Value of intercondylar notch plasty

CT studies and peroperative measurements of 127 knees

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The intercondylar notch diameter was measured in six knees on CT scans before and after anterior cruciate ligament reconstruction. During the operation, direct measurements of the anterior notch diameter was also performed before and after notch plasty. There was good agreement between CT and peroperative measurements, showing that the enlargement of the intercondylar notch can be measured on the CT scan. Twenty-one patients previously reconstructed because of old anterior cruciate ligament injuries were reexamined after a median of 4 years, and their notch diameters were measured by CT or at reoperation. The notch remained open in stable knees, but was narrowed in unstable knees. The notch diameter before notch plasty was assessed with a calliper at operation on 45 patients with acute and 60 patients with old injuries. Both groups had a mean intercondylar diameter of 16 mm.

The conclusion that the notch plasty stays open in stable knees emphasizes the importance of this step in the reconstruction procedure.

During recent years, interest has focused on the importance of the intercondylar fossa in the knee and its relation to the anterior cruciate ligament (Norwood and Cross 1977). It has been claimed that a narrow notch may predispose a knee to an anterior cruciate ligament tear (Lambert 1983, Kieffer et al. 1984). Unstable knees with old anterior cruciate ligament ruptures have a stenosis of the intercondylar notch (Feagin et al. 1982, Odensten and Gillquist 1985, Eriksson 1986), and at ligament reconstruction the notch has to be widened. The importance of intercondylar notch enlargement (notch plasty), by removing osteophytes and by widening the medial facet of the lateral femoral condyle, has been pointed out by Lambert (1983), Kieffer et al. (1984) and Eriksson (1986). The notch plasty provides improved exposure to the femoral attachment of the anterior cruciate ligament and prevents impingement of the graft when the knee moves from flexion to full extension.

We report that this operative widening of the notch can be measured on a CT scan, and that the notch plasty stays open in stable knees, but is narrowed in unstable knees.

Patients and methods

Six knees in 2 males and 4 females, median age 21 (17–30) years, in which an anterior cruciate ligament reconstruction was performed because of an old rupture, were CT-scanned before and within 7 days after the operation, and the anterior diameter of the intercondylar notch was measured on the CT scans. During the operation direct measurements of the anterior notch diameter was also performed before and after the notch plasty (Table 1).

Twenty-one patients (11 males and 10 females) previously reconstructed because of old anterior cruciate ligament injuries were examined. Of these 11 with a stable knee and 2 with an unstable knee at

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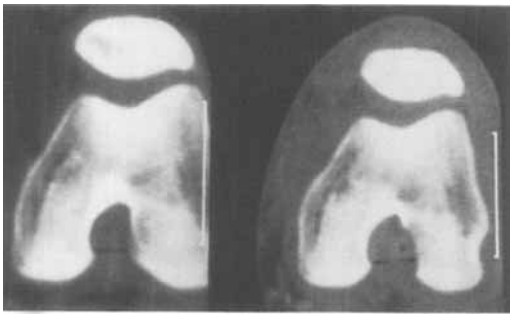

Figure 1. The anterior notch diameter was measured on a CT scan before (left) and after (right) notch plasty.

Table 1. At the reconstruction of the anterior cruciate ligamen, the intercondylar notch was widened. The preoperative (1) and postoperative (2) widths of the notch (mm) as measured with a CT scan and directly at the operation before (1) and after (2) the notch plasty

Sex	Age	CT(1)	CT(2)	Op(1)	Op(2)
F	17	17	19	14	20
M	23	17	21	14	21
F	20	15	18	15	21
F	22	16	22	16	22
F	30	16	21	16	21
M	19	15	20	13	20
Mean	*SD*	16 *0.9*	20 *1.5*	15 *1.2*	21 *0.8*

Table 2. Patient data showing that the mean diameter (mm) of the intercondylar notch was at follow-up unchanged in stable knees (21 mm), but was narrowed in unstable knees (17 mm; $P < 0.001$)

Case	A	B	C	D	E	F	G
1	F	28	1	36	1	16	op
2	M	28	1	46	1	17	op
3	M	25	1	48	1	15	op
4	F	26	1	54	1	17	op
5	F	24	2	48	1	16	op
6	M	28	2	46	1	18	op
7	M	29	2	42	1	22	op
8	F	31	2	44	2	23	op
9	F	27	1	78	2	19	CT
10	F	43	1	60	2	25	CT
11	M	49	1	78	2	19	CT
12	M	30	1	72	2	20	CT
13	M	29	1	72	2	23	CT
14	M	43	1	60	2	18	CT
15	M	28	1	66	2	24	CT
16	F	27	1	60	1	16	CT
17	F	26	2	30	2	20	CT
18	F	26	2	39	1	16	CT
19	M	34	2	36	2	21	CT
20	F	28	2	42	2	18	CT
21	M	29	2	44	2	20	CT

A Sex
B Age at examination
C Surgical technique: 1 Xenograft®, 2 Goretex®
D Follow-up: Months between primary notch plasty and last measurement of notch diameter
E Stability: 1 unstable, 2 stable
F Notch diameter (mm) at follow-up
G Measured at operation or CT

follow-up were CT-scanned, and the notch diameter was assessed a median of 3–6 years after the reconstruction (Table 2). The intercondylar notch diameter in 7 patients with unstable knees and in 1 patient with a stable knee was directly measured at reoperation a median of 4–5 years after the primary reconstruction (Table 2). At the first reconstruction, a notch plasty was performed in all 21 cases.

The pivot shift sign (Galway et al. 1972) and an arthrometric examination (KT-1000, Med-Metrics Corp. San Diego, CA, USA; Daniel et al. 1985a) were used as criteria for anterior stability. Patients with a clearly positive pivot shift sign and an injured-uninjured arthrometric difference of 3 mm or more at 89 N anterior pull were selected for the unstable group. Patients with a negative pivot shift sign and an injured-uninjured arthrometric difference less than 3 mm at 89 N pull were selected for the stable group (Daniel et al. 1985b).

At the primary reconstruction, the intercondylar notch was always enlarged with an osteotome to a minimum of 20 mm, measured with a calliper, by removing osteophytes and by partially removing the medial facet of the lateral femoral condyle. The transverse anterior notch diameter between the medial and lateral femoral condyles was measured with the knee in 90° of flexion. The surgical techniques that were used in this study included artificial anterior cruciate ligament substitution with a bovine tendon prosthesis (Xenograft®) or a polytetrafluoroethylene (Goretex®) ligament prosthesis (Dahlstedt et al. 1989, 1990).

CT-examinations were performed with 4-mm consecutive scans. The patients were placed in the supine position with the knees flexed 40° on a plastic support.

To evaluate the effect of gantry angulation, a plastic femur was cut on the medial facet of the lateral femoral condyle exactly as a notch plasty is performed during reconstruction. The plastic femur was examined with 4-mm scans in the cut area. This was done with a gantry angle of + 20°, 0°, and –20°.

The scans examined with a –20° gantry angle were considered to demonstrate the anterior intercondylar notch diameter most accurately. All the patients were examined with a gantry angle of –20°. The intercondylar diameter was measured with the computer in two consecutive scans, and the mean value was calculated (Figure 1).

During the period from January 1986 to December 1989, we reconstructed 45 patients with acute anterior cruciate ligament injuries and 60 patients with old injuries. At the operation, the notch diameter was assessed with a calliper before notch plasty.

Statistics

The Student's *t*-test was used, and $P < 0.05$ was considered significant.

Results

Peroperative enlargement of the intercondylar notch can be measured on a CT scan (Table 1). The notch stayed open in stable knees, but was narrowed in unstable knees ($P < 0.001$; Table 2).

The notch diameter in acutely and chronically injured knees was the same (16.5 ± 2.3 mm and 16.9 ± 2.6 mm, respectively).

Discussion

We were afraid that the enlarged intercondylar notch in the long-term would become narrow due to formation of new bone, especially when artificial grafts were used. The aim of the first part of the study was to show that CT could be used to measure the notch width. However, the number of double measurements is limited; but considering the relatively high radiation dose to the patient, this part of the study could not be extended.

The relation between the intercondylar notch and the anterior cruciate ligament is important (Norwood and Cross 1977, Kieffer et al. 1984). Houseworth et al. (1987) analyzed the intercondylar notch in acute tears from notch-view roentgenograms using computer graphics. Their conclusion was that a stenotic or narrowed posterior arch places a risk for an anterior cruciate ligament tear. Anderson et al. (1987) described the dimensions and configuration of the intercondylar notch by CT and found significant differences between normal and anterior cruciate ligament injured knees as regards anterior notch width and opening notch angle.

We have confirmed that the anterior diameter of the notch can be analyzed by computed tomography. Further, we have confirmed that in failed reconstructions with unstable knees the notch is narrowed (Feagin et al. 1982, Eriksson 1986). Some studies claim that acutely injured knees have a small notch diameter (Houseworth et al. 1987, Andersson et al. 1987). Other studies have not shown notch stenosis in acute cases (Odensten and Gillquist 1985), but substantial narrowing in bilateral anterior cruciate ligament tears (Souryal et al. 1988). Our results indicate that both old and acutely injured knees have a narrow notch compared to values given in the literature for normal knees (21 mm; Odensten and Gillquist 1985).

Our conclusion that the notch plasty stays open in stable knees emphasizes the importance of this step in the reconstruction procedure.

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