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No change in patellar height following open wedge high tibial osteotomy using a novel femur-referenced measurement method

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ABSTRACT

Background: Open wedge high tibial osteotomy (HTO) can influence the tibial slope and thereby the landmarks of currently used patellar height indices. The purpose of this retrospective study was to compare and validate a new femur-referenced patella height measurement method to currently used patellar height indices in a cohort of HTO patients.
Methods: Patellar height (Caton–Deschamps, Blackburne–Peel and Insall–Salvati Indices and our newly developed Femoral Patellar Height Index) as well as tibial slope were analysed. Full-weight-bearing long-leg anteroposterior radiographs as well as anteroposterior and lateral radiographs of the knee in 0° of extension were used. Radiographs were performed preoperatively, and at six weeks, three, six, 12 and 18 months postoperatively. Measurements were recorded twice by two observers. The second observation was performed after a delay of three months.
Results: A total of 99 patients with a mean age of 46.2 ± 8 years were included. A statistically significant pre- to postoperative increase in tibial slope was found in all methods. Patellar height decreased according to Caton–Deschamps and Blackburne–Peel Indices. The Insall–Salvati Index as well as the novel Femoral Patellar Height Index remained unchanged. Intra-rater (interclass correlation coefficient (ICC) 0.914–0.998) and inter-rater (ICC 0.955–0.989) reliability were highest in the new index.
Conclusion: Detected changes of patellar height following open wedge HTO depend on the method used. Tibial slope increases following surgery. Our new index with a femoral reference for measuring patellar height was validated and good to excellent intra- and inter-rater reliability were demonstrated. Following HTO, the Femoral Patellar Height Index can be recommended as a standardized method to measure patellar height.

1. Introduction

1.1. Background

In patients with medial compartment osteoarthritis of the knee and varus malalignment, high tibial osteotomy (HTO) is a well-established and widespread treatment option [1–6]. Not only young patients benefit from this procedure; active elderly patients also show good to excellent clinical and radiological results [7,8]. The aim of open wedge HTO is to change the frontal plane knee

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alignment. However, concurrent changes such as an inadvertent decrease in the patellar height and an increase in the tibial slope were also reported [9–13] and techniques to prevent these effects were widely discussed [10,14–17].

To measure patellar height, different methods were described. So far, none of them can be recommended as the gold standard [18,19]. This is mostly based on method-dependent discrepancies [20]. Measurement methods can be divided into two groups: methods based on a femoral or a tibial reference point [21]. The most common tibia-referenced patellar height measurement methods are the Insall–Salvati Index (ISI) [22], the Blackburne–Peel Index (BPI) [23] and the Caton–Deschamps Index (CDI) [24]. Methods with a femoral reference point are less available. The majority of both groups uses lateral view radiographs and are influenced by the knee flexion angle. Moreover, patellar tendon slackening and quadriceps muscle tension are not standardized in these methods. In particular, quadriceps tension has a significant influence on the values obtained by ISI, CDI and BPI [25]. Therefore, a high variety in intra- and inter-rater reliability must be expected.

Although the clinical relevance of patellar height is assigned to the patellofemoral joint and to changes in contact pressure, these tibia-referenced indices are widely used following open wedge HTO [26]. Depending on the surgical technique used, cartilage pressure in the patellofemoral joint can change and influence the clinical result [26]. Inadvertent decrease in the patellar height as well as increased tibial slope can cause specific new complaints [27,28], can affect the knee function, and can complicate a later total knee arthroplasty [29].

Changes of the anatomical landmarks such as the tibial slope caused by open wedge HTO can result in inconsistent pre- and postoperative patellar height values for tibia-referenced indices [19,30]. Therefore, a new method is necessary to measure patellar height in patients receiving open wedge HTO. In HTO patients, standard anteroposterior and lateral radiographs of the knee joint used for preoperative diagnostics and postoperative bone healing evaluation as well as long-leg full-weight-bearing radiographs used for preoperative planning and postoperative evaluation of correction are available. These radiographs can be used for patellar height measurements. A strict protocol for long-leg full-weight-bearing radiographs, with full extension of the knee joint and quadriceps muscle relaxation leads to standardized and reproducible results [31].

1.2. Purpose of the study and hypothesis

The purpose of the study was to compare and validate a new patellar height measurement method, that is referenced at the femur, to currently used patellar height indices in a cohort of open wedge HTO patients. It was hypothesised that the new index, based on long-leg full-weight-bearing radiographs can measure patellar height more reliably than currently used measurement methods. Moreover, it was hypothesised, that there is no change in patellar height following open wedge HTO using the new femoral-referenced Femoral Patella Height Index (FPHI).

2. Material and methods

2.1. Patients

To analyse patellar height and tibial slope in this retrospective study, radiographs of a former prospective study evaluating clinical and radiological results after open wedge HTO were used [1,2]. Approval of the local ethics committee (142/2008MPG2) as well as patient's written informed consent were obtained. Consecutive patients indicated for open wedge HTO because of symptomatic medial compartment osteoarthritis or an articular lesion of the medial knee joint and varus limb alignment were included. The gap size of the osteotomy was not limited. Exclusion criteria for further statistical analysis were (1) clinically relevant disorders of the bone metabolism (i.e. osteoporosis), (2) an acute infection, (3) limited range of motion preventing full leg extension, (4) conversion to a total knee arthroplasty during follow up, and (5) postoperative revision surgery that could result in a change in patellar height.

All patients were operated on between 8 December 2008 and 10 February 2011. A total of 135 patients were operated on during this period that met our inclusion and exclusion criteria. All patients were operated on with an open wedge HTO using Tomofix plate; 26.7% (n = 36) declined to participate and were therefore excluded from further statistical analysis (Figure 1). In total, 99 patients met the inclusion criteria. Clinical and radiological evaluations were performed preoperatively, and at six weeks, three, six, 12 and 18 months postoperatively. The radiographic examination included long-leg full-weight-bearing anteroposterior radiographs as well as an anteroposterior view in full extension of the knee joint and a lateral view in 30° degrees of flexion. The total lost to follow up (preoperative to 18 months follow up) was 6.1% (n = 6).

2.2. Radiographic measurement

Radiographic measurements were recorded twice by two observers. The second observation was performed after a delay of three months. Both observers were experienced in digital planning of open wedge HTO and were trained by a highly experienced consultant (SS). Tibial slope, as well as patellar height were analysed. In detail, the measurements included: (1) tibial slope according to Amendola et al. [32], Brazier et al. [33], as well as Moore and Harvey et al. [34] (Figure 2); (2) tibia-referenced patellar height according to CDI [24], BPI [23] and ISI [22] (Figure 3); and (3) femur-referenced patellar height according to the newly developed FPHI (Figure 4).

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