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Binomial theory applied to the creation of a treatment algorithm for patellofemoral pathology

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ABSTRACT

The annual prevalence of patellofemoral pathology in the general population is 22.7%, and in adolescents, it is 28.9%. Diagnosing this pathology is complex and requires a proper clinical examination and complementary imaging studies for adequate treatment. This study aims to clarify, simplify, and present a diagnostic and treatment algorithm based on casuistry using binomial theory.

Materials and methods: A retrospective study included 100 patients, 70% female, with an average age of 31, diagnosed with patellofemoral pathology, treated with different therapeutic options described in the literature, and followed up for 12 months, evaluated using the Lysholm scale.

Results: Among the surgically treated patients, 75% scored between 65 and 83 points on the Lysholm scale after one month; at six months, 72% scored between 84 and 100 points; after one year, 92% scored between 84 and 100 points; and the remaining 8% showed no improvement or required additional surgical procedures. The Q angle, TT-TG, and Fulkerson classification were correlated, obtaining *P* values of 0.65, 0.72, and 0.55 respectively, suggesting a positive correlation between these variables. Finally, the three variables were correlated for surgical decision-making, obtaining a *P* value of 0.85, with a positive and statistically significant correlation.

Conclusion: The algorithm proposed in this study shows good results at the one-year follow-up and should be considered as a management option for patients with patellofemoral pathology.

Level of Evidence: IV. Observational retrospective case series study.

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1. Introduction

The annual prevalence of patellofemoral pathology in the general population is 22.7%, and 28.9% in adolescents. Incidence rates in military recruits ranged from 9.7 to 571.4 per 1000 person-years, in amateur runners in the general population from 1,080.5 per 1000 person-years, and in amateur athletes in the adolescent population from 5.1% to 14.9% during one season. One study reported a point prevalence of 13.5% [1] within military populations. However, in Ecuador, there are no epidemiological studies on this condition.

Patellofemoral pathology emerges as one of the most complex challenges for orthopedic surgeons. It is characterized by a wide variability in clinical presentations and treatment options. Diagnosis of this pathology is hindered by a clinical examination that lacks specificity and can be challenging for professionals unfamiliar with it. The necessity for complementary examinations, particularly imaging tests, adds an additional layer of complexity, as the technical quality of these results is crucial for diagnostic guidance. Consequently, patellofemoral pathology becomes a high-level technical challenge for diagnosis, and the wide range of treatment options makes it even more complex to manage [2,3].

The following is a retrospective observational case series study of patients diagnosed with patellofemoral pathology treated through various bone and soft tissue procedures, aiming to clarify, simplify, and present a diagnostic and treatment algorithm based on case series using binomial theory.

2. Materials and methods

A retrospective observational case series study was conducted with patients diagnosed with patellofemoral pathology in its various manifestations, treated with different therapeutic modalities described in the literature. Out of a total of 500 patients treated, a simple random sampling was applied to obtain a representative sample of 100 patients, representing a sample of 100 cases from January 2009 to December 2020 in Quito, Ecuador. Of these patients, 70% were female and 30% were male, with a mean age of 31 years (σ = 12, CI = 29.7; 33.3), and they were followed up for 12 months to evaluate their evolution and patient satisfaction with the procedure using the Lysholm scale [4–6] (Table 1).

Regarding clinical manifestations, 55% of the sample presented objective patellar instability, 35% potential patellar instability, and 10% patellar pain syndrome. Additionally, 70% of patients reported anterior knee pain and a sensation of instability, while 45% presented a positive apprehension test and 40% a positive "J" sign.

In relation to the Fulkerson classification [7], it was found that 22% of patients corresponded to type I, 28% to type II, 32% to type III, and 18% to type IV.

Furthermore, 85% of the patients presented a Q angle greater than 20°, a TT-TG (tibial tuberosity – trochlear groove) distance greater than 20 mm, and the various Fulkerson classifications. These patients underwent management of cartilage lesions, management of intra-articular pathology, lateral release, proximal alignment, and distal alignment, while the remaining 15% responded positively to non-surgical measures (Table 2).

Inclusion criteria required that patients presented: femoropatellar pathology, underwent surgical intervention, had available contact information, and had at least one year of follow-up.

From the obtained data, a Dummy dichotomous model was created to convert the variables into a binomial theory. Binary decision tree theory was applied to develop a treatment algorithm, which was contrasted with the procedures applied in the sample.

The model developed was based on multiple logistic regression, which utilized multiple variables with binary responses. This approach applied a binomial model to scenarios with non-binary response options. Specifically, each starting point or node, defined by parameters such as TT, TG and angle Q, allowed for the creation of additional nodes categorized by the Fulkerson classification. From these nodes, treatment options were derived. The model classified patients accordingly and integrated surgical options into the decision-making framework.

Table 1
Summary of descriptive statistics for data collection.

Prevalence in data base	93%
Sample size	100
Average age of sample	31
Mode	34
Median	32
Confidence interval	±2.3
Lower limit	28.7
Upper limit	33.3
Standard deviation	12
N	100
α	0.05
Confidence	95%

Table 2
Summary of descriptive statistics for patient type and treatment.

Dejour classification	Objective patellar instability	55%
	Potential patellar instability	35%
	Painful syndrome	10%
Clinical test	Apprehension test positive	45%
	J sign	40%
Fulkerson classification	Fulkerson I	22%
	Fulkerson II	28%
	Fulkerson III	32%
	Fulkerson IV	18%
Treatment	Surgical	85%
	Non-surgical	15%

Upon finding statistical significance, the definitive treatment algorithm was developed.

A decision algorithm based on binomial theory was created, grounded in the statistics of the patients treated by the research group and the outcomes obtained, as well as the available published evidence at that time. This process enabled the development of a decision-making system based on prior classifications, imaging findings, and physical examination results. The outcomes of the treated patients were satisfactory, providing the necessary statistical basis. Using a dummy model, these results were transformed into binomial theory. Additionally, a decision tree was designed; statistical models were run that delineated the critical branches, thereby establishing the final decision-making algorithm, which demonstrated specific sensitivity and specificity.

A decision tree model was used to structure and evaluate clinical decisions at each node. This approach systematically maps out potential treatment pathways and associated outcomes, considering the multifactorial nature of patellofemoral instability. Although the decision tree nodes were not strictly binary, each decision point was designed to include multiple alternatives based on probabilities assigned to specific factors such as trochlear dysplasia, *Q* angle, and TT-TG distance.

2.1. Decision tree structure

1. **Initial node:** This node represented the patient's initial evaluation, including clinical parameters (pain and instability symptoms), radiographic findings (TT-TG and *Q* angle measurements), and history of prior dislocations.
   Options: Continue with conservative management versus proceed with surgical evaluation.

2. **Intermediate nodes:** At this stage, specific anatomical features and dynamic measurements were analyzed to determine surgical or non-surgical treatment options. For example:
   - Patients with an elevated *Q* angle (>20°) and TT-TG distance >20 mm were recommended surgical options such as tibial medialization osteotomy or medial patellofemoral ligament reconstruction.
   - Patients with normal measurements were included in a conservative management protocol involving intensive physical therapy and follow-up.
3. **Final Node:** Here, expected outcomes were evaluated in terms of therapeutic success based on historical data and probabilistic models. Success probabilities were calculated using binomial expansions to integrate multiple factors at each decision point. For example:
   - The probability of success for a patient with severe trochlear dysplasia and an elevated *Q* angle after osteotomy was adjusted based on prior literature and study outcomes.

2.2. Probabilistic model

The decision outcomes at each node were integrated into a model based on binomial expansions to calculate the algorithm's effectiveness along each treatment pathway. This model allowed for:

- Identifying combinations of anatomical factors predicting better surgical outcomes.
- Quantifying the impact of clinical decisions in terms of pain reduction, functional improvement (Lysholm score), and reintervention rates.

For instance, a node related to osteotomy showed an 85% probability of significant functional improvement when performed in patients with TT-TG distance >20 mm and *Q* angle > 20°, compared to a 65% probability in those with TT-TG at the upper normal limit (15–20 mm).

2.3. Model validation

The algorithm was retrospectively validated by comparing it with observed outcomes in a cohort of 100 patients. The obtained values for functional improvement (Lysholm score) and success rates correlated strongly with the probabilities calculated in the model, showing a high concordance (correlation coefficient of 0.82).

2.4. Clinical implementation

The proposed algorithm not only provides a tool for evidence-based decision-making but also offers a dynamic and adaptive approach to individualize treatment according to specific patient characteristics. This ensures each decision is grounded in robust clinical and probabilistic data, optimizing clinical outcomes and minimizing the risk of complications.

This approach guarantees that decisions are reproducible and can be easily adapted to other cohorts or clinical settings with similar characteristics.

The model described in this work combines decision trees and binomial probabilities to analyze and predict clinical management outcomes in patients with patellofemoral instability. Below are the equations used, along with mathematical and statistical explanations to ensure reproducibility and clinical applicability.

1. Problem definition:

   The model aims to estimate the probability P(S)P(S)P(S) of clinical success for each therapeutic decision based on:

- Anatomical factors (X_1, X_2, X_3, …, X_n), such as trochlear dysplasia, Q angle, and TT-TG distance.
- Treatment options (T): conservative management (T_0) or surgical options (T_1, T_2, …, T_m).
- Clinical outcomes (Y): functional improvement ($Y = 1$) or failure ($Y = 0$).

   Clinical success is defined by functional indicators (Lysholm score > 85) and pain reduction (VAS score < 2).

2. Decision tree and conditional probability:

   At each decision tree node, the conditional probability of success is calculated as:

$$P(S|X,T) = \frac{n_s}{n_t}$$

where: n_s number of patients with success ($Y = 1$) for a combination of factors X and treatment T and n_t total number of patients undergoing T with characteristics X.

Example: If ns = 68 and nt = 80 for patients with severe trochlear dysplasia (X_1) treated with surgery (T_1), then:

$$P(S|X_1T_1) = \frac{68}{80} = 0.85$$

3. Binomial modeling for non-binary decisions:

   For decisions where outcomes are not strictly binary, we used the binomial expansion to integrate multiple factors:

$$P(S|X) = \sum_{K=0}^{n} \binom{n}{k} P^K (1-P)^{n-k}$$

where n: total number of anatomical or clinical factors considered, p: probability associated with each individual factor (X_i) contributing to success, and k: number of relevant factors activated in each combination.

Example: For three factors ($n = 3$) with individual probabilities $p_1 = 0.8$, $p_2 = 0.7$, and $p_3 = 0.9$, the total probability of success is calculated by combining the factors as follows:

$$P(s|x) = (0,8*0,7*0,9) + (0,8*0,7*0,1) + \cdots$$

This approach allows for incorporating interactions between variables into the calculation of the total probability.

4. Validation of decisions using logistic regression:

   To evaluate the influence of factors X_i on the probability of success P(S), a multivariable logistic regression model was fitted [6–8]:

$$\log\left(\frac{P(S)}{1-P(S)}\right) = \beta_0 + \sum_{i=1}^{n} \beta_i X_i$$

where β_0: constant term and β_i: coefficient measuring the impact of factor X_i on clinical success.

The values of β_i were estimated using the maximum likelihood estimation (MLE) method, and statistical significance was assessed with a p-value ($p < 0.05$).

2.5. Example of interpretation

If $\beta_1 = 2.1$ for the Q angle, this indicates that an increase of one unit in the Q angle (in degrees) is associated with an exponential increase of $e^{2.1} \approx 8.2$ fold in the probability of success.

5. Integration of results into the algorithm:

Finally, the calculated probabilities were integrated into the decision tree. Each node includes:

- Conditional probability P(S|X).
- Recommended choice based on the highest probability.

2.6. Example of a node

- If P(S|T1) = 0.85 (surgical treatment) and P(S|T0) = 0.60 (conservative management), the algorithm suggests T1.

2.7. Practical implementation

This mathematical approach allows the model to be reproduced in other clinical settings. Input data (anatomical measurements, functional outcomes) can be adjusted for specific cohorts, and statistical calculations can be performed using tools such as R, Python, or specialized software.

This level of detail ensures the algorithm is applicable, reproducible, and adaptable across different institutions.Subsequently, a search was conducted using MeSH terms, and the PRISMA methodology was applied for the selection of relevant articles. Results from different studies were compared, and the diagnostic and therapeutic algorithm was established and contrasted with the gathered information.

The study was conducted in accordance with the ethical standards recognized by the Helsinki Declaration and Resolution 008430 of 1993, and it has the approval of the Institutional Ethics Committee. Additionally, informed consent was obtained from the patients who participated in the study.

3. Results

A simple random sampling based on probability was conducted. Consequently:

$$n = \frac{Z^2 p(1-p)}{e^2}$$

$$n = \frac{1.96^2 * 0.93 * 0,07}{0.05^2}$$

$$n = 99,9 = 100$$

where n is the sample size, z is the value for the 95% confidence interval, e is the standard error of 5%, p is the probability of success in obtaining a patient meeting the described inclusion criteria, and $1 - p$ is the probability of failure or exclusion of patients.

Among surgically intervened patients, 75% exhibited a result ranging from 65 to 83 points on the Lysholm scale during the first month of follow-up, considered as fair. At 6 months, 72% achieved a result between 84 and 100 points, classified as good, and at one-year follow-up, 92% displayed results between 84 and 100, indicating a favorable outcome and an improvement in quality of life. However, the remaining 8% showed no improvement or required further surgical procedures, some of which were due to non-compliance with physical therapy (Table 3).

Based on these results, a Dummy variable model correlating Q angle, TT-TG, and Fulkerson classification was created, obtaining P values of 0.65, 0.72, and 0.55, respectively, suggesting a positive correlation among these variables. Subsequently, the three variables were correlated for surgical decision-making, yielding a P value of 0.85, indicating a positive and statistically significant correlation.

Table 3
Summary of Lysholm scale average.

	Month 1	Month 6	Month 12
Lysholm scale average	78.8	86.2	96.4

Finally, based on these findings, a treatment algorithm was developed based on a binomial decision theory (Schemes 1 and 2).

In these 100 cases, an algorithm designed to evaluate the validity and reproducibility of the proposed treatments was used. The binomial theory served as the mathematical foundation for the creation of this algorithm, facilitating the construction of decision trees that outlined critical paths for the application of the treatments. The analyses revealed that the algorithm had a sensitivity of 97.06% and a specificity of 93.75%. The positive predictive value (PPV) and the negative predictive value (NPV) were also 97.06% and 93.75%, respectively. These results indicate that the algorithm is capable of correctly identifying the majority of patients with surgical pathology, as well as distinguishing those without surgical need with high precision. To obtain the intraobserver and interobserver kappa values, the algorithm was applied by three surgeons from the same surgical team, each with more than 10 years of experience, yielding an intraobserver kappa value of 94%. For the interobserver reliability assessment, the algorithm was applied by eight orthopedic surgeons with over 20 years of experience, resulting in an interobserver kappa value of 90%.

The kappa coefficient (κ) was used to measure the agreement between observers on key radiographic variables:

$$\kappa = \frac{P_0 - P_e}{1 - P_e}$$

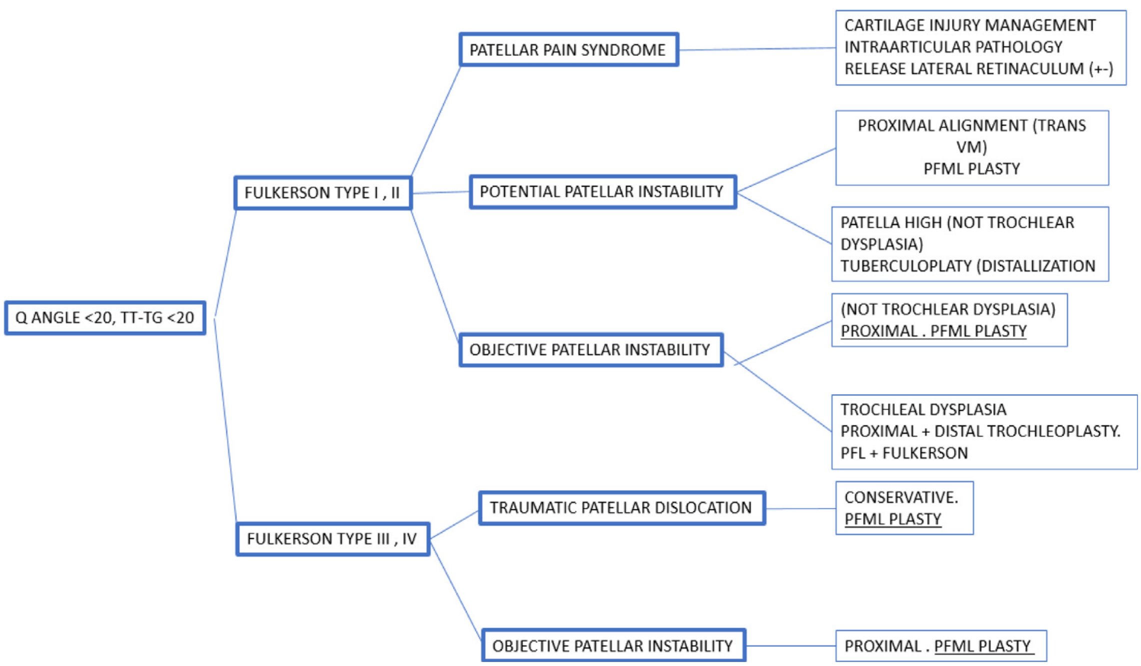
where P_0: observed proportion of agreement between evaluations and P_e: expected proportion of agreement by chance.

These kappa indices suggest that the algorithm presents low variability among different observers, both in the same instance of observation and among different observers in various instances. The low inter- and intraobserver variability confirms the high reproducibility of the algorithm when applied by different surgeons (Table 4).

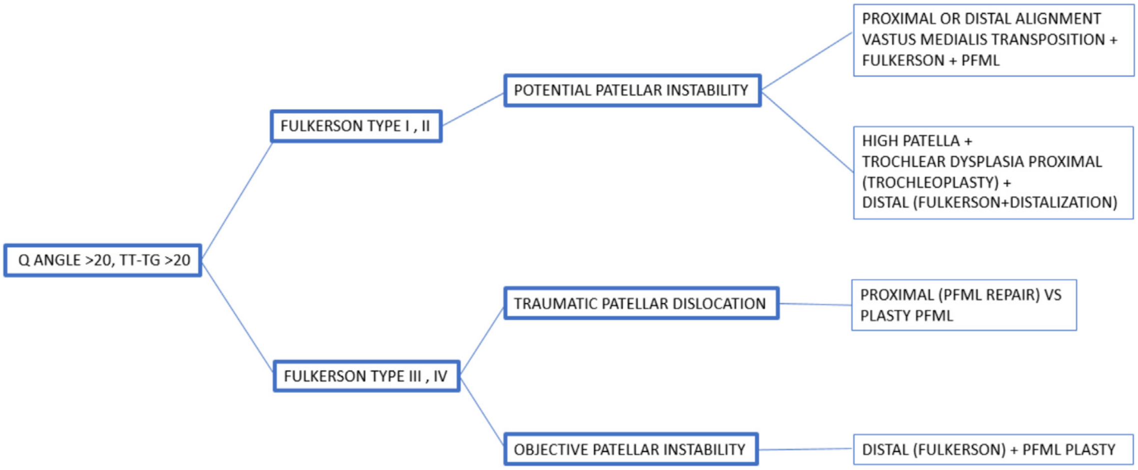
These results corroborate that the algorithm is not only effective in terms of sensitivity and specificity but also in its reproducibility, providing a reliable framework for decision-making in the treatment of femoropatellar pathology. The high sensitivity suggests that the algorithm is effective in detecting cases that require surgical intervention, while the high specificity indicates that the algorithm minimizes the misclassification of non-surgical cases as positive, avoiding unnecessary treatments.

In practical application terms, these values suggest that the algorithm can serve as a robust guide for the diagnosis and treatment of femoropatellar pathology. The high predictive values indicate that the algorithm is effective in predicting both the presence and absence of the pathology, which is crucial for proper treatment planning.

The consistency in the reproducibility of the algorithm, demonstrated by the high kappa indices, ensures that different surgeons can apply it uniformly, guaranteeing standardized diagnostic and therapeutic decision-making. This uniformity in the application of the algorithm is essential for clinical practice, as it minimizes treatment variability and improves the quality of patient care.



Scheme 1. Postponed treatment algorithm for patients with Q angle < 20 and TT-TG < 20.



Scheme 2. Postponed treatment algorithm for patients with Q angle > 20 and TT-TG > 20.

Table 4
Evaluation results of the algorithm to determine validity and reproducibility in the treatment of femoropatellar pathology.

	Surgical pathology present	Non-surgical pathology/absent pathology	Total
Positive	66	2	68
Negative	2	30	32
Total	68	32	100
Sensitivity		97.06%	
Specificity		93.75%	
Positive Predictive Value (PPV)		97.06%	
Negative Predictive Value (NPV)		93.75%	
Intraobserver Kappa Index		94%	
Interobserver Kappa Index		90%	

4. Discussion

Patellofemoral instability presents as a multifactorial condition encompassing various disorders. Patellar dislocations, predominantly in adolescent females, often manifest primarily in the second decade of life. The incidence of patellar instability varies between 5.8/100,000 and 29/100,000 in the 10–17-year-old age group. The stability of the patellofemoral joint is influenced by both bone morphology and soft tissue restraints, which play a crucial role in the proper functioning of the knee extensor mechanism [3].

Anatomically, the lateral facet of the femoral groove is more prominent, high, and large than the medial facet, exhibiting similar and congruent articular characteristics. The lateral facet of the femoral groove, along with the lateral retinaculum, shows greater resistance and amplitude compared to the medial side, widely recognized and accepted for its importance in resisting lateral forces [8–10].

Mechanical imbalances, often associated with anatomical abnormalities such as lateral overhang of forces directed medially, can lead to patellofemoral dislocation. Dejour et al. from the Lyon school have classified patients with femoropatellar pathology associated with instability into three groups: objective patellar instability/dislocation (OPI/OPD), potential patellar instability/possible patellar dislocation (PPI/PPD), and painful patellar syndrome (PPS), using both clinical history and objective descriptions with statistical data to establish a threshold of anatomical abnormalities [11–15].

The OPI or OPD group includes patients with at least one documented history of patellar dislocation, defined as complete displacement of the patella with respect to at least one anatomical risk factor. The OPI/OPD group can be further subdivided based on the number and type of dislocations into recurrent (more than 3 episodes), habitual (during each early knee flexion), and other presentation patterns. The PPI or PPD group includes patients who present at least one factor of anatomical instability and report knee pain but do not report any documented patellar dislocation. The PPS group includes patients who complain of knee pain but do not present any reported or documented anatomical instability factor of dislocation/subluxation. Much of this group is not within the spectrum of disorders known as patellar instability [16–19].

Key signs and tests are fundamental to significantly influence diagnosis and treatment. The apprehension test, patellar tilt test, quadrant test, J sign, and/or abnormal patellar tracking are clinical aspects preferred by authors to evaluate patients [20–23].

4.1. Anatomical risks and radiological assessment

Understanding these key factors is essential to determine the most appropriate treatment choice. A thorough understanding of the various anatomical abnormalities contributing to patellofemoral joint (PFJ) instability is required to select the optimal therapeutic option for each patient.

In 1987, Dejour et al. described the four major anatomical factors predisposing to patellar dislocation: trochlear dysplasia (TD), high patellar position (PA), excessive TT-TG distance, and patellar tilt. Over the past decade, several authors have corroborated and emphasized the importance of these risk factors, although the patellar tilt angle, whose relevance has slightly diminished, is still considered a consequence of the other factors [12,23,24].

It is essential to accurately evaluate true sagittal views, axial views at 30° knee flexion, and anteroposterior views, which should be properly performed by a radiologist for precise treatment. Lateral views should be obtained by superimposing the two femoral condyles in a monopodal position with a 20° flexion [12–15,23–25].

Computed tomography (CT) and magnetic resonance imaging (MRI) can clearly show the general shape of the trochlea and can quantify axial malalignment (TT-TG), patellar tilt, and some rotational deformities [25,26].

4.2. Trochlear dysplasia

Trochlear dysplasia stands out as the primary and most frequently associated risk factor with patellar instability, being diagnosed in up to 96% of patients with OPI. This condition involves a pathological anomaly in the shape of the femoral trochlear groove, which may manifest as a flat or shallow groove, with or without an associated supratrochlear prominence, and its origin is usually genetic [12–15].

On the sagittal view radiograph, trochlear dysplasia is characterized by three pillars: the crossing sign, the supratrochlear spur, and the double contour sign. The combination of these images is essential to obtain a clear definition of trochlear dysplasia. The crossing sign, first described by Dejour et al., refers to the point where the radiographic line of the trochlear groove meets the projection of the anterior part of the femoral condyles, representing the exact position where the groove and the anterior femoral condyle have the same anteroposterior (AP) height, indicating the transformation of a segment of the trochlea into a plane. The supratrochlear spur is a protrusion on the superolateral part of the trochlea that has a functional effect during trochlear interaction, like a ski ramp. The double contour sign is observed as a double line on the anterior aspect of the condyles, representing a hypoplastic medial facet with a lower AP height compared to the groove and lateral condyle, and it should end below the crossing sign [12–15].

Axial projections obtained with the knee flexed at 30° are used to assess the shape of the trochlea, measure the sulcus angle, and evaluate patellar dysplasia classified according to Wiberg. The sulcus angle is calculated by drawing two lines, from the deepest point of the groove to the highest point of each condyle. In trochlear dysplasia, this angle increases or is impossible to measure [12–15].

In our institution, the sulcus angle is not usually used to quantify trochlear dysplasia. Instead, axial radiographs are primarily used to assess the presence of condylar or patellar fractures. To analyze the shape of the trochlea in the axial plane, we prefer the use of axial images on computed tomography or magnetic resonance imaging. Comparing the radiographic sagittal image and the transverse images, trochlear dysplasia can be classified according to Dejour et al. [12–15].

4.3. TT-TG

The TT-TG distance (tibial tubercle-trochlear groove) is positioned as the third risk factor for patellar instability, although, unlike trochlear dysplasia and high patella, it does not have the ability to individually induce patellar dislocation. This radiographic measurement represents the lateral vector of the quadriceps acting on the patella, and its value is influenced by femoral/tibial rotation and coronal alignment of the knee in varus/valgus, which modifies the *Q* angle, defined by the lines of quadriceps traction and the patellar tendon crossing at the center of the patella. For an accurate measurement of this angle, it is fundamental that the patella be centered in the trochlea [25–28].

Secondary factors such as excessive femoral anteversion, tibial external rotation, subastragaline joint pronation, or deformities such as genu valgum and recurvatum may alter anatomical stability and coronal *Q* angle, clinically evaluated and radiologically measured as axial TT-TG distance. An increase in femoral anteversion, by causing internal rotation of the distal femoral epiphysis, increases the lateral vector, thus increasing the risk of lateral compartment degeneration and patellar dislocation. Likewise, an increase in TT-TG distance may predispose to patellofemoral disorders [29,30].

Despite controversy surrounding its value due to low reproducibility, TT-TG distance remains the best index to date for measuring *Q* angle. Although the TT-PCL value, recently proposed, has not proven superior to TT-TG for differentiating patients with patellofemoral instability, it remains a good alternative for quantifying axial malalignment. However, it is essential to have measurements that assist the physician in patient evaluation and preoperative surgical planning, which could be used to assess surgical outcome [28–30].

Traditionally, a pathological TT-TG distance assessed on computed tomography (CT) has a cutoff value of 20 mm. Recently, several authors have used magnetic resonance imaging (MRI) to calculate TT-TG distance, proposing a cutoff value of around 13 mm. However, for the application of our algorithm, a cutoff value of 20 mm is maintained [28–30].

5. Algorithm

The algorithm must be characterized by establishing defined objectives, supported by reliable and quantifiable data. This premise is essential for achieving therapeutic success in as many patients as possible. Although the assessment of patient medical history and physical examination are fundamental aspects in this process, they alone are insufficient. Definitive decision-making must be based on a meticulous analysis of radiographic and imaging studies.

It is imperative to categorize patients into subgroups according to their individual anatomical characteristics and apply a personalized approach to address each anomaly through the corresponding surgical procedure. This approach resembles an adaptation of surgical procedures to the needs of each patient, selecting and adjusting specific treatment according to their individual requirements.

The algorithm previously presented has exhibited highly satisfactory results in the patients to whom it has been applied and continues to be applied, demonstrating favorable indices in recovery scales and notable patient satisfaction (Schemes 1 and 2).

6. Conclusions

The conclusions derived from this study shed light on the effectiveness and relevance of the treatment algorithm developed to address patellofemoral instability. The application of this algorithm reflects the accumulation of clinical experience over the years, supported by the good results obtained in 92% of patients as measured by the Lysholm scale.

The preeminent influence of intrinsic factors in the genesis of patellofemoral instability is highlighted. Among these factors, trochlear dysplasia emerges as the most significant, with its evaluation being essential through radiographic and cross-sectional imaging studies. Identifying trochlear dysplasia requires meticulous correlation between bone findings on radiographs and cartilage characteristics on magnetic resonance imaging, particularly paying attention to the sagittal involvement of the patellotrochlear region, which provides substantial value in surgical decision-making.

The second intrinsic factor of importance is the presence of high patella, whose evaluation also demands a comprehensive approach considering both osseous and cartilaginous aspects. This combined evaluation provides crucial information to determine the appropriate surgical indication, allowing precise intervention planning.

The third intrinsic factor, axial alignment, is quantified by the TT-TG distance, which is evaluated in different diagnostic imaging modalities such as computed tomography and magnetic resonance imaging. Considering the various thresholds of normality in these modalities contributes to a more accurate assessment of axial alignment and, therefore, better surgical planning.

Regarding available surgical options, a positive evolution is observed in the employed techniques, which have proven to be increasingly reliable in treating patellofemoral instability. The key to success in addressing patellar dislocation lies in making an accurate diagnosis, validated by the identification of at least one instability factor, followed by the sequential application of the treatment algorithm. This approach allows for the correction of each anomaly individually, thus contributing to preventing misdiagnoses, overdiagnosis, and minimizing the risks of iatrogenic surgery.

The algorithm through this random sample has demonstrated its high validity and reproducibility. The high sensitivity and specificity, along with the high intra- and interobserver kappa indices, suggest that the algorithm is a reliable and effective tool for the evaluation and treatment of femoropatellar pathology. These findings support its use in clinical practice, providing a standardized and reproducible approach to managing this condition.

In summary, the proposed treatment algorithm stands as an invaluable tool in clinical decision-making for patients with patellofemoral instability, offering a systematic and personalized approach that translates into favorable outcomes and increased patient satisfaction.

CRediT authorship contribution statement

Pablo Agustín Ramos Guarderas: Validation, Supervision, Investigation, Funding acquisition, Formal analysis, Conceptualization. **Gonzalo Fernando Arteaga Guerrero:** Validation, Supervision, Conceptualization. **Medardo Javier Vargas Morante:** Validation, Supervision, Investigation. **Pablo David Ramos Murillo:** Visualization, Investigation, Conceptualization. **Carlos Patricio Peñaherrera Carrillo:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Investigation, Formal analysis. **Francisco Endara Urresta:** Writing – original draft, Software, Investigation, Formal analysis, Data curation. **Daniel Alejandro Ramos Murillo:** Software, Data curation. **Alejandro Xavier Barros Castro:** Methodology, Investigation, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary material

Supplementary material to this article can be found online at https://doi.org/10.1016/j.knee.2025.05.012.

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