.55$
Global assessment (Good/poor)	3/3	5/5	6/5	26/12	$P = 0.40$

Table 6 Influence of intra-articular procedures (preoperative and 4-year follow-up: $n = 100$ cases; 11-year follow-up: $n = 65$ cases)

Chondral procedures	Grade of chondral lesions					
	II		III		IV	
	Yes	No	Yes	No	Yes	No
Preoperative	$n = 7$	$n = 9$	$n = 10$	$n = 11$	$n = 34$	$n = 14$
Pain score (Mean ± SD)	3.60 ± 0.80	3.25 ± 0.80	3.70 ± 0.70	3.30 ± 0.77	3.32 ± 0.64	3.00 ± 0.88
Global assessment (Good/poor)	0/7	0/9	0/10	0/11	0/34	0/14
4-year follow-up	$n = 7$	$n = 9$	$n = 10$	$n = 11$	$n = 34$	$n = 14$
Pain score (Mean ± SD)	2.05 ± 1.47	1.35 ± 1.37	2.20 ± 1.58	1.45 ± 1.42	0.85 ± 0.99	0.86 ± 1.03
Global assessment (Good/poor)	3/4	6/3	4/6	8/3	21/13	12/2
11-year follow-up	$n = 5$	$n = 5$	$n = 6$	$n = 5$	$n = 30$	$n = 8$
Pain score (Mean ± SD)	1.55 ± 1.27	0.81 ± 1.37	1.50 ± 1.28	0.76 ± 0.72	1.03 ± 1.10	0.88 ± 0.83
Global assessment (Good/poor)	3/2	2/3	3/3	3/2	20/10	6/2

plication associated with a higher elevation. However, in the experiments of Ferguson et al. [6] and Wagner et al. [19], elevation over 1 cm is assumed to result in no further decrease of the patellofemoral joint load.

The local treatment of chondral lesions appears to have no influence on the early or late results. Because of the low power of this study, it is impossible to discuss its prognostic value. It is likely that peeling has no influence at all [9], while drilling down to the subchondral bone could have led to the formation of fibrocartilage, and then to a better clinical outcome.

A better prognosis in grade IV chondral lesions has already been reported by Radin [15] and Schmid [17]. Our study confirms the experimental results of Retaillaud et al. [16]: therefore, the Maquet procedure should only be proposed for Outerbridge grade IV chondral lesions, where the expected success rate is higher and remains unchanged with longer follow-up. For grade I–III lesions the lower success rate could be only a placebo effect.

In this study there was no correlation between the preoperative clinical status and both patellofemoral joint space narrowing and preoperative chondral lesions. It is then impossible to select the proper patients with grade IV chondral lesions by only clinical or standard X-ray examination. Arthroscopy is too invasive for diagnostic purposes, and we nowadays use computed tomography with an arthrogram for the preoperative selection.

References

1. Bandi W (1989) Les résultats de l'avancement de la tubérosité antérieure du tibia. Rev Chir Orthop 66: 275–278
2. Bessette GC, Hunter RE (1988) The Maquet procedure. Clin Orthop 232: 159–167
3. Engebretsen L (1989) Advancement of the tibial tuberosity for patellar pain. Acta Orthop Scand 60: 20–22
4. Fabrin J, Damgaard-Iversen B (1986) Patello-femoral pain syndrome treated by anterior displacement of the tibial tuberosity a. m. Bandi. Acta Orthop Belg 52: 645–650
5. Ferguson AB (1982) Elevation of the insertion of the patellar ligament for patellofemoral pain. J Bone Joint Surg [Am] 64: 766–774
6. Ferguson AB, Brown TD, Fu FH, Rutkowski R (1979) Relief of patellofemoral contact stress by anterior displacement of the tibial tubercle. J Bone Joint Surg [Am] 61: 159–166
7. Hejgaard N, Watt-Boolsen S (1982) The effect of anterior displacement of the tibial tuberosity in idiopathic chondromalacia patellae. Acta Orthop Scand 53: 135–139
8. Lund F, Nilsson BE (1980) Anterior displacement of the tibial tuberosity in chondromalacia patellae. Acta Orthop Scand 51: 679–688
9. Mankin HJ (1982) The response of articular cartilage to mechanical injury. J Bone Joint Surg [Am] 64: 460–466
10. Maquet P (1963) Considérations biomécaniques sur l'arthrose du genou. Un traitement biomécanique de l'arthrose fémoro-patellaire. L'avancement du tendon rotulien. Rev Rhum 30: 779–785
11. Maquet P (1976) Advancement of the tibial tuberosity. Clin Orthop 115: 225–231
12. Maquet P (1979) Mechanics and osteoarthritis of the patellofemoral joint. Clin Orthop 144: 70–73

13. Mendes DG, Soudry M, Iusim M (1987) Clinical assessment of Maquet tibial tuberosity advancement. Clin Orthop 222:228–238
14. Outerbridge RE (1961) The etiology of chondromalacia patellae. J Bone Joint Surg [Br] 43:752–757
15. Radin EL (1986) The Maquet procedure. Anterior displacement of the tibial tubercle. Clin Orthop 213:241–248
16. Retaillaud JL, Darmana R, Devallet P, Mansat M, Morucci JP (1989) Etude expérimentale de l'avancement de la tubérosité tibiale. Rev Chir Orthop 75: 513–523
17. Schmid F (1993) The Maquet procedure in the treatment of patellofemoral osteoarthrosis. Long term results. Clin Orthop 294:254–258
18. Sudmann E, Salkowitsch B (1980) Anterior displacement of the tibial tuberosity in the treatment of chondromalacia patellae. Acta Orthop Scand 51:171–175
19. Wagner J, Cheval P, Nelis JJ (1982) Incidence du degré d'avancement du tendon rotulien sur les contraintes fémoro-patellaires. Acta Orthop Belg 48: 639–650