

# Trochleaplasty – Functional and Subjective Results: A Follow-Up Study

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## Research Article

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### ABSTRACT

**Study background:** We investigated the clinical, radiographic and subjective outcomes of 39 patients (42 knees) treated with trochleaplasty for recurrent dislocation of the patella at our institution.

**Methods:** We retrospectively reviewed our operative experience of this technique both, clinically and radiographically. All patients had trochlea dysplasia of at least Dejour type B. The mean follow-up was 48.9 months (range 12–109). Validated questionnaires were used (SF-36, Tegner-Score, Lysholm-Score).

**Results:** There was no postoperative recurrence of patellar dislocation. There were no wound problems, infections or thromboembolic complications. One patient required an evacuation of haematoma. The average of Tegner's activity Score was 5 points (55% reached 5 or more points). Mean Lysholm-Score was 81.3 points, 57,1% (24/42) had  $\geq 84$  points (good results), 40,5% (17/42)  $\geq 90$  points (excellent results).

**Conclusion:** Trochleaplasty is a technically demanding surgical procedure yet it can reliably address recurrent patellar dislocations and promote excellent function and quality of life. Future studies will elucidate whether trochleaplasty will check or prevent patellofemoral osteoarthritis in the long term.

## INTRODUCTION

Acute dislocation of the patella is a common injury with an incidence of 5.8/100'000 <sup>[1]</sup>. Recurrent events cause pain, significant loss of physical function, activity and quality of life. Most patients are athletically active adolescents or young adults with a slightly higher proportion of females (52–56%) <sup>[2-4]</sup>. Redislocation rates vary in the literature from 15–60% <sup>[2,5]</sup>.

Patellofemoral instability is a multifactorial clinical problem. Besides passive (e.g. patellofemoral ligaments) and active (e.g. quadriceps femoris muscle) stabilizers the congruence of patella and trochlear groove (static stabilizer) is a crucial factor. In patients who show patella instability associated with insignificant trauma predisposing factors have to be elucidated <sup>[6]</sup>. Well-known risk-factors are patella alta, malrotation of femur or tibia and hyperlaxity <sup>[7]</sup>. In the early phase of motion from extension to flexion the correct tracking of the patella into the trochlear groove is crucial for stability <sup>[8]</sup>. Dejour estimated that trochlea dysplasia is present in up to 85% of patients with recurrent dislocation <sup>[9]</sup>.

A dysplastic trochlea is characterised by a flattened or even convex sulcus. The lateral aspect of the trochlea is shortened and inclined in dorsolateral direction. This leads to incongruence with the patella and subsequent instability. For diagnosis of a dysplastic trochlea a true lateral x-ray is paramount. The typical findings are a crossover-sign, supracondylar spur and double contour, which are also the criteria for the classification by Dejour and Saggin <sup>[10]</sup>. In 1994, Bereiter and Gautier <sup>[6]</sup> described the operative technique "trochleaplasty" to solve the problem of missing congruence between patella and trochlear groove <sup>[6]</sup>. The detailed steps for the procedure are presented below.

The aim of our study was to assess the functionality, satisfaction and lasting patellar stability after trochleaplasty by retrospective review. We therefore report about functional and subjective results 12 to 109 months after trochleaplasty.

## METHODS

Between October 2004 and November 2011, 43 patients (46 knees) were treated with trochleaplasty with a female:male ratio of 5:1. 3 patients were treated for both knees. The indications for surgery were recurrent dislocation of the patella and the presence of trochlea dysplasia of at least type B according to the classification of Dejour and Saggin <sup>[10]</sup>. Contraindications were

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advanced cartilage damage of the trochlear groove (despite instability and dysplasia) as well as open epiphyseal growth plates. The mean age of our patients at surgery was 20.6 years (range 13–41 years). Clinical and standardised radiological follow-up was performed at 6 weeks and 1 year after surgery. The height of the patella was measured with the Caton–Deschamps–Index on true lateral radiographs and the TTTG–distance (tibial tuberosity trochlear groove) on MRI slides. We also classified the preoperative level of arthrosis of patellar cartilage [11]. With a follow-up of at least 12 months all patients were retrospectively evaluated, the mean follow-up was 48.9 months (12–109 months). We used three questionnaires to assess activity (Tegner–Score), functional impairment (Lysholm–Score) [12] and quality of life (SF–36) [13]. 31% (13/42 knees) had previous surgery: arthroscopy, evacuation of cartilage flakes, medialisation of the tibial tuberosity, lateral release and medial patellofemoral ligament repair. Reasons for loss to follow-up included change of address, lack of willingness to participate in the study, disability to answer questions (1 patient lacked mental capacity) and incomplete questionnaires. For statistical analysis SPSS (Version 21) was used.

### Operative Technique

The surgical procedure was performed as described by Bereiter. Using a lateral parapatellar approach direct visual inspection of the trochlea groove is performed and the articulating surface of the patella evaluated for cartilage damage and extent of dysplasia. After detaching the synovium at the cartilage–bone junction two curved osteotomes are used to develop an osteochondral flake by chiselling off the trochlear groove from the lateral condyle from proximal to distal until just before the notch. The development of the new trochlear groove in the subchondral bone is achieved by using chisels and a ball–milling machine. The previously created osteochondral flake is placed into the new–shaped groove and fixed with a 3 mm Vicryl band (Ethicon Products®) by transosseous suture. The bone graft gained from the chisels and milling machine is used to enhance the lateral condyle and is then fixed with fibrin glue. Re–attachment of the synovium is performed with a continuous suture. To optimize the patellar tracking we regularly perform a reefing of the medial patellofemoral ligament but without using a graft. The lateral joint capsule and retinaculum are closed after placing an intra–articular drain. Subcutaneous tissue and skin are sutured.

### The Postoperative Treatment Followed a Standardized Protocol

The intra–articular drainage is removed after 24 h and sutures at 14 days after surgery. Mobilisation was carried out with full weight–bearing in a knee–brace with limited flexion to 60° for 3 weeks and afterwards 90° for 3 weeks as well as 20° block to full extension for 6 weeks. Avoiding full extension of the knee creates a continuous contact pressure between the patella and the newly–fashioned trochlear groove and this supports healing and centralization of the patella. Thromboembolism prophylaxis with low molecular weight heparin (Fragmin®) was prescribed. Six weeks after surgery the brace was removed. Physiotherapy continued to reach full range of motion, optimize muscle status and return to normal daily living and sporting activities.

## RESULTS

### Patient Demographics and Preoperative Findings

A total of 42 knees (39 patients) could be included into the analysis. 31% (13/42) had undergone previous surgery (arthroscopy, arthrotomy, medialisation of tibial tuberosity, lateral release, reconstruction of medial patellofemoral ligament) with persistent instability before trochleaplasty. Preoperatively all patients had a positive apprehension sign. The degenerative changes of the patellar cartilage were also evaluated preoperatively. 60% showed none or only mild alterations, 40% had already advanced arthritic changes and were graded according to Kellgren and Lawrence Score [11]: 11 grade 0 (26%), 6 grade I (14%), 8 grade II (19%), 10 grade III (24%), 7 grade IV (17%).

### Radiographic Results

We classified the trochlea dysplasia according to Dejour and Saggin [10] (**Figure 1**) prior to surgery. 15 were type B (36%), 21 type C (50%) and 6 type D (14%). In our study the TTTG–distance (tibial tuberosity trochlear groove) averaged 12.6 mm with a range of 6.5–20 mm (**Figure 4**). Half of our patients showed a patella alta with a mean Caton–Deschamps–Index of 1.20 (range 0.88–1.55). The typical crossing–sign was seen preoperatively in all patients with none after trochleaplasty (**Figure 2**).

### Postoperative Clinical Findings

Postoperatively patients displayed no apprehension sign in 41/42 knees (97.6%). 1 year after trochleaplasty in 10/42 knees the patients complained about slight load dependent anterior knee pain (23.8%), all the others were pain–free. We did not see any limitation in range of motion in the operated knee.

### Patient Satisfaction, Quality of Life and Functional Scores

The average of Tegner's activity Score was 5 points (range 3–9). 55% of the patients reached a Tegner score of 5 or more points (**Figure 5**).

The Lysholm–Score reached a mean value of 81.3/100 points (range 39–100). 40.5% (17/42) had an excellent result with 90 or more points, 57.1% (24/42) a good result with 84 or more points (**Figure 6**).

The average value for physical health component summary score (PCS) and mental health component summary score (MCS) in SF–36 showed little variation compared to German norm population (PCS: male 48.9, female 49.6, MCS: male 51.1, female 52.5) (**Figure 7**).

Asked to whether they would decide to undergo surgery for trochleaplasty again, all patients answered "yes".

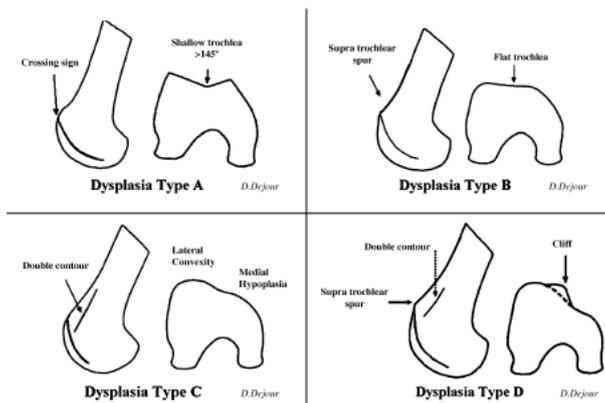


Figure 1. Trochlea dysplasia classification according to D. Dejour [10].



Figure 2. lateral radiographs preoperative (left) and 1 year after trochleoplasty (right).

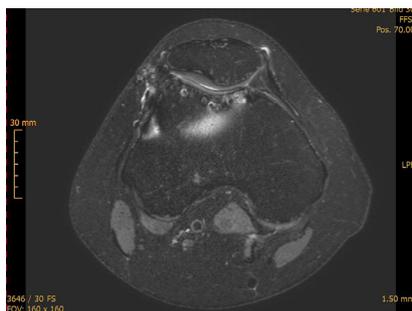


Figure 3. MRI right knee 60 months after trochleoplasty (MR PD SPAIR TRA DRIVE).

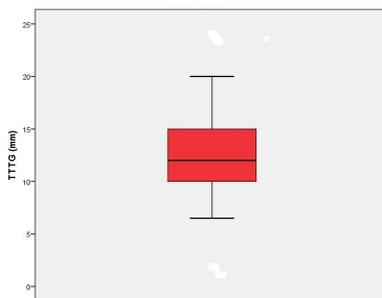


Figure 4. TTTG-distance (tibial tuberosity trochlear groove) averaged 12.6 mm (6.5–20 mm).

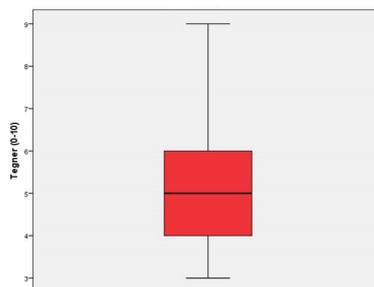
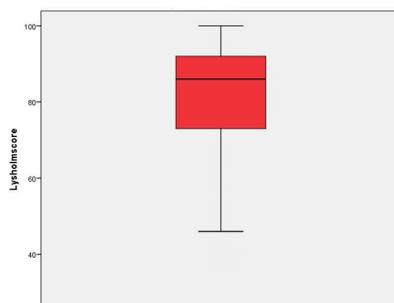


Figure 5. Tegner's activity Score after trochleoplasty [12].



**Figure 6.** Lysholm-Score after trochleaplasty <sup>[12]</sup>.

SF-36	Trochleaplasty	German norm population (20–29)
Physical health component summary score (PCS)	F: 49.6 M: 59.8	F: 54.47 M: 54.07
Mental health component summary score (MCS)	F: 52.5 M: 58.6	F: 49.6 M: 49.94

**Figure 7:** SF-36 after trochleaplasty <sup>[13]</sup>.

### Complications

We had a low complication rate with only 1 patient who needed evacuation of hematoma on the 3<sup>rd</sup> day after surgery. We did not experience any problems with wound healing and had no infection or thromboembolic events. Furthermore we had no recurrence of dislocation while 1 patient reported persistent slight tendency for subluxation. This patient received a distalisation and medialisation of the tibial tuberosity 25 months after trochleaplasty and was then satisfied follow-up. Another patient needed an arthroscopy with debridement of scars 15 months postoperatively.

## DISCUSSION

Patellofemoral instability with recurrent dislocation of the patella represents a complex anatomical, mechanical and clinical challenge. Trochlea dysplasia is well known to be one important anatomical factor responsible for chronic instability. Furthermore recurrent dislocation of the patella due to instability may lead to osteoarthritis of the patellofemoral joint.

To address the trochlea dysplasia different surgical techniques have been described. An osteotomy with elevation of the lateral facet and interposition of a tibial graft was propagated by Albee <sup>[14]</sup>. Cartilage impaction without fixation to the subchondral bone describes the procedure for restoration of the intercondylar groove described as trochleoplasty by Masse <sup>[15]</sup>. Also Dejour et al reported about a remodelling technique for the trochlea, they used an osteotomy of both femoral condyles to create a V-shaped trochlea <sup>[16]</sup>.

Further evolution of the surgical techniques presented above was the trochleaplasty technique of Bereiter and Gautier <sup>[6]</sup>. Their aim was to create a more anatomical correction of the trochlear groove by using curved osteotomes and optimize the position of the new groove <sup>[6]</sup>. So far only few studies dealing with the outcome after trochleaplasty have been presented. The most actual data are presented in the study of Grehn et al. <sup>[17]</sup>. They showed in more than 250 patients – since starting with trochleaplasty in 1991 – no recurrent dislocation, a significant improvement of function, increased activity in most cases while 20% still experienced pain.

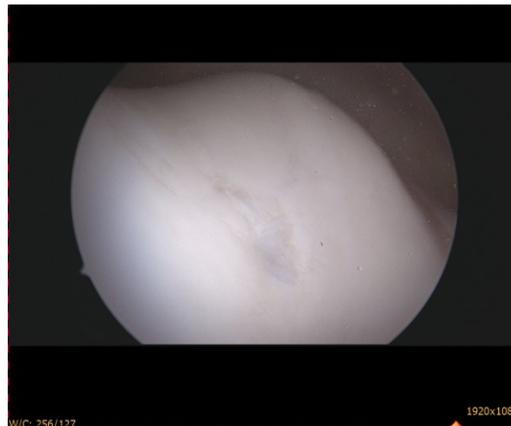
In this study we report our single-center results after trochleaplasty using the Bereiter technique. The primary aim of surgery was to achieve a stable patellofemoral joint. Our results show that the method achieves predictably patellofemoral stability as we did not have any re-dislocations. Only one patient showed a positive apprehension-sign at follow-up. Even if patients had undergone previous surgery before trochleaplasty it is still a reliable surgical treatment if the instability is based on trochlea dysplasia. Because we had a very low complication rate we can also state that the trochleaplasty of Bereiter is a safe surgical technique.

The subjective outcome showed 40,5% (17/42) excellent results in Lysholm-Score (**Figure 6**) as well as satisfactory activity level with a mean value of 5 points in Tegner's activity Score (**Figure 5**). Before surgery most of the patients stopped their sport activities because of pain, instability and fear of the next patella dislocation. Individual patients could even reach competitive sports level after trochleaplasty.

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23.8% of our patients complained about slight load-dependent anterior knee pain. Von Knoch et al reported concerns regarding postoperative patellofemoral pain. The preoperative pain became worse in 33.4% of knees after trochleoplasty [18]. The reasons for development of postoperative pain or worsening of preoperative pain are not clear yet. Perhaps it is based on a progression of the preoperative osteoarthritic changes in the patellofemoral joint. It is known that preoperative damage of the trochlear cartilage will result in less satisfactory results [19].

Our study is limited as the results for long-time follow-up in our study group are not yet available. The degree of degenerative changes after trochleoplasty or the worsening of pre-existing osteoarthritis and its clinical relevance should be subject of further research. As shown in MR-slides and intraoperative views from a knee 60 months after trochleoplasty there are only few degenerative changes. In addition the drill hole in the center of the trochlear groove is filled with cartilage (**Figures 3 and 8**). If there might be a retardation of osteoarthritic progression after trochleoplasty has to be evaluated in longterm follow-up.



**Figure 8.** Arthroscopic view of trochlea of the right knee 60 months after trochleoplasty.

## CONCLUSION

Compared to the literature our results are similar with respect to stability of the patellofemoral joint, patient's satisfaction, level of activity and knee function [17-20]. One of the most important steps for successful therapy of patellofemoral instability is the exact clinical, radiological and MRI examination to identify the factors which lead to the instability. Limitations for trochleoplasty are chronic dislocation, osteoarthritis of the trochlear cartilage with subchondral sclerosis and open physis.

According to our results we suggest that trochleoplasty as described by Bereiter and Gautier [6] represents a demanding surgical procedure for reconstruction of the trochlea's morphology and stability of the patellofemoral joint. Recurrent patellar dislocations can be reliably avoided while activity and quality of life can be preserved or improved with only little or moderate functional impairment in most of the patients. It can also be used in conjunction with other procedures (e.g. soft tissue balancing with MPFL-reconstruction and lateral enlargement plasty). Even if it might contribute to degenerative changes or worsening of those pre-existing in the patellofemoral joint, the gained stability of the patella and the satisfaction of the patients are sufficient to recommend this procedure – especially when compared with natural history.

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