

# Trochleaplasty for patellar instability due to trochlear dysplasia

## A minimum 2-year clinical and radiological follow-up of 19 knees

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**Background** Recurrent patellar dislocation may be associated with trochlear dysplasia. Trochleaplasty is a surgical procedure which strives to deepen the trochlear groove. We evaluated the clinical and radiological effect of trochleaplasty after a minimum follow-up of 2 years.

**Patients and methods** We examined 19 knees in 16 patients at a mean of 3 years after trochleaplasty. Postoperatively, a subjective questionnaire, a Kujala score, and tests for potential patellar redislocation and apprehension were evaluated. On radiographs we evaluated the preoperative and postoperative crossing sign, trochlear depth, trochlear bump, and patellar height. On CT scans, the pre- and postoperative tibial tuberosity to trochlear groove distance (TTTG) and the patellar inclination angle were measured.

**Results** 16 of 19 knees improved subjectively. The Kujala score increased from 56 to 80 points at the latest follow-up. None of the patients sustained a redislocation. 5 patients had medial parapatellar tenderness, including 4 with persistent apprehension. Radiological signs of trochlear dysplasia were corrected.

**Interpretation** Patellofemoral instability with underlying trochlear dysplasia can be treated successfully by trochleaplasty.

meyer 1967). Brattström (1965) found that the lateral condyle was significantly lower in patients with recurrent patellar dislocation than in patients without patellofemoral pathology. Dejour et al. (1994) found that dysplasia of the femoral groove occurred in 85% of patients with recurrent patellar dislocation.

Different techniques have been described to correct trochlear dysplasia surgically. Albee (1915) elevated the lateral condyle by an osteotomy and interposition of a tibial graft. Masse (1978) described a technique in which the trochlear groove was remodeled, and Dejour et al. (1990) deepened the trochlea by an osteotomy after peeling off the cartilage. Bereiter and Gautier (1994) described a similar technique in which the cartilage is peeled off, and the subchondral trochlea is deepened with a high-speed burr.

We compared preoperative and postoperative clinical and radiological parameters in patients with recurrent patellar instability and trochlear dysplasia before and after trochleaplasty using the technique described by Bereiter and Gautier (1994).

### Patients and methods

#### Indications for operation

Indications for trochleaplasty were 2 or more patellar dislocations or 1 patellar dislocation with a persistent Fairbank's apprehension sign of more than

As a consequence of trochlear dysplasia with a low lateral condyle, the depth of the trochlear groove is reduced and the patella cannot engage properly (Pollard 1891, Drew 1908). Trochlear dysplasia was first described by Richerand in 1802 (Iser-



Figure 1. Intraoperative finding of a flat trochlea before peeling of the cartilage.

1 year (patient experiences pain and anxiety, while the examiner attempts to lateralize the patella in the extended leg) in the presence of all radiological signs of trochlear dysplasia. This includes a positive crossing sign, where the trochlea is crossing the lateral femoral condyle on a straight lateral view, a reduced trochlear depth, a trochlear bump, and minimal translation on a straight lateral radiograph (Dejour et al. 1994). Every patient had preoperative MRI to evaluate the cartilage of the trochlea. Contraindications for operation were degenerative deformation of the trochlea and open epiphyseal plates.

#### *Surgical technique*

Through a parapatellar lateral incision, the trochlea is exposed by retracting the patella medially in full extension. The cartilage is separated from the synovium and is detached with a rasp. The medial and lateral condyles are peeled off using curved osteotomes until 5 mm cranial of the notch, together with the trochlea in one piece, leaving a bone stock of 2 mm on the cartilaginous fragment (Figure 1). Then the subchondral groove is deepened using a straight chisel and a high-speed burr. The trochlear cartilago-bony flake is now pressed into the newly formed bony groove and fixed with 2 transosseous vicryl strings in the deepest part of the new trochlea. The synovium is reattached to the condylar edges with a continuous absorbable suture (Figure 2). The insertion of the vastus medialis obliquus muscle at the patella is tightened with one suture.



Figure 2. Intraoperative finding after trochleaplasty with the deeper trochlear groove. The trochlear cartilage is fixed with 2 transosseous vicryl strings. The synovium is reattached with continuous absorbable braided 2-0 suture to the condylar edges.

The lateral retinaculum is left open. The joint is closed by adaptation of the synovium and the skin is closed. Intraarticular drainage is removed after 24 h. A knee immobilizer at 30° of flexion is left for 6 weeks. Daily knee flexion exercises are allowed without restriction, but with a physiotherapist. No more than 30° of extension is allowed for 6 weeks. Full weight bearing is allowed from the first day.

#### *Patients (Table)*

Between 1999 and 2001, we performed trochleaplasty in 19 knees of 16 patients (3 bilateral). 13 patients were women (2 bilateral). The average age at surgery was 22 (17–40) years. 16 knees had suffered from recurrent patellar dislocation, and 3 knees had suffered from persistent apprehension of more than 1 year after 1 patellar dislocation. The apprehension sign was positive in all patients. 5 patients had undergone previous surgery, such as cartilage debridement, medial retinacular suture, lateral retinacular release, or medialization of the tibial tuberosity.

All patients were available for follow-up at a mean of 3 (2–4) years. The clinical postoperative evaluation consisted of a subjective questionnaire (Drez et al. 2001), the Kujala knee score (Kujala et al. 1993), and of a physical examination (apprehension to lateral displacement, medial quadriceps tenderness, patellofemoral pain). Signs of trochlear dysplasia (Dejour et al. 1994), and also patellar height were evaluated on straight lateral radiographs, the latter by using the Caton ratio (1989).

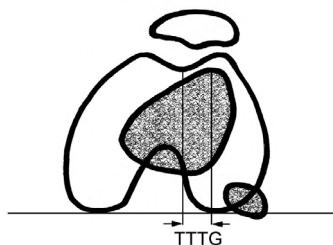


Figure 3. Tibial tuberosity to trochlear groove (TTTG) distance: the distance (in mm) between the most anterior point of the anterior tibial tuberosity and the deepest point of the trochlear groove, measured in 2 superimposed CT images at the level of the proximal tibia and the distal femur.

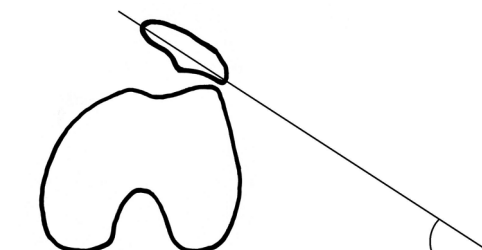


Figure 4. Patella inclination angle (PIA): the angle between the transverse axis of the patella and the bicondylar line.

The tibial tuberosity to trochlear groove distance (TTTG) (Figure 3) (Goutallier et al. 1978) and the patellar inclination angle (PIA) (Figure 4) (Beaconsfield et al. 1994) were measured on transverse CT scans.

#### Statistics

Pre- and postoperative clinical and radiological findings were compared using the Wilcoxon signed rank test, with significance set at  $p < 0.05$ . We used the mean values of the 3 patients operated bilaterally. Thus, only 16 knees were used for the statistical analysis. We hypothesized that the Kujala score should increase, the “crossing sign and positive trochlear translation disappear, the trochlear depth increase, the Caton index and the number of patella alta decrease, and that the TTTG and the PIA should increase.

#### Results (Table)

16 of 19 knees had improved subjectively. According to Drez’s subjective score (Drez et al. 2001), 10 knees had an excellent result, 6 had a good result, 1 had a fair result and 2 patients had a bad result. All patients reported improved stability. No redislocation occurred, but 4 patients reported a persistent apprehension, still suffering from anxiety, while the examiner attempted to lateralize the patella in the extended leg. 5 patients had a tenderness of the medial patellofemoral retinacular area. In 12 knees the pain level became reduced, while there was increased pain in 2 knees postoperatively. Overall, the Kujala score increased from 56 (27–67) points

to 80 (43–99) points at the latest follow-up ( $p = 0.003$ ). The preoperative crossing sign was grade I in 7 cases, grade II in 3, and grade III in 9 cases according to Dejour et al. (1990). Postoperatively, a persistent crossing sign of grade I was found in 3 cases ( $p < 0.001$ ), but none of these patients had a fair or bad result. Postoperatively, a positive trochlear translation remained in 3 knees ( $p < 0.001$ ); 1 of them had a fair result and two had a good result. The mean depth increased from 0.6 (–3 to 3) mm preoperatively to 7 (4–9) mm postoperatively ( $p < 0.001$ ). All knees had a normal trochlear depth postoperatively. The Caton ratio decreased from 1.2 (0.85–1.47) preoperatively to 1.1 (0.82–1.28) postoperatively. The number of knees with patella alta decreased from 10 to 2 ( $p = 0.004$ ). The mean TTTG decreased from 20 (10–24) mm preoperatively to 9.9 (5–15) mm postoperatively ( $p = 0.001$ ). The mean PIA decreased from 22° (5–35) preoperatively to 8° (1–20) postoperatively ( $p < 0.001$ ). 2 of 3 patients with fair or bad results had degenerative changes of the trochlea preoperatively, which increased in 1 of them postoperatively.

#### Discussion

Trochlear dysplasia is a predisposing factor for recurrent patellar instability (Dejour et al. 1994). Proximal or distal soft tissue realignment procedures, with or without transfer of the tuberosity, have had limited success in patients with trochlear dysplasia (Harilainen and Sandelin 1993, Aglietti et al. 1994, Schneider et al. 1997, Fulkerson 2002).

## Patient data

A	B	C	D	E	F	G	H	I	J	K	L	M	N
HA	27	m	y	n	43	91	excellent	3	6	21	5	19	12
HA	29	m	y	n	43	91	excellent	3	6	18	7	15	12
VB	18	f	y	n	62	86	good	0	8	18	14	24	2
VB	19	f	y	n	62	98	excellent	2	9	20	13	29	12
MB	25	f	n	n	62	43	bad	0	8	16	6	24	12
KC	29	f	n	n	60	65	good	2	6	13	7	14	2
MG	18	m	n	n	68	99	excellent	-3	9	20	10	34	14
MS	25	f	n	n	64	93	excellent	3	8	20	12	28	14
BK	18	f	n	n	67	66	good	0	6	22	12	19	1
ML	17	f	n	y	57	93	excellent	0	7	19	12	29	10
SN	21	f	n	y	52	61	good	0	7	10	14	14	4
DS	21	f	n	n	69	86	good	-2	7	16	8	18	3
GS	40	f	n	y	52	93	excellent	0	7	20	7	15	3
AS	17	f	n	y	41	75	good	2	4	24	8	24	20
CS	21	f	n	y	58	55	bad	-2	6	24	13	29	12
CS	17	f	y	n	60	96	excellent	1	7	23	15	35	1
CS	17	f	y	n	57	91	excellent	1	6	19	6	20	3
SS	21	f	n	n	61	93	excellent	2	8	16	5	5	2
MW	25	m	n	n	27	45	fair	0	8	18	14	21	9
Mean	22.4				56.1	80.0		0.6	7.0	18.8	9.9	21.9	7.8
A	Patient				H				Subjective score postoperatively				
B	Age				I				Trochlear depth preoperatively, mm				
C	Sex				J				Trochlear depth postoperatively, mm				
D	Bilateral				K				Tibial tuberosity to trochlear groove distance preoperatively, mm				
E	Previous operation				L				Tibial tuberosity to trochlear groove distance postoperatively, mm				
F	Kujala preoperatively				M				Patellar inclination angle preoperatively, °				
G	Kujala postoperatively				N				Patellar inclination angle postoperatively, °				

Since the medial patellofemoral ligament (MPFL) ruptures or lengthens regularly after patellar dislocation (Fithian et al. 1995), MPFL reconstruction has a high success rate in patients with normal trochlear anatomy (Fithian et al. 1995, Muneta et al. 1999, Garth et al. 2000, Nomura et al. 2000, Drez et al. 2001). However, in knees with an underlying trochlear dysplasia, the ligamentous insufficiency is not a cause, but rather a consequence of recurrent dislocation (Masse 1978, Dejour et al. 1990, Bereiter and Gautier 1994).

Our findings show that trochleaplasty is an effective and safe procedure, which prevents patellar subluxation or dislocation.

Other than the technique of Albee (1915), which elevates the lateral condyle and increases lateral patellofemoral pressure, the techniques of Masse (1978), Dejour et al. (1990) and Bereiter and Gautier (1994) deepen the trochlea, which results in a relative increase of the lateral condyle. Such a remodeling of the trochlear groove in the proximal part might lead to an improved engagement of the

patella in the early flexion phase. The technique of Masse impacts the cartilage without fixation of the underlying bone, while the technique of Dejour peels off the cartilage before the trochlea is remodeled by an osteotomy of the two condyles, lowering them in the central aspect. Using this technique, a V-shape of the trochlea is achieved rather than a concave shape. The technique of Bereiter allows a concave modeling of the trochlea, as has been demonstrated on postoperative transverse CT scans in our study (Figures 5 and 6). In addition, the TTTG is normalized without having performed a transfer of the tuberosity in any knee.

A less satisfactory result can be expected if the trochlear cartilage has degenerated. To force the degenerated and unelastic cartilago-bony layer back to the deepened subchondral groove may result in cartilage fracture and further. However, the procedure by itself seems not to initiate evident degenerative changes of the condyles during the first 2 years after surgery, although Bereiter and Gautier (1994) found the development of pannus



Figure 5. Preoperative axial CT scan with a flat trochlea.



Figure 6. Postoperative axial CT scan with an improvement of the trochlear depth, measured at the same level and in the same patient as in Figure 5.

on histological examination of the groove where the vicryl sutures were placed. We did not see any postoperative detachment of the cartilago-bony layer in any patient; however, the long-term vitality of the cartilage after trochleoplasty is still an open question.

Preoperative imaging work-up with straight lateral view and a CT scan is important for identification of all features of trochlear dysplasia (Dejour et al. 1980, 1994, Galland et al. 1990, Beaconsfield et al. 1994). Preoperative MRI may show degenerative trochlear cartilage. The goal of the operation is the anatomical reconstruction of the trochlea by eliminating the crossing sign and the trochlear bump, and by deepening the groove and decreasing the TTTG.

Trochleoplasty should be avoided in the case of open epiphysis. It is unclear whether preoperative arthritic changes are a contraindication and whether the procedure enhances or initiates femoropatellar arthritis, since recurrent instability itself results in patellofemoral arthrosis in one third of the patients (Maenpaa and Lehto 1997, Maenpaa et al. 1997).

No competing interests declared.

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