

# Rehabilitation-related variability in the x-ray indicators of intrinsic patellofemoral pathology

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**Introduction.** Rehabilitation is an accepted method for the initial treatment of pathologies intrinsic to the patellofemoral joint, leading in many cases to an improvement of clinical manifestations.

**Purpose.** The purpose of this study is to determine whether rehabilitating therapy causes any variation in the radiological indices that define a painful patellar syndrome or patellofemoral instability.

**Materials and methods.** This is a prospective study of 50 subjects, divided up into 2 groups. The first group comprised 25 individuals afflicted with a painful patellar syndrome without signs of instability; the second group comprised another 25 individuals with patellofemoral instability. All the subjects were subjected to standardized x-ray study both before and after undergoing a rehabilitation protocol.

**Results and conclusions.** Rehabilitation led to significant changes in the patellofemoral index of subjects with a painful patellar syndrome and in both this index and the patellofemoral congruence angle in patients with patellofemoral instability.

**Key words:** patella, patellofemoral syndrome, patellofemoral instability, rehabilitation, x-ray evaluation.

## Variación de los indicadores radiográficos de la patología patelofemoral intrínseca con la rehabilitación

**Introducción.** La rehabilitación es un método aceptado para el tratamiento inicial de la patología intrínseca de la articulación patelofemoral, obteniendo en muchos casos una importante mejoría de las manifestaciones clínicas.

**Objetivos.** En el presente estudio se intenta comprobar si la terapia rehabilitadora produce alguna variación en los índices radiológicos que definen un síndrome rotuliano doloroso o una inestabilidad femoropatelar.

**Material y método.** Hemos realizado un estudio prospectivo, sobre 50 sujetos, divididos en dos grupos. Un primer grupo se constituyó con 25 individuos afectados de un síndrome rotuliano doloroso, sin signos de inestabilidad, y un segundo grupo con otros 25 que presentaban una inestabilidad femoropatelar. En todos ellos se realizó un estudio radiográfico estandarizado previo y posterior a la aplicación de un protocolo de rehabilitación.

**Resultados y conclusiones.** La rehabilitación hizo variar el índice fémoro-rotuliano de forma significativa en los individuos con un síndrome rotuliano doloroso, y este índice y el ángulo de congruencia en los pacientes con una inestabilidad femoropatelar.

**Palabras clave:** patela, síndrome patelofemoral, inestabilidad femoropatelar, rehabilitación, evaluación radiológica.

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In some of our prior work<sup>1</sup>, as well as in that of several other authors, it has been shown how plain films together with knowledge of the patient's medical history and clinical examination make it possible to diagnose intrinsic patellar pathology.

Thus we know that the patellofemoral index and the congruence angle are significantly altered in patients with this pathology. Alterations are also present, albeit to a lesser extent, in the Caton index, which measures patellar height, and the sulcus angle<sup>2</sup>.

Kramer<sup>3</sup> described exercises that facilitate soft tissue mobilization thereby decreasing lateral patella pressure and enhancing cartilage metabolism. Bennett and Stauber<sup>4</sup> suggested that the patellofemoral pain syndrome could result from a disrupted neuromuscular control of the quadriceps, especially during the eccentric control phase. Knight<sup>5</sup> described the rapid results obtained with the DRAPE program (*daily adjustable progressive resistive exercise*).

Even if it is widely known that a rehabilitation program exerts a beneficial effect on the clinical manifestations of the patellofemoral pain syndrome, in this paper we set about finding out whether physical therapy can modify the radiographic alterations found.

## MATERIALS AND METHODS

This is a prospective study that reports data from 50 patients from the western area of the Almería province (Spain) collected between January 1999 and January 2001. The data were analyzed and processed at the University of Granada. There was a total of 7 men and 43 women, with a mean age of 29.26 years (range: 14-50), with a standard deviation of 9.8. All of them presented with knee pain, specifically located in the patellofemoral joint.

To participate in the research project, patients were required to present with patellofemoral pain of more than 6 months' duration attributable to an intrinsic patellofemoral pathology, and to have expressed their desire to participate in the study either orally or in writing.

Patients with one or more of the following characteristics have been excluded: age over 14 years or under 50 years; pregnant women; any medical or surgical problem that according to the researchers could interfere with participating in the study or entail a significant risk for the patient; patients with mental or legal disability; drug abusers; and patients that presented with obvious changes in their patellofemoral joint.

Twenty-five patients were gathered of each of the pathologies considered:

1. Group I was made up of the 25 patients affected by the so-called patellofemoral pain syndrome (PFPS), i.e. a clinical entity of diverse etiology, characterized by anterior knee pain, with potential pseudolocking episodes and failure but without dislocation or instability. A preliminary x-ray study was used to confirm the belonging of individuals in the group. Of them, 19 were women (76.0%) and 6 were men (24%). Mean age was 28.04 years (range: 14-50), with a standard deviation of 9.27. In this group, the condition was found to be bilateral in 80% of cases.

2. Group II was formed by 25 patients with signs of patellar instability, 24 women (representing 96% of this group) and one male, with a mean age of 30.48 years

(range: 16-50 years), with a standard deviation of 10.30. In this group, bilaterality appeared in 40% of patients.

These individuals were initially asked about their previous medical history and subjected to a thorough physical examination. Whenever the condition was found to be bilateral, data for the clinically more highly symptomatic knee were recorded.

The radiographic study was carried out systematically by means of anteroposterior, lateral (at 30° knee flexion) and axial (at 20 and 45° flexion) views. Anteroposterior x-rays were used only in order to rule out concomitant alterations. The lateral view was used to study patellar height and inclination. Axial views were used to study the congruence angle, the sulcus angle, the patellofemoral index and the patellofemoral angle.

To be able to come up with reproducible axial views we used an adjustable bucky, placing patients in the supine position with their knees at the end of the x-ray table, resting the knees and the lower legs on the said device.

Patellar height was measured using the Caton method<sup>6</sup> (fig. 1). Patellar inclination was assessed by means of the method described by Maldague and Malghem<sup>7</sup>. The congruence angle and the sulcus angle were measured in the axial views taken at 45° flexion, according to Merchant's classical description<sup>8</sup> (fig. 2), while the patellofemoral angle and index were obtained at 20° flexion, using the technique first described by Laurin<sup>9</sup> (fig. 3).

Assessment of radiographic patellar inclination is based on the fact that in the normal knee the posterior patellar profile is represented by 2 lines. The most posterior one corresponds to the middle crest, whereas the anterior one is the lateral facet. If the patella is inclined outward either the 2 lines overlap or the lateral facet overhangs behind the crest and the anteroposterior diameter of the bone increases.

The congruence angle measures the relationship between the patella and the intercondylar notch. To obtain this measurement, the sulcus angle is bisected, a line that will serve as a reference. A second line is drawn from the apex of the sulcus angle to the lowest part of the patella's articular crest. The angle formed by these 2 lines is the congruence angle. If the angle is lateral to the reference line, it is considered positive; if it is medial to the line it is deemed negative.

The patellofemoral angle is obtained by drawing a line tangential to the apex of the medial and lateral condyles in Laurin's projection and another following the lateral patellar facet. In normal conditions, the patellofemoral angle opens outward.

The patellofemoral index indicates the relationship between the width of the medial and lateral joint spaces: it is considered normal if its value is under 1.6.

All patients included in the study were subjected to a 6-month-long rehabilitation program, based on mobilizations, lower limb elasticity exercises, neuromotor control and



Figure 1. Caton index.

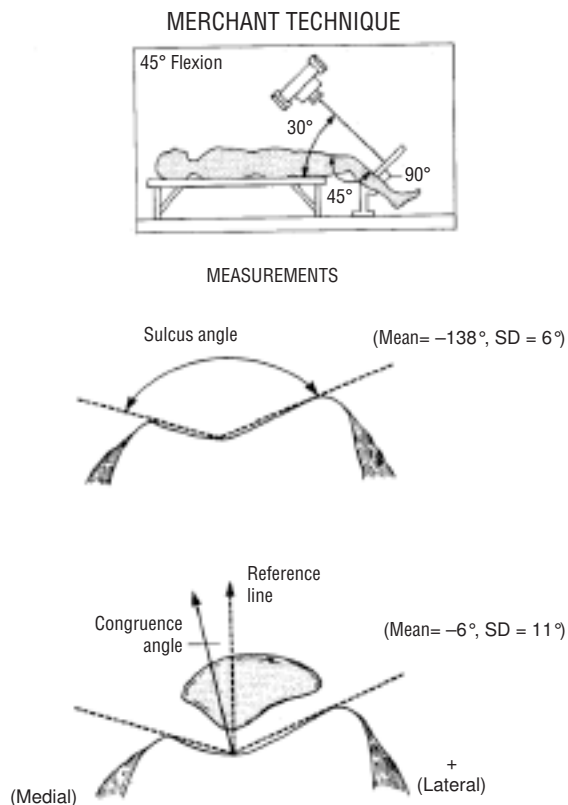


Figure 2. Merchant technique and measurements<sup>8</sup>.

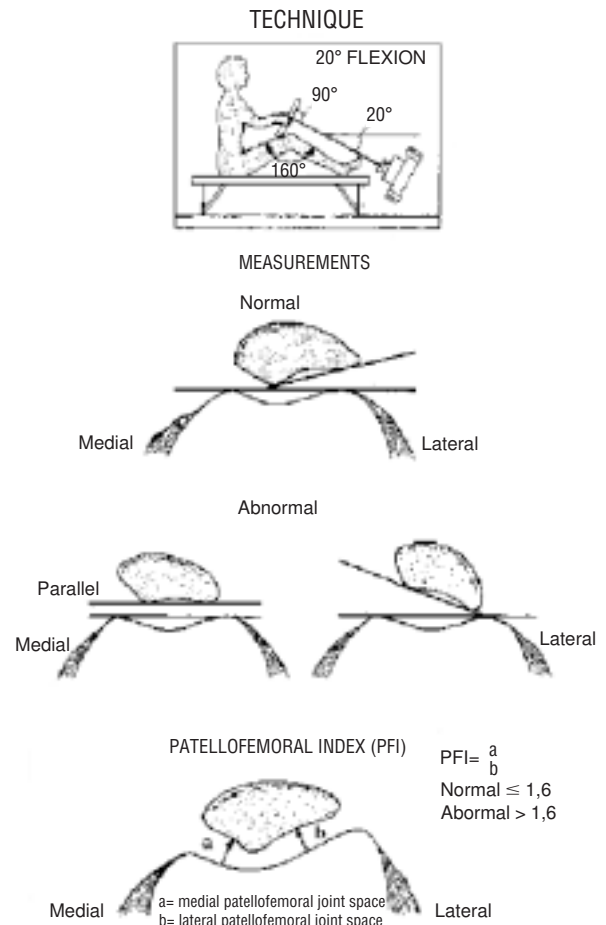


Figure 3. Laurin technique and measurements<sup>9</sup>.

muscle strengthening techniques. Treatment, supervised by the hospital's rehabilitation unit, was tailored to the needs of each patient. During the first two months, daily sessions (5 times a week) were conducted in the hospital gym, and during the last 4 months each patient performed exercises at home, being subjected to monthly supervisions, always by the same doctor.

Once rehabilitation was concluded, patients underwent a new clinical examination and the same radiopgraphic evaluation as before was carried out.

In order to comply with the goals of the present study we carried out a statistical analysis with the observations available. For each of the 2 groups, we performed a descriptive analysis for all the variables and a comparison between observations made before and after rehabilitation. The comparison between the 2 observations was made in 2 different ways, depending on the variable being compared. If it was a quantitative variable, we used the Wilcoxon test for paired samples; if it was a qualitative one we used McNemar's exact test.

In all cases, we used the SPSS 11.0 statistical software with the exact test module as well as the LogXact 1.0 statistical package.

## RESULTS

The rehabilitation program indicated does not produce significant variations of patellar height (Caton index), whose mean values are normal in patients with PFPS (group I) and rises slightly above this level for patients with instability (group II). Values are shown in table 1.

The abnormal patellar inclination shown radiographically by 23 patients del group I (92%) and all 25 in group II only improves following the therapy administered in one case in group I, which is not statistically significant.

The congruence angle, which is much higher in group II, improves significantly with rehabilitation, whereas it changes moderately in group I (table 2).

The patellofemoral angle está alterado (nulo o abierto hacia adentro) en todos los casos, en both groups y no vira a la normalidad en ningún caso con la rehabilitación.

The patellofemoral index is in excess of normal values in both with more significantly higher values in patients with patellar instability. The rehabilitation program is successful in significantly decreasing this index, although neither group reaches normal mean values. Data are shown in table 3.

## DISCUSSION

The first step in the treatment of patellofemoral pathology ought to be a good rehabilitation program.

There is evidence in the literature of the effectiveness of physical therapy to address the patellofemoral pain syndrome as regards pain relief, although there is no clear evidence as to functional development<sup>10</sup>. There is strong evidence of how open and closed kinetic chain exercises can be equally effective.

The most important goal of rehabilitating treatment will be the strengthening of the quadriceps, especially of the vastus medialis oblique muscle, which acts as a barrier to the lateralizing tendency of the patella during knee extension. The vastus medialis oblique muscle guarantees the vertical, horizontal and rotational stability of the patella. Nonetheless, the balance of the forces acting on the knee is

**Table 1.** Patellar height in both groups before and after rehabilitation, expressed in terms of the index's value

|                | Caton index    |                          | Statistical significance |
|----------------|----------------|--------------------------|--------------------------|
|                | Initial        | Following rehabilitation |                          |
| Group I (PFPS) | 1.0940 ± 0.096 | 1.0968 ± 0.089           | p = 1                    |
| Group II (PI)  | 1.2752 ± 0.067 | 1.2992 ± 0.122           | p = 1                    |

PI: patellar instability; PFPS: patellofemoral pain syndrome.

**Table 2.** Congruence angle in both groups before and after rehabilitation, expressed in terms of mean degrees and standard deviation

|                | Congruence angle |                          | Statistical significance |
|----------------|------------------|--------------------------|--------------------------|
|                | Initial          | Following rehabilitation |                          |
| Group I (PFPS) | -2.48 ± 5.12     | -2.64 ± 2.64             | p = 0.125                |
| Group II (PI)  | 16.48 ± 9.16     | 14.60 ± 9.01             | p = 0.032                |

PI: patellar instability; PFPS: patellofemoral pain syndrome.

**Table 3.** Patellofemoral index in both groups before and after rehabilitation, expressed in terms of the index's value

|                | Patellofemoral index |                          | Statistical significance |
|----------------|----------------------|--------------------------|--------------------------|
|                | Initial              | Following rehabilitation |                          |
| Group I (PFPS) | 1.9440 ± 0.6669      | 1.8656 ± 0.5986          | p = 0.001                |
| Group II (PI)  | 3.2972 ± 0.9821      | 3.1984 ± 1.0091          | p = 0.004                |

PI: patellar instability; PFPS: patellofemoral pain syndrome.

of vital importance, for which reason the hamstrings must also be treated. Also stretching of the peripatellar musculature should be included so as to avoid a poor recentering of the patella during knee flexion and extension.

We think it is logical for patellar height not to undergo any changes during rehabilitation since it is a parameter that depends on the length of the patellar tendon, which is variable in every individual (the average is 4.6 cm, with a range between 3.5 and 5.5 cm<sup>11</sup>), but very difficult to modify during rehabilitation; it determines the vertical position of the patella, i.e. its height in relation with the joint line.

Although x-ray inclination is a parameter that given its qualitative nature and the possibilities considered (inclined or non-inclined patella) could be useful in differentiating normal from pathological subjects, we believe that it is not sensitive enough to changes, which means that the changes that occur need to be extremely significant to be visible on the x-ray.

As is the case with radiographic patellar inclination, the opening of the patellofemoral angle, regarded as pathological or not, could be useful to identify an abnormal patella, but it will not be sensitive enough to distinguish the 2 types of pathology studied or to show the evolution obtained following treatment.

We have seen that the rehabilitation program exerts an influence on the patellofemoral index, which improved in both groups. We consider that, given its numerical character, it is a much more sensitive parameter than the previous one to assess patellar inclination. As we stated in our earlier

work<sup>2</sup>, the patellofemoral index is the measurement with the highest discriminating capacity between healthy and unhealthy subjects, so that after establishing a cut-off point at the 1.6 mark, we found in a previous study a sensitivity rate of 0.92 and a specificity rate of 1.00.

We believe that the congruence angle is a good indicator of lateral patellar displacement and can accurately differentiate between patients with a simple PFPS and those with patellar instability<sup>2</sup>. We have seen how physical therapy significantly improves the magnitudes in group II, i.e. it helps center the patella in the femoral sulcus. However, more studies are needed to ascertain as from what values such improvement can be predicted.

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### REFERENCES

1. Ruiz-Iban MA. Patología patelofemoral intrínseca. Valor predictivo de la radiología simple. *Avances de Traumatología*. 2005;35:51-7.
2. Rosales Varo AP. Patología patelofemoral intrínseca. Valor predictivo de la radiología simple. Tesis Doctoral. Facultad de Medicina: Universidad de Granada; 2002.
3. Kramer PG. Patella malalignment syndrome: rational to reduce excessive lateral pressure. *J Orthop Sport Phys Ther*. 1986; 8:301-9.
4. Bennet JG, Stauber WT. Evaluation and treatment of anterior knee pain using eccentric exercise. *Med Sci Sport Exerc*. 1986;18:526-30.
5. Knight K. Rehabilitating chondromalacia patellae. *Physician Sport Med*. 1979;7:147-8.
6. Caton G, Deschamp G, Chambat P, Lerat JL, Dejour H. Les rotules basses: á propos de 128 observations. *Rev Chir Orthop*. 1982;68:317.
7. Maldague B, Malguem J. Apport du cliché de profil du genou dans le despistage des instabilités rotuliennes: rapport préliminaire. *Rev Chir Orthop*. 1985; 71 Supl 2: 5.
8. Merchant AC, Mercer RL, Jacobsen RH, Cool CR. Roentgenographic analysis of patello-femoral congruence. *J Bone Joint Surg Am*. 1974;56A: 1391.
9. Laurin CA, Dussault R, Levesque HP. The tangencial X-Ray investigation of the patellofemoral joint: X-Ray technique, diagnostic criteria and their interpretation. *Clin Orthop*. 1979;144:16.
10. The Cochrane Library, Issue 1. Chichester, UK: John Wiley & Sons, Ltd; 2004.
11. Reider B, Marshall JL, Koslin B, Ring B, Girgis FG. The anterior aspect of the knee joint an anatomical study. *J Bone Joint Surg Am*. 1981;63A:351-6.

### Conflict of interests

The authors have declared that they have no conflict of interests.