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The Pathologic Double Contour Sign and the Trochlea Shape Patterns can
diagnose trochlea dysplasia

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  - **Rafael Sales Fernández.** Main author, write up of paper, images, etc.
  - **Nisarg Shah.** Contribution to MRI scan reading
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Trochlea dysplasia, Pathologic Double Contour, Trochlea Shape Patterns, Patella instability, Trochleoplasty.
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Introduction

We define trochlea dysplasia as “an abnormally developed proximal trochlea with a distinctive pattern of deformity that causes patella mal-tracking and increased forces on the patellofemoral joint that can result in instability or chondral damage”.

Trochlea dysplasia is a complex three-dimensional deformity with different degrees of severity. Diagnosis of trochlea dysplasia can be difficult for the general orthopaedic surgeon who does not treat patella instability regularly. Multiple qualitative and quantitative measures have been described in the literature to define trochlea dysplasia based on plain radiographs or advanced imaging studies (1). Some of them are difficult to use in practice as they require relatively complex calculations. Nelitz (2) found that the quantitative measures of the femoral trochlea are of limited value in the assessment of trochlea dysplasia.

Objectives

The goal of this study is to describe the distinct morphologic patterns of the normal and dysplastic trochleae, the Trochlear Shape Patterns (TSP) seen on the axial views of the MRI scan of the knee.

Our hypothesis is that the Pathologic Double Contour sign and the Trochlea Shape Pattern type 3 are diagnostic (pathognomonic) of trochlea dysplasia.

Material and Method

Two cohorts of patients were included in the study.
Cohort 1 (no patella instability) included the MRI scans of 100 patients who had surgery for meniscal pathology or ACL injury. Exclusion criteria was skeletal immaturity (open growth plates), arthritis or history of patellofemoral disorders (instability, arthritis, anterior knee pain).

Cohort 2 (patella instability) included the MRI scan of 66 adult patients who have been diagnosed with severe trochlea dysplasia as per Oswestry-Bristol classification(3) and recurrent patella instability. The diagnosis of trochlea dysplasia was either made by an expert on patella instability or a radiologist.

The presence of the Pathologic Double Contour sign and the type of Trochlea Shape Pattern were identified on the axial views of the MRI scan for the two cohorts of patients at the level of the specific anatomic references described in this paper (zone 0, PFCL and tv-DPFL).

Assessment of trochlear morphology: Anatomical references

To study the morphology of the trochlea, two simple transverse lines (Fig.1) are identified in the sagittal views of the MRI scan, T1 sequence (video on how to identify these anatomical references: https://youtu.be/nDSOhuK0dw8).

- The PFCL (Posterior Femoral Condyle Line). This transverse line is tangent to the more proximal portion of the posterior aspect of lateral femoral condyle (PLFC line), just above the cartilage.

- The tv-DPFL (transverse component of the Distal Femoral Physis Line). This transverse line is parallel and tangent to the transverse component of the distal femoral physis (tv-DFP) scar and passes through the most proximal part of the femoral insertion of the anterior cruciate ligament (FIACL) at the level of the most proximal part of Blumensaat line.
These two reference lines define the *Trochlear Specific Zones* (TSZ) which correlate to the anatomic location of the trochlea:

- Zone 0 (TSZ 0) area proximal to the PFCL line.
- Zone 1 (TSZ 1) area between the PFCL and tv-DFPL lines.

These anatomic reference lines, visualised in the sagittal views, are used to assess the shape of the trochlea at the corresponding transverse/axial cuts.

**Definition of the Pathologic Double Contour (PDC) sign**

The *Pathologic Double Contour* (PDC) sign (Fig. 2) is a radiologic sign seen on the axial views of the MRI scan proximal to the tv-DFPL. It is an area of flat or convex lateral trochlea which is elevated over the contour of the medial femoral condyle (MFC).

The Pathologic Double Contour is formed by two distinct osseous contours separated by a cliff.

The baseline is the contour of the medial femoral condyle and the elevated contour is formed by the dysplastic elevated trochlea. These two contours are separated by a cliff or drop off sign.

The *supratrochlear spur* (STS) is a specific variant of the *Pathologic Double Contour*, where the progressive elevation of the lateral trochlea from lateral to medial will end in a summit and then a cliff. The summit of the STS is proximal and medial to the lateral trochlea. The STS can be mild to severe depending on the steepness of the elevation and the height from the MFC baseline.

**Definition of the Trochlear Shape Patterns**

Three basic morphologic patterns of trochlear shape were identified (Fig. 3).
Type 1 (normal trochlea): This pattern corresponds to a normally developed trochlea.

There is no PDC. In this pattern, there is a clearly defined sulcus delineating the lateral and medial trochlear facets with a sulcus angle of <165°.

Type 2 (normal but shallow trochlea): There is no PDC. In this pattern the sulcus/trochlear groove is shallow (defined arbitrarily as sulcus angle >165°) but the lateral and medial facets are present. Although the difference between TSP 1 and 2 is generally obvious by simple eyeball, if in doubt the sulcus angle is measured and if >165° then it would be classified as type 2. This pattern is considered a normal but relatively shallow trochlea.

Type 3: This pattern is characterised by the presence of a Pathologic Double Contour.

Within this group we identify three different patterns:

- Type 3a: is a flat or downslope inclination of the lateral trochlea facet which ends medially in a sudden cliff (no supratrochlear spur).

- Type 3b: is a progressive lateral to medial elevation of the lateral facet (convexity) which ends in a (small) summit and then a cliff. The summit is the supratrochlear spur.

- Type 3c: is a steep lateral to medial elevation of the lateral facet which ends in a (high) supratrochlear spur (STS) and then a cliff. The type 3c is a more severe form of the type 3b where the STS is the main anatomical abnormality.

Statistical Analysis

The Pearson Chi-Square $\chi^2$ Test (comparison between two categorical variables) was used to determine if the distribution of the Trochlear Shape Patterns was the same between the two cohorts (no patella instability and trochlea dysplasia/patella instability). Expected frequencies in all cells were greater than five. The null hypothesis
(H₀) was that the observed distribution of *Trochlear Shape Patterns* was the same (random observation) between the two cohort of patients. The alternative hypothesis (H₁) was that distribution of the *Trochlear Shape Patterns* was different (not random) between the two cohorts. The level of significance was set at p < .05.

Cramer V was used to determine the strength of the association between TSP and patella instability.

**Results**

** Demographics**

The patient demographics of the two cohorts is shown in Table 1.

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>gender</th>
<th>Side</th>
<th>Age</th>
</tr>
</thead>
<tbody>
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<td></td>
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<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td><strong>Patella Instability</strong></td>
<td>66</td>
<td>24</td>
<td>42</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>100%</td>
<td>36%</td>
<td>64%</td>
<td>38%</td>
</tr>
<tr>
<td><strong>No Patella Instability</strong></td>
<td>100</td>
<td>63</td>
<td>37</td>
<td>51</td>
</tr>
<tr>
<td></td>
<td>100%</td>
<td>63%</td>
<td>37%</td>
<td>51%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>166</td>
<td>87</td>
<td>79</td>
<td>76</td>
</tr>
<tr>
<td></td>
<td>100%</td>
<td>52%</td>
<td>48%</td>
<td>46%</td>
</tr>
</tbody>
</table>

There were statistically significant differences in the distribution of gender between patients with no patella instability and patients with patella instability/trochlea dysplasia ($\chi^2(1)=11.310$, p.001, n=166).

There was no statistically significant difference in the distribution of the laterality of the knee affected (left or right) between the two cohorts ($\chi^2(1)=2.758$, p.097, n=166).

**Pathologic Double Contour (PDC) and Trochlear Shape Patterns (TSP)**
In the no patella instability cohort only 3 patients (3%) showed a Pathologic Double Contour (PDC). In the patella instability/trochlea dysplasia cohort all patients showed a PDC.

Table 2.

Distribution of the Trochlear Shape Patterns (TSP) at Different Levels in the Two Cohorts of Patients

<table>
<thead>
<tr>
<th>TSP Specific Zone 0</th>
<th>Total</th>
<th>PFCL</th>
<th>tv-DFPL</th>
<th>Total</th>
</tr>
</thead>
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<tr>
<td>Cohort 2</td>
<td>Cohort 1</td>
<td>Cohort 2</td>
<td>Cohort 1</td>
<td>Cohort 2</td>
</tr>
<tr>
<td>TSP 1</td>
<td>0</td>
<td>74</td>
<td>74</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>0%</td>
<td>74%</td>
<td>45%</td>
<td>0%</td>
</tr>
<tr>
<td>TSP 2</td>
<td>0</td>
<td>23</td>
<td>23</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>0%</td>
<td>23%</td>
<td>14%</td>
<td>2%</td>
</tr>
<tr>
<td>TSP 3a</td>
<td>4</td>
<td>3</td>
<td>7</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>6%</td>
<td>3%</td>
<td>4%</td>
<td>36%</td>
</tr>
<tr>
<td>TSP 3b</td>
<td>37</td>
<td>0</td>
<td>37</td>
<td>27</td>
</tr>
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<td></td>
<td>56%</td>
<td>0%</td>
<td>22%</td>
<td>41%</td>
</tr>
<tr>
<td>TSP 3c</td>
<td>25</td>
<td>0</td>
<td>25</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>38%</td>
<td>0%</td>
<td>15%</td>
<td>21%</td>
</tr>
<tr>
<td>Not able to classify</td>
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<td></td>
<td>0%</td>
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<td>166</td>
<td>66</td>
</tr>
<tr>
<td></td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

*Cohort 2: patella instability; *Cohort 1: No patella instability

In the no patella instability cohort (Table 2), the majority of patients showed a normally developed trochlea with a TSP type 1 (74% at the level of the TSZ 0 and 85% at the PFCL). A TSP type 2 (shallow trochlea) was seen in 23% of patients at the TSZ 0 and in 13% at the PFCL. Only three patients showed a TSP type 3 (small pathologic double contour). At the level of the tv-DFPL, 96% of patients had a TSP type 1, 4% a TSP type 2 and there were no TSP type 3.

In the cohort of patients with patella instability/trochlea dysplasia (Table 2), at the level of the TSZ 0, no patient showed a TSP type 1 or 2 and all patients showed a TSP type 3 (pathologic double contour was present).
At the PFCL, there were no TSP type 1, one TSP type 2 (2%) and 98% were TSP type 3, of which 36% were TSP type 3a, 41% TSP type 3b and 21% TSP type 3c.

At the tv-DFPL the morphology of the trochlea was more aberrant and in 20% of patients it was not possible to classify the shape of the trochlea into any of the *Trochlear Shape Patterns*. At this level no supratrochlear spur was found (no TSP type 3c).

A Chi-square goodness of fit test was conducted to determine if the distribution of *Trochlear Shape Patterns* (TSP) was the same between the two cohorts of patients. There was a statistically significant difference in the distribution of the *Trochlear Shape Patterns* (TSP) between the no patella instability and patella instability/trochlea dysplasia cohorts at the level of TSZ 0 ($\chi^2(2)=154.019$, p<.001, n=166) and PFCL ($\chi^2(4)=154.415$, p<.001, n=166).

The strength of the association between the *Trochlear Shape Patterns* (morphology of the trochlea) and patella instability was measured using Cramer’s V ($\phi_c$).

Cramer’s V showed a very strong relationship between *Trochlear Shape Patterns* and patella instability at the TSZ 0 ($\phi_c=.963$, p<.001) and PFCL ($\phi_c=.964$, p<.001) meaning that TSP type 3 (and the presence of the PDC) is strongly associated with patella instability.

**Discussion**

In this paper, the characteristic *Trochlear Shape Patterns* (TSP) seen in the axial views of the MRI scan have been described.

The main finding of the present study is that the *Pathologic Double Contour* sign is pathognomonic of trochlea dysplasia. Normal trochleae show TSP type 1 and type 2 in the axial views at any level. The presence of the *Pathologic Double Contour* sign (PDC) or *Trochlea Shape Pattern type 3* (TSP 3) at the level of the tv-DPFL, or proximal to it
(Posterior Femoral Condyle Line (PFCL) or Trochlear Specific Zone 0) can be used for the diagnosis of trochlea dysplasia.

**Anatomical references**

Multiple quantitative variables have been described in the literature to define trochlea dysplasia(1). However, no uniform anatomical reference exists on where to measure trochlear dysplasia on axial magnetic resonance imaging(4) and different authors have used different anatomic references to describe and measure their variables (5-13).

Selecting an accurate and reproducible reference level is a decision of paramount importance(4),(14). The same variable measured at different levels of the distal femur can have very different values.

Resnick et al(14) suggested the characteristics of the ideal metric for trochlea dysplasia:

- use of cartilaginous contour, simplicity, use of reproducible/accurate reference level
- and theoretical soundness.

The two anatomical references lines described in this paper (PFCL and tv-DFPL) provide a simple, reproducible and consistent method to measure variables for the study of trochlea morphology. The limits of accuracy are imposed by the technical aspects of how the MRI scan is performed, such as the slice thickness (between 3-4mm), obliquity of the cutlines and degree of flexion of the knee.

These reference lines are not dependent on the size of the patient and they can be easily identified on MRI or CT scans.

Trochlea dysplasia is a proximal deformity of the trochlea. The location of these two lines correlates well with the area where trochlea dysplasia develops. The definitive shape of the trochlea in adults (normal or dysplastic) is determined during growth by the anterior flange of the distal femoral physis (af-DFP) (15-17). The af-DFP arises from
the anterior part of the transverse distal femoral physis (tv-DFP) and extends proximally
towards the anterior cortex of the distal femur (Fig. 4).

All morphologic abnormalities seen in trochlea dysplasia are found proximal to the tv-
DFPL (which corresponds to the transverse distal femoral physis, tv-DFP). The PFCL and
Trochlea Specific Zone 0 are references which are proximal to the transverse distal
femoral physis and therefore ideal for the assessment of trochlea morphology.

**Trochlear Shape Patterns (TSP) and diagnosis of trochlea dysplasia**

Trochlea dysplasia has been described as a complex three-dimensional deformity with
different degrees of severity. This paper shows that there is a consistent pattern of
deformity in trochlea dysplasia which is observed on the MRI scan axial views as the
*Pathologic Double Contour* and *Trochlear Shape Pattern* type 3.

The characteristic feature of trochlea dysplasia on the MRI axial views is the *Pathologic
Double Contour* which was present in all patients with trochlea dysplasia and was seen
at, or proximal to, the tv-DFPL. The PDC is never present in normal trochleae.

The PDC is a qualitative sign defined by the osseous contour of the MFC and lateral
trochlea. Some authors\(^\text{10}\),\(^\text{18}\),\(^\text{19}\) have recommended using the cartilaginous
contour for the assessment of trochlea dysplasia. However, the cartilaginous contour
can be difficult to judge in certain MRI scan sequences and it can be affected by the
degree of chondral wear of the trochlea\(^\text{12}\). We have found that the osseous contour
is very reliable for the recognition of the PDC and offers the additional advantage that it
can be identified on CT scans.

Multiple qualitative and quantitative measures have been published in the literature to
define trochlea dysplasia based on radiologic studies.
H. Dejour and Walch(5) were pioneers in trying to define trochlea dysplasia by qualitative signs (crossing sign, re-centering beak which was later termed supratrochlear spur by D. Dejour) and quantitative measures (trochlear bump, trochlear depth, trochlear angle) based on true lateral X-rays.

Due to fair intra and interobserver agreement of the Dejour and Walch classification of trochlea dysplasia(20),(21), David Dejour described what is the most commonly used classification for trochlea dysplasia nowadays. His classification was based on lateral X-rays but also on axial CT scans. He described 4 types of trochlea dysplasia based on (qualitative) radiologic signs found in lateral X-rays, mainly the presence of a crossing sign, supratrochlear spur and double contour signs(22),(23). This classification has also shown fair interobserver and intra-observer agreement(4),(23) and other experts have found this classification unhelpful in their practice(24),(25).

In Dejour’s classification(22), the diagnosis of trochlea dysplasia is based on the presence of the *crossing sign*. It is well known how difficult it is to obtain a true lateral X-ray in normal orthopaedic practice, unless fluoroscopy is used. Failing to obtain a true lateral X-ray can cause false positives and false negatives in the diagnosis of trochlea dysplasia(26).

Advanced imaging studies provide a more reproducible method for assessment of trochlea dysplasia as compared to plain radiography. Although CT scan provides the most detailed assessment of the osseous anatomy (1mm slices), it involves radiation and also does not provide information about the cartilage of the patellofemoral joint. MRI scan has the advantage of superior assessment of cartilage and soft tissues with no radiation, but the main disadvantage is that the assessment of the osseous anatomy is
inferior to CT scans, as the slices are done every 3 to 4 mm. Despite these disadvantages, MRI scan is still considered the gold standard for assessment of trochlea dysplasia. Quantitative variables such as the Lateral Trochlear Inclination Angle (6) or the sulcus angle are easy to measure and reproducible in the normal trochlea, where there is a clearly defined groove and a medial and lateral facet. However, when they are used in the dysplastic trochlea, these variables become unpractical or unreliable because of the difficulty measuring angles in the convex surface or in the presence of the Pathologic Double Contour. This has led to development of different measurements to try overcome this problem. Multiple authors have tried to provide quantitative (morphometric) values based on advanced imaging studies that would help in the definition or diagnosis of trochlea dysplasia(1),(9),(11),(13),(27),(28). Nelitz(2) found that the quantitative measures of the femoral trochlea have shown to be of limited value in the assessment of trochlea dysplasia or when guiding treatment. These quantitative measures are often complex and not user friendly for daily use(14),(28),(29) and they are unable to discriminate completely between normal and abnormal trochleae(2),(9),(11),(27). More importantly, they also fail to quantify severity and when treatment is required. For purely diagnostic purposes, a qualitative variable such as the Pathologic Double Contour, is a much simpler way to determine if a trochlea is dysplastic. The results of the present study show that the presence of a PDC or a TSP type 3 at the level of, or proximal to, the tv-DPFL is diagnostic of trochlea dysplasia and can be used as a screening test.
All patients with trochlea dysplasia showed a PDC and a type 3 TSP (of any subtype 3a, 3b or 3c). In the no patella instability group only 3 patients showed a TSP3 in the TSZ 0. These 3 patients had a very mild form of trochlea dysplasia which was not associated with patella instability and was compatible with normal function.

Trochlear Shape Patterns Type 1, 2 and 3

The Oswestry Bristol classification(3) classifies trochlear morphology in 4 categories based on axial MRI scans: normal trochlea, mild, moderate and severe dysplasia which represent (as per author’s description) a normal, shallow, flat and convex trochlea (dome chondral surface). The criteria to differentiate between normal, mild/shallow and moderate/flat is poorly defined.

In the present study, three Trochlear Shape Patterns were identified. TSP type 1 and 2 are considered normal. TSP type 1 is a completely normally developed trochlea. TSP type 2, a relatively flat trochlea (sulcus angle >165%), was present in 23% of patients of the no patella instability cohort. Because of reduced mechanical constraint of the relatively shallow trochlea, these patients may have a theoretical increased risk of patella dislocation. This pattern is commonly seen in patients with patella instability and no other anatomical abnormalities (ie. patella alta, trochlea dysplasia). However, this Trochlear Shape Pattern cannot be considered pathological (ie. is not a mild form of trochlea dysplasia) as it is present in 23% of the population and it is compatible with normal function. Only TSP type 3 (presence of PDC) can be considered pathological (it is not present in normal individuals).
The hallmark of the TSP type 3 and trochlea dysplasia is the presence of the *Pathologic Double Contour*. The division of the TSP type 3 in the three subcategories (3a, 3b and 3c) accounts for the different morphologies seen in trochlea dysplasia. The supratrochlear spur was only seen proximal to the PFCL indicating that, when present, it is a proximal morphological abnormality of trochlea dysplasia. The severity of trochlea dysplasia can be determined by the height of the pathologic double contour taking the medial femoral condyle as a reference. Moderate or severe forms of trochlea dysplasia with a significant elevation of the trochlea or the TSP type 3c (presence of a significant STS) normally require operative treatment in the form of trochleoplasty.

**Conclusions**

The normal and dysplastic trochleae show distinct morphologic patterns in the axial views of the MRI scan, the Trochlear Shape Patterns (TSP). TSP type 1 and 2 are considered morphologically normal trochleae. The *Pathologic Double Contour* (PDC) is a qualitative sign that allows clinicians to discriminate between normal and dysplastic trochleae and is pathognomonic of trochlea dysplasia.

The presence of the *Pathologic Double Contour and Trochlea Shape Pattern* type 3 (TSP 3) proximal to the tv-DFPL (PFCL 0 or TSZ) are diagnostic of trochlea dysplasia. They can help orthopaedic surgeons to identify and refer patients with trochlea dysplasia to the appropriate surgeon who can perform trochleoplasties. In a similar way, the absence of the PDC allows for the recognition of normal trochleae and rule out the need for trochleoplasty.


**Figure Legends**

**Fig.1. Reference lines for the assessment of trochlear shape.**

Sagittal T1 sequence MRI scan of the knee.

Left image: Posterior Femoral Condyle Line (PFCL) yellow horizontal line just above the cartilage of the lateral femoral condyle (purple arrowhead). Green arrowheads indicate the profile of the LFC. White asterisk: fibular head. TSZ 0 Trochlear Specific Zone 0 is the area proximal to the PFCL. TSZ 1 trochlea specific zone 1 (area between PFCL and tv-DFPL)

Right image: transverse Distal Femoral Physis Line (tv-DFPL) yellow horizontal line at the confluence of the transverse distal femoral physis (white arrowheads), proximal insertion of the ACL (red arrowheads) and Blumensaat line. Red arrowheads Anterior cruciate ligament.
Fig. 2. The Pathologic Double Contour (PDC) and Trochlear Shape Patterns (TSP).

A) Depiction of the PDC with its three components. 1 (red dotted line) lateral trochlea contour; 2 (blue dotted line) cliff; 3 (green dotted line) Medial Femoral Condyle (MFC) contour (baseline).

B) TSP type 3a; C) TSP type 3b; C) TSP type C (Supratrochlear spur).

Fig 3. Trochlear Shape Patterns

TSP type 1. Normal trochlea. Sulcus angle <165°. No PDC

TSP type 2. Shallow trochlea. Sulcus angle >165°. No PDC

TSP type 3. The hallmark is the presence of the Pathologic double contour (PDC). TSP type 3a: flat or downslope inclination of the lateral facet which ends medially in a sudden cliff (no supratrochlear spur). TSP type 3b: a progressive lateral to medial elevation of the lateral facet (convexity) which ends in a (small) summit and then a cliff. The summit is the supratrochlear spur. TSP type 3c: a steep lateral to medial elevation of the lateral facet which ends in a (high) supratrochlear spur (STS) and then a cliff. Type 3c is a more severe form of type 3b where the STS is the main anatomical abnormality.

Fig. 4. Growth plate of the distal femur in a 14 year old male.

The transverse distal femoral physis (tv-DPF) indicated by the purple arrowheads, is responsible for the longitudinal growth of the femur. The anterior flange of the distal femoral physis (af-DPF) indicated by the blue arrowheads, is responsible for the development of the trochlea.
Table 1

**Epidemiology of the two Cohorts With Regards Age, Gender and Knee Affected.**

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<thead>
<tr>
<th>Total</th>
<th>gender</th>
<th>Side</th>
<th>Age</th>
</tr>
</thead>
<tbody>
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<td></td>
<td>Male</td>
<td>Female</td>
<td>Right knee</td>
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<td>Patella Instability</td>
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<td>24</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>100%</td>
<td>36%</td>
<td>64%</td>
</tr>
<tr>
<td>No Patella Instability</td>
<td>100</td>
<td>63</td>
<td>37</td>
</tr>
<tr>
<td>Total</td>
<td>166</td>
<td>87</td>
<td>79</td>
</tr>
<tr>
<td></td>
<td>100%</td>
<td>52%</td>
<td>48%</td>
</tr>
</tbody>
</table>
Table 2.

Distribution of the *Trochlear Shape Patterns* (TSP) at Different Levels in the Two Cohorts of Patients: Patella Instability (PI) and No Patella Instability (No PI)

<table>
<thead>
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<th>Trochlea Specific Zone 0</th>
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*Cohort 2: patella instability; Cohort 1: No patella instability*
Trochlea Shape Patterns (TSP)
The Pathologic Double Contour Sign and the Trochlea Shape Patterns can diagnose trochlea dysplasia

- **Conflict of Interest:** The authors of this paper declare that they have not conflict of interest to disclose.

Rafael Sales Fernández  
7th of December 2021

Nisarg Shah  
7th of December 2021