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Distal tuberosity osteotomy in open wedge high tibial osteotomy can prevent patella infera: a new technique

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Abstract

To prevent patella infera in open wedge high tibial osteotomy, a new operation technique was developed. Instead of a proximal tibial tuberosity osteotomy, a distal osteotomy was performed and the tuberosity was fixed with one screw to the tibia. Initial experience in 17 patients was evaluated and compared with results of 20 patients with open wedge high tibial osteotomy with proximal tuberosity osteotomy. Distal tuberosity osteotomy in open wedge high tibial osteotomy appears effective in preventing patella infera.

Keywords: Tibial tuberosity; Osteotomy; Patella infera; Tibia

1. Introduction

In medial open wedge high tibial osteotomy (OWHTO) for valgus correction of medial compartment osteoarthritis of the knee the patellar height may change resulting in postoperative patella infera [1–3]. A decrease in patellar height associated with OWHTO has been attributed to distalisation of the tuberosity as a result of valgisation and to shortening of the patellar ligament by scarring [1,3,4]. Reduced patellar height can be the cause of patellofemoral problems and may complicate a conversion to total knee replacement for progressive arthritis of the knee [2,3,5,6].

A new operation technique was developed by one of the authors (AW) to prevent distalisation of the tuberosity and subsequently prevent patellofemoral problems. In the normal OWHTO technique the tuberosity remains attached to the distal part of the tibia by performing a proximal tuberosity osteotomy (PTO) or by positioning the osteotomy above the level of the tuberosity. In our newly developed technique we perform a distal tuberosity osteotomy (DTO) so the tuberosity remains attached to the proximal part of the tibia. Opening of the wedge will not change the position of the tuberosity and consequently, there will be less change of patellar height. The purpose of this report is to describe a new operation technique: a distal tuberosity osteotomy in open wedge high tibial osteotomy and to evaluate our first experiences in clinical practice.

2. Materials and methods

2.1. Operation techniques

2.1.1. Previous OWHTO technique with proximal tuberosity osteotomy

Through a midline incision, the tibial tuberosity and distal part of the patellar tendon is exposed. Starting posterior to the patellar tendon insertion, a PTO is performed: an osteotomy of the proximal tuberosity parallel to the anterior tibial cortex. After that, the tibial osteotomy is made behind the tuberosity, which is protected by an angular blade. Opening of the tibial osteotomy causes the tuberosity to move distally as it is attached to the distal part of the tibia (Fig. 1).

2.1.2. New OWHTO technique with distal tuberosity osteotomy

In the new technique we perform a DTO, so the tuberosity remains attached to the proximal part of the tibia. Therefore, the patellar height is not changed after opening of

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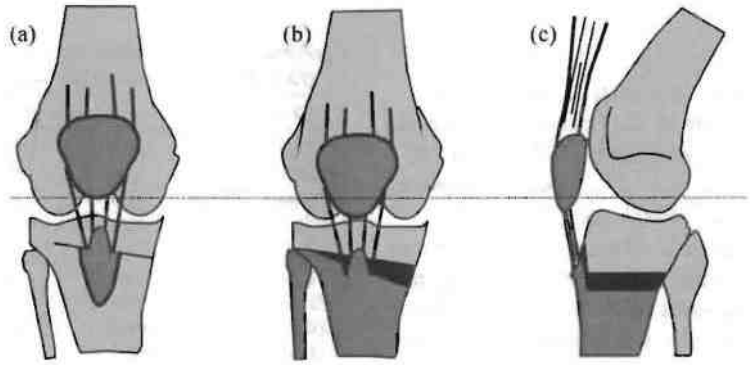

Fig. 1. OWHTO with PTO, leading to lowering of the patella. (a) before opening of the wedge, AP-view; (b) after opening of the wedge, AP-view; (c) after opening, lateral view.

the tibial osteotomy (Fig. 2). In contrast to the previous technique, first, the tibial osteotomy is made leaving at least 1 cm thickness of the tuberosity. After that, osteotomy is performed posterior to the tuberosity. Starting from the tibial osteotomy the tuberosity is cut distally in the frontal plane directed towards the anterior tibial cortex. The length of the osteotomized tuberosity should be at least 2.5 cm for small valgus corrections. In larger corrections, the tuberosity length must be longer and should be planned to at least overlap the distal tibial part for 2.0 cm after the wedge is opened. After medial plate fixation of the tibial osteotomy, we fix the distal part of the tuberosity with a bicortical screw to the tibia. As a stable fixation is reached the postoperative rehabilitation protocol for the OWHTO needs no adjustments due to the new technique.

2.2. Patient evaluation

Between March 2001 and October 2002, 17 consecutive patients operated according to the new OWHTO technique with the DTO were included for the study. A historical control group was formed from all patients operated upon from June 2000. The only selection criterion was presence of a suitable pre-operative lateral radiograph in 30° of flexion. All patients in this group were operated according to the routine operation technique, with the PTO.

The tibial osteotomy was fixed by a Tomofix plate (Mathys Medical, Bettlach) after filling of the wedge with tri-calcium phosphate (ChronOS-Mathys Medical Ltd). The patients in both groups suffered from medial compartment osteoarthritis of the knee and were operated by two surgeons (AW and RVH). For details on the demographics age and sex see Tables 1 and 2.

Postoperative care consisted of knee flexion and extension exercises starting the day after the operation. For the first 6 weeks there was restricted weight bearing (10 kg) with two crutches and thrombosis prophylaxis with low molecular weight heparin. After 6 weeks full weight bearing was allowed.

For each patient, the patellar height was measured by the Caton (-Deschamps) index [7] (CI) on pre- and 6 weeks postoperative lateral radiographs at 30° of knee flexion. The CI, the ratio between the distance from the inferior tip of the patellar articulating surface and the antero-superior angle of the tibia and the patellar articular surface length (Fig. 3), decreases with patella baja and increases with patella alta.

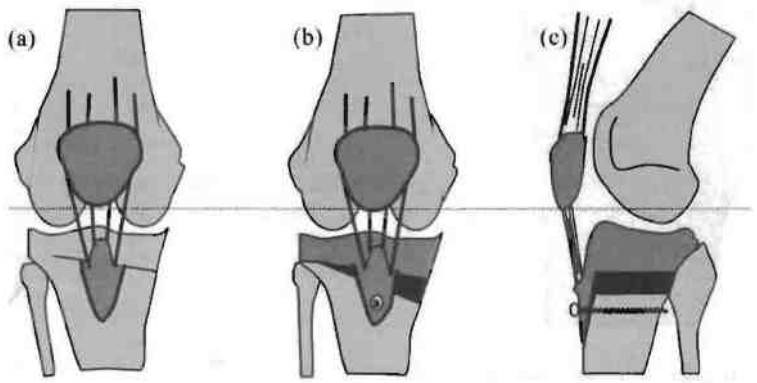

Fig. 2. OWHTO with DTO, leaving the patellar height unchanged. (a) before opening of the wedge, AP-view; (b) after opening of the wedge, AP-view; (c) after opening, lateral view.

Table 1
Data of patients with OWHTO with distal tuberosity osteotomy. Correction angle, pre- and postoperative Caton index (CI) and change of CI (Δ-CI)

Nr	Male/Female	Age	Correction	Pre-CI	Post-CI	Δ-CI
1	m	41	9	0.78	0.82	0.03
2	m	27	10	0.72	0.72	0.00
3	m	51	15	0.74	0.68	−0.05
4	m	41	6	0.75	0.78	0.03
5	m	42	7	0.85	0.83	−0.03
6	m	46	10	0.97	0.87	−0.11
7	m	62	9	0.87	0.79	0.01
8	f	42	10	0.59	0.56	−0.03
9	m	59	10	1.00	0.97	−0.03
10	m	44	15	0.85	0.83	−0.02
11	m	64	13	0.79	0.76	−0.03
12	m	37	12	0.90	0.87	−0.03
13	f	53	14	0.67	0.64	−0.03
14	m	48	7	0.73	0.73	0.00
15	m	54	8	0.80	0.80	0.00
16	m	61	10	0.94	0.91	−0.03
17	m	48	7	0.74	0.74	0.00
Mean		48	10	0.80	0.78	−0.02
(S.D.)		(10)	(2.8)	(0.11)	(0.10)	(0.03)

The normal value of CI is 0.96 (S.D. 0.13) in males and 0.99 (S.D. 0.13) in females. The patella is considered low (patella baja) when CI<0.6 and high (patella alta) when CI > 1.3 [2]. In the two groups, the pre-operative and post-operative CI was measured and compared using the paired *t*-test with $P<0.05$ considered significant.

Table 2
Data of patients with OWHTO with proximal tuberosity osteotomy. Correction angle, pre- and postoperative Caton index (CI) and change of CI (Δ-CI)

Nr	Male/Female	Age	Correction	Pre-CI	Post-CI	Δ-CI
18	f	23	5	1.14	1.06	−0.08
19	f	44	7	0.83	0.74	−0.09
20	f	63	10	1.03	0.76	−0.26
21	m	29	8	0.71	0.58	−0.13
22	f	51	7	0.92	0.74	−0.18
23	m	52	7	0.92	0.79	−0.13
24	m	38	3	0.84	0.79	−0.05
25	m	21	9	0.93	0.83	−0.11
26	f	59	5	0.97	0.86	−0.11
27	m	37	8	0.85	0.78	−0.08
28	m	33	9	0.93	0.84	−0.09
29	m	53	10	0.74	0.62	−0.12
30	m	43	8	0.68	0.51	−0.16
31	f	48	13	0.48	0.24	−0.23
32	m	26	6	1.03	0.97	−0.06
33	f	45	7	0.72	0.66	−0.06
34	m	50	14	0.86	0.71	−0.14
35	m	51	14	0.85	0.63	−0.23
36	m	32	12	0.95	0.82	−0.13
37	m	42	10	0.73	0.65	−0.08
Mean		42	8.6	0.86	0.73	−0.13
(S.D.)		(11)	(3.1)	(0.15)	(0.17)	(0.06)

3. Results

Tables 1 and 2 show the calculated pre- and postoperative Caton indices (CI) of the patients operated with the DTO and the PTO, respectively, together with the OWHTO correction angles.

In the DTO group (Table 1), the patella height was not essentially changed with a mean preoperative CI of 0.80 (range: 0.59–1.00) and a mean postoperative CI of 0.78 (range: 0.56–0.97). The tuberosity osteotomy was radiographically healed at 6 weeks postoperative in all but two patients. In one patient, the tuberosity was fractured during the tuberosity osteotomy due to a tibial osteotomy leaving less than 1 cm thickness of the tuberosity. In another patient the tuberosity fixation screw was positioned too proximal and slightly upward ending posteriorly in the opened wedge. At 6 weeks no consolidation was found and the screw was repositioned more distally with uneventful bone healing in 6 weeks. In none of the patients a secondary displacement of the tuberosity or the proximal tibia was found after the start of full weight bearing.

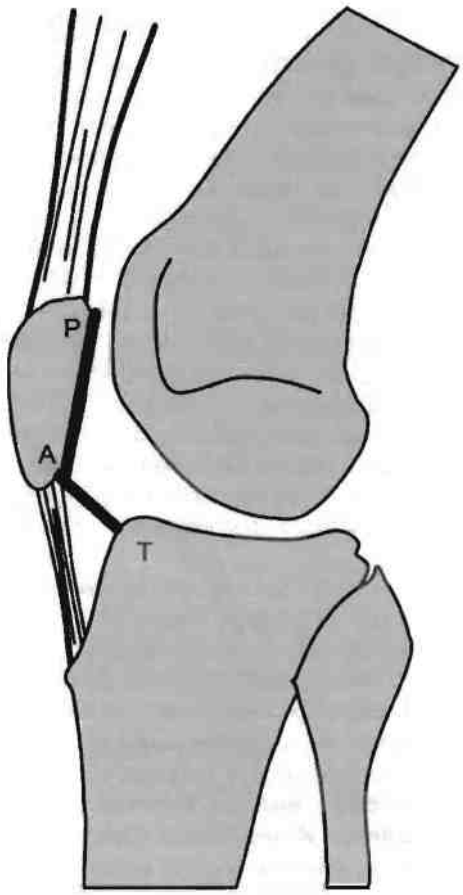

Fig. 3. Calculation of the Caton (-Deschamps) Index (CI index). PA is the length of the articular surface of the patella; AT is the distance from the inferior tip of the patellar articulating surface to the antero-superior aspect of the tibia. The CI Index is calculated as the ratio AT/PA.

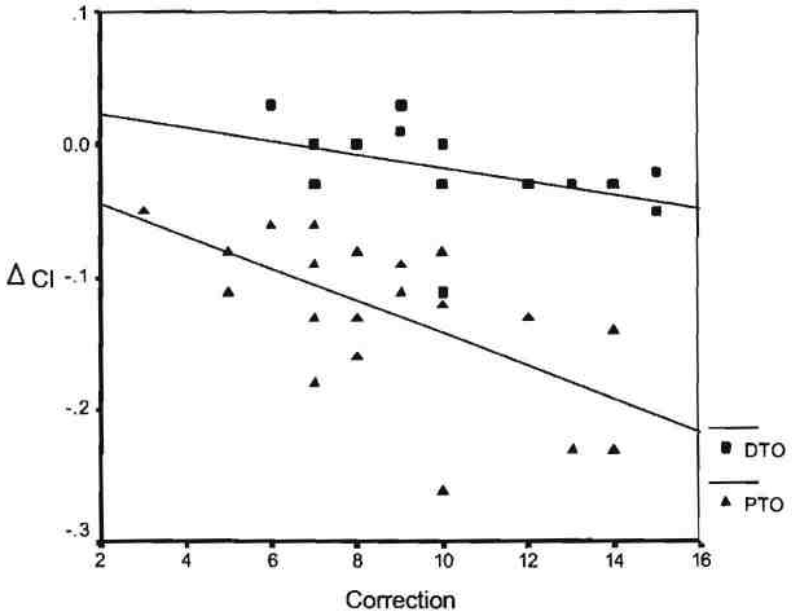

Fig. 4. The relation between change of Caton index (Δ-CI) and correction angles in PTO and DTO, showing a decrease in CI at higher correction angles in the PTO group.

In the PTO group (Table 2), the patella height decreased significantly ($P<0.001$) with a mean preoperative CI of 0.86 (range: 0.48–1.14) and a mean postoperative CI of 0.73 (range: 0.24–1.06). Bone healing of the tuberosity osteotomy was uneventful and complete at 6 weeks follow-up in all patients.

In Fig. 4 the relation between the angle of correction of the OWHTO and the difference between pre- and postoperative CI (Δ-CI) for both groups is displayed. The mean correction angle was slightly larger in the DTO group as compared to the PTO group (10 vs. 8.6°). In the PTO group, correction angle and patellar height were found to be related: the larger the correction angle of the OWHTO the lower the postoperative patellar height resulting in an increase of Δ-CI with increasing correction angles (Fig. 4).

4. Discussion

Open wedge high tibial osteotomy in medial osteoarthritis of the knee has gained a lot of popularity in recent years. However, the traditional open wedge technique results in a decrease of patellar height, which may lead to patella infera [2–4]. Patella infera following OWHTO causes anterior knee pain, patellar locking, crepitus and limitation of knee motion. Eventually, the altered patellofemoral congruency and contact stress can lead to patellofemoral osteoarthritis [8]. The new distal tuberosity osteotomy technique described in this paper addresses this problem. In addition, specific difficulties with conversion of failed HTO with patella infera to total knee arthroplasty [3,5,6] can be prevented.

Decrease of patellar height following OWHTO is mainly caused by the distalisation of the tuberosity when a PTO is used or the tibial osteotomy is made proximal to the tibial tuberosity. In those situations a decrease of patellar height is inevitable as was already shown by Goutallier [8] in a mathematical model. Opening of the osteotomy causes distalisation and lateralisation of the tuberosity and the patella. With the OWHTO technique with a DTO, the tibial tuberosity remains attached to the proximal tibia and opening the osteotomy will leave patellar height unchanged. Hernigou [4] uses another strategy to avoid patellar height decrease after OWHTO: positioning of a cement wedge between the posterior tibial cortices and no wedge anteriorly which results in almost no elevation of the anterior margin of the osteotomy. However, this technique can lead to unwanted additional tibial slope correction, especially in large valgus corrections.

The decrease of patellar height can also be the result of shortening of the patellar ligament by scarring with adherence of the patellar tendon to the tibia proximal of the tuberosity insertion [1,3,4]. Methods used to avoid scarring of the patellar ligament include meticulous surgical techniques avoiding large postoperative haematoma's, anti-inflammatory medication [9], continuous passive motion with flexion–extension exercises preventing immobilization [4], and daily manual patella mobilization exercises [3]. Small decreases of the Caton index in the DTO group in individual patients were within the measurement error and not related to the amount of OWHTO-correction. This might also be attributed to scarring of the patellar tendon, despite the immediate postoperative movement protocol that was used.

In this study we found that a distal tuberosity osteotomy during OWHTO prevents a decrease of patellar height measured with the Caton Index. Wright et al. [3] used the Blackburne–Peel ratio and the Insall–Salvati ratio as a measure of patellar height and found patella infera in 64% of their patients after OWHTO and no significant change in patellar ligament length. Tigani et al. [2] found a significant reduction of the Caton index after OWHTO similar to the results that were found in the patients with the PTO in the present study. In the PTO group, all patients showed lowering of the patella after the OWHTO and a direct relation was found between the change in patellar height and the amount of correction of the OWHTO. Small corrections in patients with normal patellar height are unlikely to lead to symptomatic patella infera. However, based on the results of this study, we advise use of the DTO-technique in cases in which higher valgus corrections of >10° are indicated and in patients with pre-existing patella infera.

We encountered two complications of the DTO technique in the patients in this study: a fracture of the tibial tuberosity due to a tuberosity thickness of less than 1 cm and imprecise screw fixation with positioning of the tuberosity screw in the opened wedge of the HTO. Another problem is the length of the saw cut, which should leave enough room for distal screw fixation after the wedge of the HTO is opened. With meticulous surgical technique and preoperative planning, these complications can easily be prevented.

A weak point in our study is the formation of the experimental and the control group. The selection of the control patients is based on availability of preoperative radiographs. These patients might differ from those who did not require a lateral image in 30° for diagnostics. The only way to scientifically show that the distal tuberosity osteotomy technique leads to a more normal patella height is with a randomized controlled trial.

We conclude that the distal tuberosity osteotomy is a safe technique and that it can prevent lowering of the patella following OWHTO, especially in patients who need a major degree of valgus correction for medial compartment osteoarthritis of the knee.

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