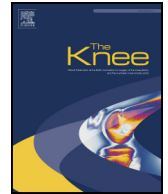


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## The Knee



## Plateau–patella angle: An option for the evaluation of patellar height in patients with patellar instability

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### ABSTRACT

**Background:** Patellar instability is a debilitating disease. An important factor related to recurrent dislocation is patellar height. A new method of patellar height measurement, the plateau–patella angle (PPA), was proposed in 2011. However, to date, there is no study evaluating the use of this method in patients with patellar instability. The aim of this study was to evaluate the PPA in patients with recurrent patellar dislocation.

**Methods:** This was a retrospective evaluation of the radiographs of 78 knees with patellar instability. Patellar height was measured using the Insall–Salvati (I/S), Caton–Deschamps (C/D) and Blackburne–Peel (B/P) indices and the PPA. The qualitative and quantitative correlations between the various methods and between observers were calculated.

**Results:** The PPA had a Pearson correlation of 0.76 ( $P < 0.001$ ) with the I/S index, 0.78 ( $P < 0.001$ ) with the C/D index and 0.90 ( $P < 0.001$ ) with the B/P index. In the qualitative correlation using the Spearman coefficient, the PPA had a correlation of 0.52 ( $P < 0.001$ ) with the I/S index, 0.72 ( $P < 0.001$ ) with the C/D index and 0.70 ( $P < 0.001$ ) with the B/P index. The correlations between the conventional methods were as follows: 0.57 ( $P < 0.001$ ) between the I/S and C/D indices; 0.61 ( $P < 0.001$ ) between the I/S and B/P indices; and 0.73 ( $P < 0.001$ ) between the C/D and B/P indices.

**Conclusion:** The determination of the PPA is a reproducible method that is consistent with the methods currently used to measure patellar height in patients with recurrent patellar dislocation.

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## 1. Introduction

Patellar instability is a highly debilitating disease that primarily affects young people and has an immediate impact on daily activity. It may also lead to the development of patellofemoral arthrosis. With an incidence of 1:1000, patellar dislocations comprise approximately three percent of knee injuries, mainly affecting young women [1–5]. The origin of patellar instability is multifactorial and is related to the bony anatomy and the relationship of the trochlea and patella, the alignment of the lower limbs, the muscle strength of the quadriceps, and the remaining static and dynamic patellar stabilizers [6].

An important factor related to recurrent dislocation is patellar height. Blumensaat [7] was one of the first to recognize the relationship between the height of the patella and instability, which was later discussed by several authors [8–11]. The evaluation

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of patellar height is therefore fundamentally important in patients with patellar instability due to the potential need for patellar height correction procedures.

The relationship to instability creates a necessity for accurate ways of measuring patellar height. One of the first methods for evaluating patellar height was proposed by Blumensaat in 1938, which was based on the evaluation of radiographic imaging with the knee flexed at 30°. When the radiographic line of the intercondylar roof is drawn and projected anteriorly, this line must cross the inferior pole of the patella when the latter is at a height considered normal [7].

Currently, the most commonly used radiographic patellar height evaluation methods are the Caton–Deschamps index (C/D) [12], the Insall–Salvati index (I/S) [13] and the Blackburne–Peel index (B/P) [14]. However, there seems to be no perfectly reproducible method of measurement. The I/S index is significantly affected by the length of the non-articulate portion of the patella, which is quite variable. The exact identification of the patellar tendon insertion is also often difficult and requires a perfect lateral view of the knee. The B/P index does not use the patellar tendon insertion, but the location of the articular line is not as clear in this method. The C/D index is also variable in identifying the antero-superior angle of the tibia, particularly in arthritic knees, due to the formation of osteophytes in the area.

In 2011, Portner and Pakzad [15] proposed a new method called the 'plateau–patella angle' (PPA). This approach requires only a single angle measurement, eliminating the need for additional calculations. Because the PPA method is an angular evaluation, it is not affected by radiographic magnification or patient size and requires only a minimum bending of the knee to 30° in the lateral radiograph.

The PPA has been validated for patellar height measurement in patients with arthrosis [16], tibial osteotomy [17] and after knee replacement surgery [18], but there is no study evaluating the use of such a method in patients with patellar instability, one of the conditions in which patellar height most affects clinical and surgical patient management. Therefore, the objective of this study was to evaluate PPA as a method for patellar height measurement in patients with recurrent patellar dislocations.

## 2. Materials & methods

A retrospective evaluation was performed on all cases of patellar instability managed by our service between June 2010 and June 2015. Patients with prior operations were excluded from the study. Digital profile radiographs were evaluated for knees diagnosed with instability. Radiographs with inadequate rotation (distance between posterior edge of the femoral condyles greater than five millimeters), poor definition of radiographic landmarks or where the knee flexion was less than 30° were excluded. From a total of 74 patients, four (5.4%) were excluded because of inadequate rotation and one (1.3%) because of inadequate knee flexion.

Digital radiographs of 78 knees (69 patients) diagnosed with patellar instability were evaluated. In this sample, 51 patients were female, and 18 were male. Forty-one knees were right knees, and 37 were left knees. The mean age was  $22.2 \pm 9.3$  years, with a maximum of 48 and a minimum of 10 years.

Patellar height in the radiographs was measured using the classical I/S, C/D and B/P methods and the PPA evaluation method. The measurements were performed by two orthopedists specializing in knee surgery, with each conducting two evaluations at two different times separated by a minimum period of 30 days. An average between the first and second measurements of each surgeon was used to perform the statistical calculations. The measurements were performed using the iSite PACS (Philips, Amsterdam, the Netherlands).

All measurements were taken according to the original description of the methods by the respective authors [12–15]. The I/S index is the ratio between the patellar tendon length and patellar length. The tendon length was measured at its deepest portion from the tendon's origin at the inferior patellar pole to its insertion at the anterior tibial tubercle. The length of the patella was measured using its greatest diagonal length. For the B/P index, the perpendicular distance was measured from the lower end of the articular surface of the patella to the anterior projection of the articular surface line of the tibial plateau and divided by the length of the articular surface of the patella. The C/D index was calculated as the ratio between the distance from the lower end of the articular surface of the patella to the upper anterior angle of the tibia and the length of the articular surface of the patella. The PPA, described in the introduction of this work, was measured between an initial line that was tangential to the medial plateau of the tibia (the same line used in the B/P method) and a second line that went from the posterior end of the medial plateau toward the lower end of the articular surface of the patella (Figure 1). The normal ranges were considered to be between 0.8 and 1.2 for the I/S index, between 0.5 and one for the B/P index, between 0.6 and 1.2 for the C/D index, and between 21° and 29° for the PPA. For the qualitative evaluation, we classified the patella as high, normal or low according to the previously described normal values.

Since the original description of the PPA involved patients between 18 and 90 years of age, we compared the patients under 18 years of age to patients older than 18 years of age to evaluate whether they differed in relation to PPA measurements.

### 2.1. Statistical analysis

Pearson's correlation coefficient was used to evaluate the intra- and inter-observer correlations of each patellar height evaluation method and also the linear correlation of the four evaluated methods. Spearman's correlation coefficient was used for the qualitative correlations between methods. Student's *t*-test was used to compare the groups of patients under 18 years of age with patients older than 18 years of age. An average between the first and second measurements of each surgeon was used to

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