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Short lateral posterior condyle is associated with trochlea dysplasia and patellar dislocation

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Abstract

Purpose Surgeons mainly consider the anterior anatomy of the distal femur in the treatment of patellar instability (PI) with trochlear dysplasia (TD). Through this research, the idea was to analyse the posterior femoral condyle length in TD. The research team posited the presence of morphological differences in the posterior part of the femoral epiphysis in TD compared to a control group. They also postulated that the posterior bicondylar angle (PCA), in the axial plane, was increased in TD.

Methods This is a single-centre morphological study of 100 patients who had a computed tomography (CT) using the same protocol. 50 patients with PI (25 dysplasias A and 25 B-C-D according to the Dejour classification), and 50 controls were included. All patients presenting a clinical PI were considered for the study. None of these patients had undergone a surgical treatment prior to imaging. Demographic characteristics, BMI, and laterality were comparable in all patients. 20 pilot CT scans were used to establish the methodology. The following measurements were performed: anterior bicondylar angle, PCA, and condylar lengths with respect to the surgical transepicondylar axis. Ratios were calculated in relation to the femoral width. TD was classified according to the Dejour classification in grade A or grades B–C–D. An analysis of variance and a linear model were performed within some groups to investigate which parameters correlated with the classification's grade.

Results This study showed a link between TD and the PCA: control group ($1.4 \pm 0.2°$), type A group ($1.6 \pm 0.3°$), and types B, C, D group ($2.6 \pm 0.3°$) ($p = 0.01$). The difference between the control group and types B, C, D TD group was significant ($p = 0.002$). In groups B, C, D, the PCA was more important, which proves that in these groups the posterior part of the lateral condyle was relatively shorter compared to the medial condyle. The greater the dysplasia, the longer the medial condyle was in the anterior posterior ($p = 0.02$).

Conclusions This study shows not only an anterior but also a posterior anomaly in PI with TD. There is a correlation between the severity of the anterior deformation and the PCA: in other words, the knee is placed in valgus in flexure which promotes the external dislocation of the patella. This anatomical study could open a field of research on the development of surgical treatments based on the correction of posterior condylar femoral anomalies in PI.

Level of evidence III.

Keywords Distal femur morphology · Condylar length · Patellar instability · Trochlear dysplasia · Transepicondylar axis · CT measurements

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Abbreviations

PI	Patellar instability
TD	Trochlear dysplasia
TD	Group trochlear dysplastic group
EPD	Episodic patellar dislocation
AP	Anteroposterior
ML	Mediolateral
sTEA	Surgical transepicondylar axis
TL	Anterior bicondylar line
PCL	Posterior condylar line
PCA	Posterior condylar angle
FME	Femoral medial epicondyle
FLE	Femoral lateral epicondyle
FMCP	Femoral medial condyle posterior (AP)
FLCP	Femoral lateral condyle posterior (AP)
FMCA	Femoral medial condyle anterior (AP)
FLCA	Femoral lateral condyle anterior (AP)
CM	Total medial condyle (AP)
CL	Total lateral condyle (AP)
mLDFA	Mechanical lateral distal femoral angle
SE	Standard error to the mean

Introduction

Controversy still exists regarding nearly all aspects of patellar dislocation and the associated morphological abnormalities of condyles. The anterior part of the distal femur in TD has been thoroughly studied [9]. However, the posterior morphological characteristics have not been widely investigated. Patellar instability (PI) may be associated with distal and posterior femoral morphological abnormalities. Surgeries focus on the correction of anterior deformities due to trochlear dysplasia [8], but PCA or posterior condylar lengths could also be correlated with TD and PI. One study has already measured condylar and trochlear normal and dysplasic length [3]. It revealed that the sTEA of the distal femur is not equidistant from the posterior and distal surfaces of the femoral condyles. It also showed that the contour of the femoral condyles should not be interpreted as being centred on the surgical epicondylar axis [16]. The latter remains a reliable reference because it is a consistent parameter of femoral alignment in the coronal plane and a stable reference for femoral rotation in the axial plane [13].

The ultimate goal in the treatment of PI is to have a good patellar tracking by correcting the local anatomy. TD is the principal morphological abnormality related with patellar dislocation. In a trochleodysplastic knee, the trochlea is shallow, flat or convex but many variations exist, and several authors have tried to analyse them and organise them in a classification system. Dejour et al. described three grades of TD based on conventional lateral radiographs, on which he evaluated the crossing sign, the trochlear bump and the trochlear depth [9]. Dejour et al. implemented the use of CT scans and proposed a four-grade classification which is now widely used to grade the severity of TD and to help in the selection of the appropriate surgical treatment [6–8]. Currently, there is an important propensity to reduce the four-grade classification to a two-grade classification [14, 18]; low-grade TD (grade A) can successfully be distinguished from high-grade TD (grades B, C and D), while distinguishing grades B, C and D proved difficult due to the high variability of the trochlear geometry [14].

The aim of this study was to investigate the overall 2D morphology of the distal femur in addition to previously described characteristics associated with TD. It sought to assess distal femoral anatomy in PI and to evaluate whether the femoral condyle in patients with TD differs from those without TD. This anatomical study also meant to analyse the correlation between anterior and posterior anatomy on axial view, as well as a link with valgus and varus knee. The hypothesis of the present study was that the trochlear dysplastic distal femur is characterised by posterior morphological changes to the condyles: there might be a correlation between the TD or anterior distal femur anatomy and posterior condyles' anatomy in patellar instability. There could be an increased PCA in TD.

Materials and methods

This is a single-centre retrospective morphological study carried out on 100 patients. 80 consecutive computed tomography scans (CT scans) randomly selected for PI with TD were assessed. All patients diagnosed with TD were classified radiologically and by CT scans as grades A, B, C or D by two orthopaedic surgeons (JR and FBC) according to the Dejour classification. These two independent observers defined the TD grade on knees to improve the precision. Once the classification was completed, 25 with grade A TD and 25 with grade B, C and D dysplasias were randomly included. 50 CT scans made for a study on patients with ACL rupture, without anatomical deformity, were randomly selected for the control group. Three groups were formed in TD Grade A or Grade B–C–D and control group. All patients presenting a clinically PI (EPD or habitual dislocation in extension) were considered for the study. The patients with TD all had their CT scan done before surgery. The exclusion criterion was a history of previous knee surgery. Demographic characteristics, size, BMI, laterality, and baseline assessments were compared, and no significant difference was observed between groups.

CT scans were performed according to the same protocol. Three observers (experienced physicians with at least 10 years of experience) assessed the following measurements: anterior bicondylar axis, posterior bicondylar axis,

Table 1 Description of morphometric studied parameters

Femoral width (FW)	Distance between FME and FLE
The posterior condylar angle (PCA)	Angle between the sTEA (line from the FLE to the sulcus of the FME) and the tangent to the posterior condyles (PCL) (Fig. 2)
TL	Tangent to the cartilage of the anterior condyles. An angle is created between sTEA and TL (Fig. 3)
FMCP	Defined by drawing a perpendicular axis from sTEA crossing the most posterior point of medial condyle on PCL. The length was defined as the distance between sTEA and posterior point (Fig. 4)
FLCP	Defined by drawing a perpendicular axis from sTEA crossing the most posterior point of lateral condyle on PCL. The length was defined as the distance between sTEA and posterior point (Fig. 4)
FMCA	Defined by drawing a perpendicular axis from sTEA crossing the most anterior point of medial condyle on TL. The length was defined as the distance between sTEA and anterior point (Fig. 4)
FLCA	Defined by drawing a perpendicular axis from sTEA crossing the most anterior point of lateral condyle on TL. The length was defined as the distance between sTEA and anterior point (Fig. 4)
The length of medial and lateral condyles	Calculated by adding anterior and posterior condyles' lengths

mechanical axis mLDFA and condyles' lengths with respect to the surgical transepicondylar axis between the groups. Ratios were calculated in relation to the femoral width (FW): the lengths obtained were divided by the FW to the epicondyles to obtain values, which are comparable with one another. There was excellent inter-observer reliability. The three observers defined the measurements on 100 knees with an intra-class correlation coefficient of 0.91–0.99 (mean error 0.98 ± 1.30 mm). To ensure reliability, images representing normal anatomy were studied, CT scans demonstrating osteoarthritis were excluded, as well as those with immature skeletons. CT scanning was performed using a CT PHILIPS BRILLANCE ICT ELITE 256, using 2-mm sequences in axial planes. All patients were briefed about the pros and cons of imaging and signed the consent form prior to enrolment. Measurement was given with the same accuracy allowing two decimals.

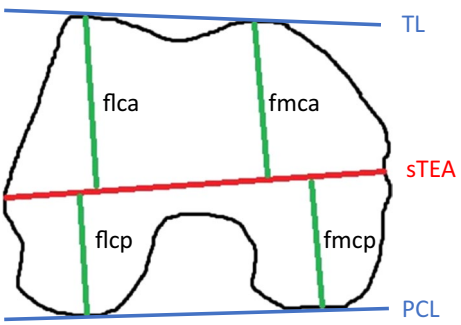

Fig. 1 Anatomic drawing of measured morphometric parameters

CT analysis: measurement techniques

To establish the methodology, pilot measurements were done with a musculoskeletal radiologist on 20 CT scans, which were not included in the study. The observers defined the landmarks on the 20 knees to improve the intra-observer precision. Axial plane was studied. It was the plane defined by the musculoskeletal radiologist where the condyles were the larger in the AP. The following measures were taken on the same slice (Table 1; Figs. 1, 2, 3 and 4). To account for the variability in the absolute measurements due to patient size, each of the measurements described (FMCP, FLCP, FMCA, FLCA, condylar lengths) were converted to a ratio by dividing the absolute value by the FW. The Ethics Committee of the Hospices Civils de Lyon approved the study (Groupement Hospitalier Est, Boulevard Pinel, 69,500 BRON). The ID number of the approval was 17-02.

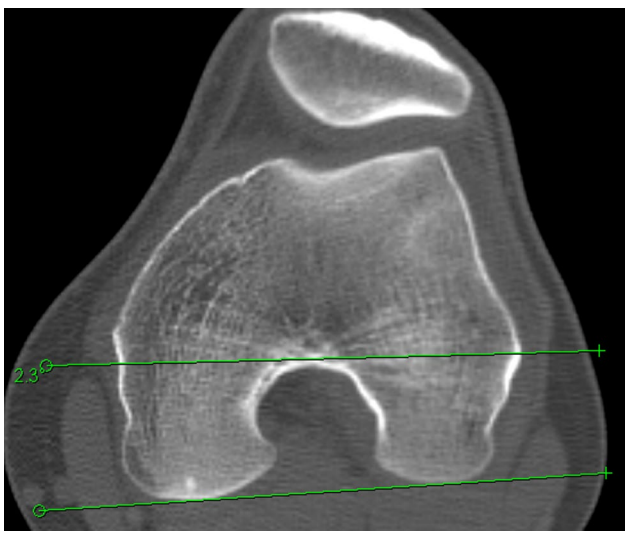

Fig. 2 Representation of the PCA measurement

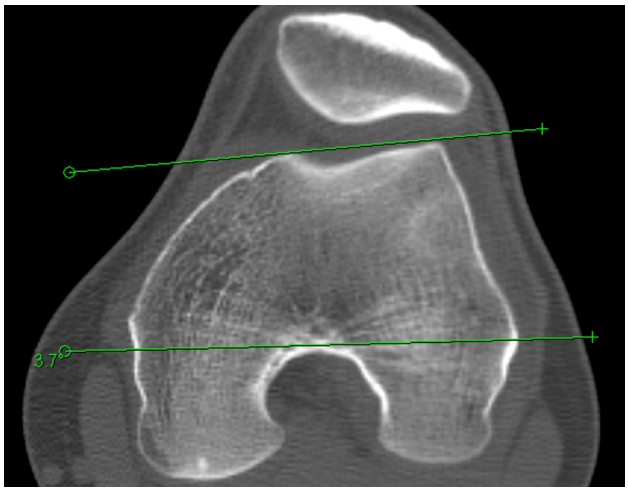

Fig. 3 Representation of the TL angle measurement

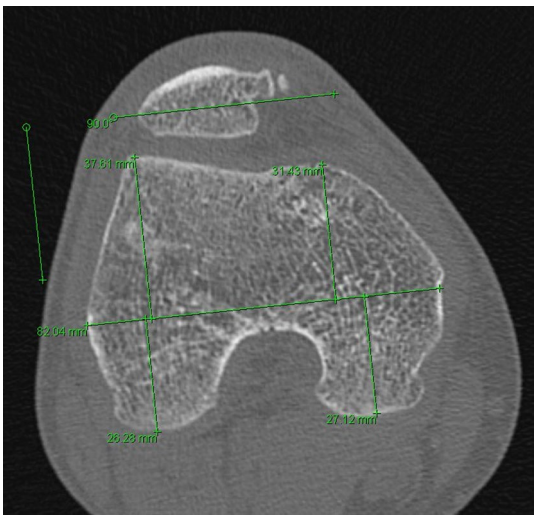

Fig. 4 Representation of FMCP, FLCP, FMCA and FLCA measurements

Statistical analysis

All data were analysed using R® software. The inter-observer reliability was then determined by calculating the intra-class correlation coefficient of the coordinates. A median of each observer's measurements was finally taken. The measurements of the conventional and morphometric parameters were reported as median ± SE. An independent Student's *t* test was performed to compare the data in the TD group with the data in the control group. Within the groups, the analysis of variance (ANOVA) and a Tukey test in linear model were also performed to investigate which parameters correlated with the order of the applied classification (Dejour grades A or B, C, D). A correlation was researched between TL and PCA with Pearson's test *r*. The qualitative (demographic) variables were compared using the chi-square and Fisher's exact tests. Required sample size was calculated considering an a priori power calculation using a 2-mm posterior condylar offset difference as the minimum clinically important difference; with $2n = 100$, that had a 99% chance of detecting such a difference. With regards to these studies, this work needed the minimum sample size of 50 patients per group to find a significant difference between groups at an alpha level of 0.05. No patient loss had to analysed insofar as it was a retrospective work. For all statistical tests, a p value under 0.05 was considered statistically significant.

Results

Between 2008 and 2017, 100 patients fulfilled the inclusion criteria. The TD group included retrospectively 50 patients with a history of recurrent patellar dislocation: 25 type A patients (15 females and 10 males; median age 25 ± 6 years), 25 with more severe type B, C or D patients (14 females and 11 males; median age 28 ± 10 years). 50 patients with a normal anatomy of the patellofemoral joint were selected to form the control group (19 females and 31 males; median age 29 ± 11 years). The control group consulted the orthopaedic surgeon for a complaint unrelated to the patellofemoral area.

There was no significant difference in the posterior or anterior condylar lengths between the groups. There was no link between the TD and condylar absolute lengths especially for the FLCP (Table 2). However, in the TD group, the distal femur in the AP direction was larger at two locations: FLCA and FMCA. At these levels, they were significantly longer in the patellar instability group (ratio FLCA/femoral width: TD group = 0.51, control group = 0.48, $p = 0.03$ and ratio FMCA/femoral width: TD group = 0.47, control group = 0.45, $p = 0.02$). There was no significant variance between FMCA and FLCA and groups, with the ANOVA test. The total medial condyle (CM) was thicker in the TD group and it increased with TD severity compared to the control group ($p = 0.02$) (Fig. 5). This data emphasised a correlation between TD and the PCA. The PCA differed between the control group (1.40 ± 0.20°), the type A group (1.60 ± 0.30°), and the types B, C, D group (2.60 ± 0.30°) ($p = 0.01$*) (Figs. 6, 7). Difference between the control group and types B, C, D TD group was significant ($p = 0.002$***) (Table 3). Therefore, the posterior part of the lateral condyle was relatively shorter compared to the medial condyle. Within the types B, C, D, the PCA was correlated with the TL ($\rho = 0.01$ $p = 0.001$). To conclude, the current study shows 24, 28 and 36% of valgus knee, respectively, in control group, type A TD group; and types B, C, D TD group.

Table 2 Results of morphometric parameters in the AP direction in the control group and the TD groups, expressed as their ratio to the FW

	Control group	Group A	Group B, C, and D	*p* value (anova)
FMCP ± SE	0.31 ± 0.01	0.31 ± 0.01	0.30 ± 0.01	n.s
FMCP ± SE	0.33	0.33 ± 0.01	0.33 ± 0.01	n.s
FLCA ± SE	0.49 ± 0.01	0.51 ± 0.01	0.51 ± 0.01	n.s
FMCA ± SE	0.46 ± 0.01	0.47 ± 0.01	0.48 ± 0.01	n.s
CL ± SE	0.80 ± 0.01	0.82 ± 0.01	0.81 ± 0.01	n.s
CM ± SE	0.78 ± 0.01	0.81 ± 0.01	0.81 ± 0.01	0.02
TL ± SE (°)	4.40 ± 0.40	5.90 ± 0.80	4.70 ± 1.00	n.s
PCA ± SE (°)	1.40 ± 1.30	1.60 ± 1.00	2.60 ± 1.20	0.01

For each parameter, the mean value is presented with standard error to the mean (± SE). A significant difference between groups is evaluated by covariance test (Anova)

A significant correlation is indicated by $p < 0.05$

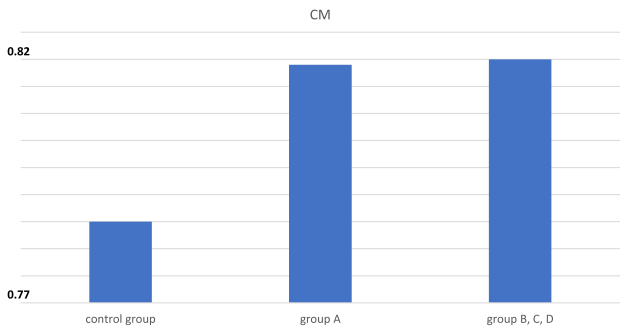

Fig. 5 Results of CM parameter, expressed as a ratio to the FW. For each parameter, the bars represent the mean results of control group, trochlear dysplasia type A or types B, C, D

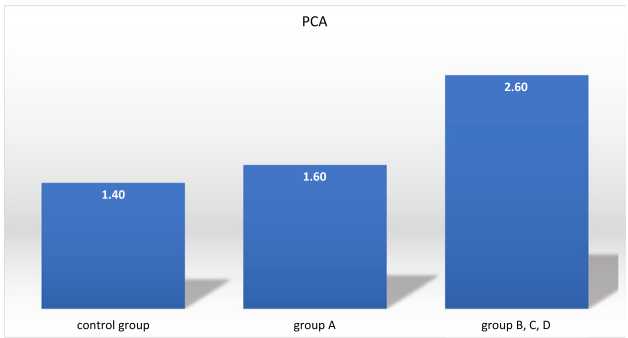

Fig. 6 Results of PCA parameter, expressed as an angle (°). For each parameter, the bars represent the mean results of control group, trochlear dysplasia type A or types B, C, D

Discussion

The most important finding of the present study was a correlation between the TD and the PCA. In the B, C, D group, the PCA is more important, which proves that in this group the posterior part of the lateral condyle is relatively shorter compared to the medial condyle. This morphological anomaly of the posterior part, behind the sTEA, could explain some dislocations in flexion. The Question is: "Considering standard error to the mean (SE) for PCA in each group, is 1 degree of difference clinically significant?" Difference between the control group and the B, C, D group is significant, so even if there is no definite answer, it could be sufficient to influence the patellar position especially in flexion. Medial condyle also seems to be larger in TD. These results are worth noting since five studies which analyse this distal femur anatomy in PI were found in literature [1, 3, 12, 15, 23].

sTEA is a stable reference for femoral rotation in the axial plane [13]. Consequently, it was chosen as the reference. The trochlear line may be considered as an additional reference axis for determining the rotational alignment [24], but there is a large variation between individuals concerning the angle between the plane of the distal femur anterior cortex and the epicondylar axis which was measured to be 9.2 ± 5.8° on the direction of medial femoral rotation [25]. Likewise, the anteroposterior axis (Whiteside's line) may lead to excessive external rotation in total knee arthroplasty (TKA) [17]. The PCA is variable. Thienpont et al. showed that on a very large anthropometric CT and 3D models database there is a 41% risk of malalignment if a fixed PCA is used in TKA. The clinical importance is that femoral axial anatomy is individual and the PCA is not necessarily parallel to the sTEA. Amaranath et al. showed that the PCL was on average 2.3 ± 1.8° internally rotated to the TEA [2]. Abadie et al. demonstrated that the value of the PCA was statistically inferior when the patella was centred [1]. The value of the anterior trochlear angle varied opposite to the PCA. Thus, the authors questioned whether there is a correlation between PCA and TD. The statistical analysis demonstrates a significant difference in the PCA between groups. These results are different from those which were reported by Van Haver et al. who found a PCA value in the control group of 2.6 ± 1.6° similar to the TD group, 2.6 ± 2.3° [23], but other

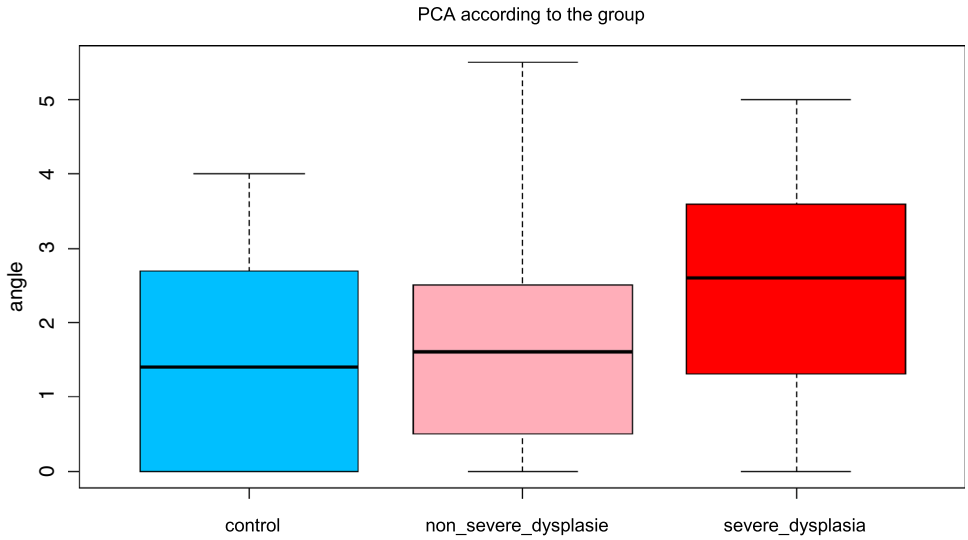

Fig. 7 Graph of the PCA according to the group

Table 3 Tukey test of PCA according to groups

	Control group (ref)	Non_severe_dysplasia	Severe_dysplasia
Angle	1.4	1.6	2.6***

*< 0.05, **< 0.01, ***< 0.005, ****< 0.001 for comparisons of dysplasia group versus control group

authors confirmed these trends. Liu et al. found that the TD group had a larger medial posterior condyle and a smaller lateral posterior condyle than the control group [15].

The distal femur is trapezoidal [4]. However, to date, limited research focusing on the AP size of the distal femur was published in patients with TD. In 2009, Biedert et al. evaluated condylar and trochlear normal and dysplasic heights [3]. They investigated the AP size of the distal femur in relation to the ML size to detect if a decreased trochlear depth was caused by a heightened trochlear floor or by a flattened lateral and/or medial trochlea. In accordance with the present results, they found that the height was not altered at the level of the lateral trochlea and that it was increased at the level of the centre and medial trochlea. Moreover, the TD can be associated with abnormalities in the posterior condylar morphology. This is what has been demonstrated in the CT scan analysis of the present study, both in normal and trochlear dysplastics knees. Besides, this is concordant with some results which emphasise the absence of isolated TD [15, 23]. In 2000, Pfirrmann et al. found no significant difference in terms of AP size of the medial and lateral femoral condyles and their ratio, and the distance between the deepest point of the trochlear floor and the PCL [19]. This might be due to an evaluation in the absolute value without angle analysis, or to the smaller population, the participation criteria or to the location of the axial slice which was used as a measurement point in this study.

No difference emerges in terms of FMCP and FLCP between groups. But there are differences in terms of FMCA and FLCA between groups. This could be related to the deformation of the anterior femur in patients with dysplasia. These results are compared to those of Van Haver et al. who did not measure FMCA and FLCA but found larger posterior condyles in the AP direction. With the use of 3D measurements, in 40 arthro-CT scans, they showed, the distal femur is larger at these locations in TD: FMCP is 6% larger, and FLCP is 8% larger. They concluded that a difference in the posterior part compensates a difference in the anterior part. This difference between the work presented here and Van Haver's study may result from the choice of a different reference axis. Measures are taken in three dimensions in Van Haver's study (between a plane tangent to the posterior cortex of the femur and parallel with sTEA and a plane tangent to the posterior condylar line and parallel with the longitudinal axis of the femur). In any case, differences in anteroposterior lengths between a healthy patient and a patient with trochlear dysplasia had already been highlighted.

In the present study, the rate of valgus knees in the control group, type A TD group and types B, C, D TD group was 24, 28 and 36%, respectively. Van Haver et al. also demonstrated that, in the PD direction, the medial condyle is 4% larger in the TD group [23]. Gillepsie et al. say that multiplanar hypoplasia of the lateral femoral condyle resulting in a valgus knee is a risk factor for patellar instability in young patients without osteoarthritis or joint hypermobility [12]. In the field of joint replacements, Thienpoint et al. add that patients need more than the average external rotation because they have more distal femoral valgus with dysplastic condyles or more proximal tibial varus with a thicker medial condyle [22]. Poilvache et al. demonstrated that, in TD and in some valgus knees, relying on the anteroposterior axis can induce an excessive external rotation of the femoral

component [20]. Also, in Van Haver et al. the assigned four-grade Dejour classification correlated negatively with the AP size of the lateral condyle ($r = -0.504$) and the lateral trochlea ($r = -0.465$) [23]. However, is the posterior lateral condyle really smaller? The lateral femoral condyle is thicker in valgus knees compared to neutral knees, thus in contradiction with conventional understanding. It suggests that in fixed valgus knees, beside arthritic wear, there is no deficiency of the posterior lateral condyle of the femur [5]. Isolated posterior lateral condyle length appears to be unrelated to patellar instability [12]. But what about the FMCP/FLCP ratio? The present study has instead interpreted the posterior lengths in relative values; which is what the PCA expresses. The outcomes of the present study confirm that there is no absolute smaller lateral condyle in TD. However, the posterior part of the lateral condyle is relatively shorter compared to the medial condyle; which is expressed by the increased PCA. In addition, as Van Haver et al. showed, the total medial condyle is larger than in the control group. They found the medial condyle was 3% larger in the TD group. The total lateral condyle was unaltered. Frosch et al. found a positive correlation between the medial femoral condylar offset and the medial tibial slope. A greater medial tibial slope indicates a larger offset of the medial femoral condyle, in patients with TD [10]. These data support the results of the present study, which shows a correlation between the AP length of the medial condyle and TD. This anatomical study could open a field of research on the development of surgical treatments based on the correction of posterior condylar femoral anomalies in PI. Knowledge of posterior condylar anatomy in trochlear dysplasia could also provide additional data in the choice of the femoral component rotation in total knee arthroplasty for these specific patients.

Rescaling by doing a ratio with FW is particularly important in the interpretation of metric parameters used. A rescaling procedure was performed to rule out absolute knee size differences from the analysis. It has already been used in other studies [21]. It must be noted that gender and femoral size are known to influence the geometry of the distal femur in general and more specifically the ML/AP ratio of the distal femur. In the current study, the control group and TD group were controlled for sex as well as FW or size differences. The other positive points were the population size and the data completion rate to 100%.

The mode of patient selection may have included a selection bias because of the difficulty in classifying grades of dysplasia, and the choice of CT scans included. The search was performed according to initial indication; then, axial sections were re-read to confirm that there was dysplasia or that it was a normal CT scan. Dysplasias were then graded. 25 grades A and 25 grades B, C, D were randomised randomly on all scanners extracted for dysplasia. Another limitation is that there is no analysis of the relationship between the femoral valgus in the frontal plane and the FLCP and the PCA, yet valgus and TD are well linked [12]. Maybe even torsional and/or coronal valgus deformity will contribute to shortness of the lateral posterior condyle. Moreover, the measurements in 2D can be flawed by differences in cartilage thickness, differences in knee size and alignment errors, which can considerably affect the measurements towards 3D [23]. In the current study, two senior surgeons evaluated CT scans to classify the TD. The focus of this study was on the morphological differences between normal and trochlear dysplastic knees. Since the Dejour classification is not only applied to grade the severity but also to assist in the treatment decision. Moreover, the presence of a trochlear bump (Dejour grades B and D) is a key factor to decide if trochleoplasty is chosen [8, 11]. The present study relied on a two-stage classification system because it has been recently shown to be interesting to simplify and distinguish low from severe grades [14]. The inter-observer reliability of the classification in Grade B versus C versus D resulted in our preference not to dissociate these three grades and place them in a single group, severe dysplasia, so as not to induce measurement bias. Therefore, dividing grade A from grade B, C, D in the current study provides a more reproduceable evaluation of the morphological characteristics, which can improve the data's veracity. Obviously, this choice does not call into question the accuracy of the classification of Dejour et al. The sTEA line is chosen as a reference but the Whiteside's Line could have been preferred. In that case, maybe the values would have been even more pronounced if the Whiteside's line or the anatomic TEA had been used.

In the day by day clinical work, PCA could be systematically added in initial imaging assessment of a patellar dislocation, or in planning of a TKA to adapt treatment.

Conclusions

The present study provides essential information for understanding EPD. The distal end of the femur can be analysed on an axial view: sTEA allows the definition of an anterior part and a posterior part. If the anterior part has often been analysed to explain the TD, there is also, in severe PI, an anomaly found in the posterior part behind the sTEA. The posterior "dysplasia" is not expressed as an absolute value but rather as a different ratio between the medial and lateral condyles. This is what the PCA expresses. TD and PCA are statistically correlated. In groups B, C, D the PCA is more substantial, which proves that in these groups the posterior part of the lateral condyle is relatively shorter compared to the medial condyle. In fact, this means that the knee is placed in valgus in flexure that promotes the external dislocation of the patella. These results emphasise the importance of considering posterior abnormalities in PI patients,

which could highlight other complementary methods such as osteotomies of the distal femur to centre the patella and to evict valgus in flexion. PCA could be another factor to evaluate when handling PI. These findings complete the understanding of the mechanisms of patellar dislocation, and they should be taken into account in the choice of femoral component rotation in total knee arthroplasties.

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Authors contributions JR performed the statistical analysis and drafted the manuscript. JR, SL, and CFB carried out the radiologic studies. JR, SC, SL, PHN, and ES carried out in the writing of the manuscript. SL, PHN and ES participated in the design of the study. ES, SL, and PHN conceived the study, coordinated and helped to draft the manuscript. All authors read and approved the final manuscript.

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Compliance with ethical standards

Conflict of interest JR: No conflict of interest. SL: consultant: Smith Nephew, Medacta; institutional support: Amplitude, Corin. SC: No conflict of interest. CFB: No conflict of interest. PHN: board membership: Effort Board; consultancy: Latilini; employment: Healthpoint; expert testimony: Healthpoint, Latilini; Royalties: Tornier; travel, accommodations: Latilini, Amplitude. ES: No conflict of interest.

Ethical approval The Ethics Committee of the Hospices Civils de Lyon approved the study (Groupement Hospitalier Est, Boulevard Pinel, 69,500 BRON). The ID number of the approval was 17-02.

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