3 Examination of the Patients with Patellofemoral Symptoms

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Patellofemoral disorders can range from traumatic injuries, instability or those leading to patellofemoral pain syndrome (PFPS). PFPS is one of the most common diagnoses in patients complaining from anterior knee pain. The cause of pain is multifactorial, can be idiopathic with an incidence between 15 and 25%. A manifold of risk factors has been proposed [1, 2], but only a few shows significant association with patellofemoral pain, including quadriceps weakness and hip abduction strength [2]. A detail medical history and a structured physical exam will help to reach a more accurate diagnosis. In this chapter we present step-by-step examination of patients with patellofemoral symptoms.

3.1 Examination

The exam of the patellofemoral joint can be challenging and we have to consider all the contributing factors. Examination has to be accurate and comprehensive to correctly identify the most suitable treatment. However, examination findings are often subtle and poorly reproducible and not always related to the patient symptoms. There

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is no single definitive test used to diagnose PFPS [3].

The experience of the clinician is essential to understand what is considered normal and what is pathologic. Physical examination is examiner-dependent [4–8] and can be influenced by many factors including the patient level of pain.

3.1.1 Clinical History

It is important to collect a detailed and comprehensive clinical history. Critically listen to the patients and ask the appropriate questions. The mechanism of injury, location, situations aggravate or alleviate symptoms [4, 9–11]. Rule out other symptoms like weight loss, erythema, or other unusual findings [12] find any other relying medical problem. Review the patient's daily living and sports activities as these may be related to the symptoms, and sometimes modifying these activities may help to solve the problem.

Patellofemoral disorders can range from traumatic injuries (patella dislocation or fracture), instability (patellofemoral instability) or those leading to PFPS.

Traumatic injuries are inherently acute and most often painful. Most commonly these include patellar fractures and dislocations. Clinician should suspect if the patient reports a fall with direct trauma during activity and need to be referred for imaging assessment. In these cases, it is not unusual to find osteochondral injuries or bony contusions.

Patients with patellofemoral instability often describe giving away or slipping symptoms, with not necessarily a previous traumatic injury. In these patients, the clinician should look for history of patellar dislocation and anatomic risk factors.

PFPS may be caused by different conditions, including but not exclusive to patella or trochlear chondral or osteochondral lesions and excessive lateral pressure syndrome. Sometimes the source of pain is idiopathic and the clinician should look for other potential predisposing factors. In compressing syndromes, pain aggravates while squatting, during long periods of time of knee flexion or after sitting a long time and then standing. In acute conditions the patient will report pain for both ascending and descending stairs. In more chronic cases the patient will elicit pain only when ascending. The concentric contraction of the quadriceps muscle during ascending stairs does not cause pain; however, eccentric contraction while descending increases compressive load to the joint [11]. Patella or trochlear chondral or osteochondral lesions are a common cause of patellofemoral pain and may derive from previous trauma. As these lesions are located at the patella or trochlea are subjected to contact pressure during activities which will elicit pain. Common signs and symptoms are intermittent inflammatory knee effusions and painful weight-bearing or impact activities (e.g., landing). Common risk factors associated with patellofemoral cartilage lesions include trochlear dysplasia, patella alta, and excessive lateral patellar tilt [13]. In these cases, the clinician should ask for imaging study to confirm or rule out chondral/osteochondral lesions.

3.1.2 Physical Examination

The physical examination should follow a structured and systematized approach. There are many clinical tests and scores available for the examination of the patellofemoral joint [6, 7]. Most of tests are assessed qualitatively (rather than quantitatively) and not supported accuracy and/or validity for the existent methods.

3.1.2.1 Static Evaluation

Effusion, erythema, increased local temperature can suggest infection, acute trauma, or inflammatory arthropathy. Numbness related to previous procedure, scars, or portals can suggest the presence of neuromas [14]. Palpate the distal quadriceps muscle and tendon, also iliotibial band. Examine the knee in extension and in flexion, move the patella to evaluate physiological movements and displacements.

Fig. 3.1 Observe the patient standing and barefoot, check changes in the skin and alignment

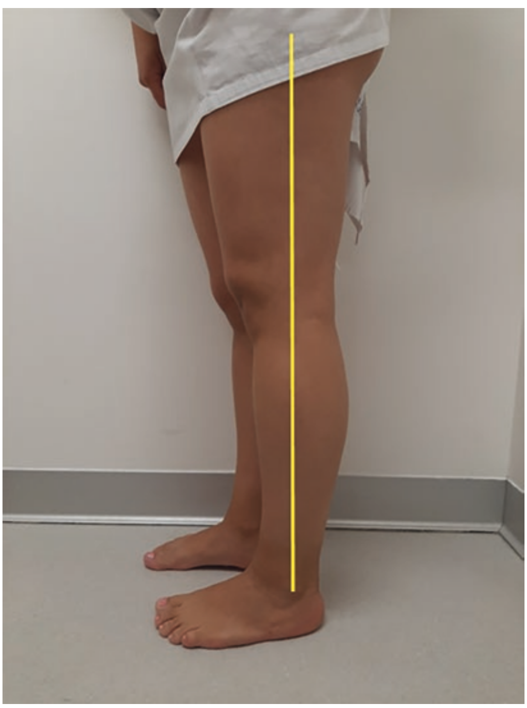

Fig. 3.2 Observe the presence of recurvatum

With the patients standing, examine the three planes, the patient's gait (barefoot and with footwear), posture, and footwear to try to identify potential contributing causes. Observe dystrophic changes, skin color, scaring tissue, scratches or rashes, barefoot gait, and excessive subtalar pronation [15]. Examine limb alignment, both frontal (varus/valgus) and sagittal (flexum/recurvatum). Genu valgus indicates a larger lateral force which leads to maltracking and subluxation, coxa vara also produces genu valgum [11]. Evaluated the patella position to determine its internal or external rotation, the presence or the bayonet sign or excessive external tibial torsion, the presence of tibia varum and the foot to check a midtarsal or subtalar joint position dysfunction (Fig. 3.1) [11].

In the lateral view look for genu recurvatum or flexion contracture (Fig. 3.2). Hyperextension (recurvatum) can indicate hyperlaxity. The Beighton score to test is applied for hypermobility evaluation [16]. An excessive recurvatum is related to Hoffa's syndrome caused by the impingement of the fat pad. Quadriceps weakness can also be present in hyperextension. However, flexion contracture can be caused by trauma, post-surgery, or excessive hamstrings tightness. In the lateral view you can evaluate the camel sign as well with the knee presenting two striking bulges: one represents the tibial tuberosity, the other one the patella.

The transverse plane or anterior view is the best for evaluating femoral rotation. The clinician must differentiate if the rotation is due or not to foot pronation. Check atrophy of the quadriceps can cause strength loss and consequently knee hyperextension. Check for any discrepancy in patella length or height. Patellofemoral instability is more frequent related to patella alta as chondromalacia with patella baja. Palpate the patella during knee flexion and extension, and search for crepitation. Crepitation near full extension suggests distal patellar cartilage lesion, and in flexion proximal patellar cartilage lesion [17].

Fact Box 1

The **static evaluation** should include the assessment of:

- The quadriceps angle (Q angle)
- Limb discrepancy
- Supine position
- Sitting position
- Foot posture

3.1.2.1.1 The Quadriceps Angle (Q Angle)

Is the angle formed by a line from the anterior superior iliac spine to the mid- patella intersecting with a line from the mid patella to the tibial tubercle with the knee in full extension. The average for males is 10–13° and 15–17° for females [11, 18]. The patella has a natural tendency to track laterally during knee flexion-extension movements [19]. An increase angle can indicate abnormal patellar tracking. It is important to interpret this angle with caution and check for hip rotation [18]. Also check for the direction of the patella; a medial orientation is indicative of a "winking" patella due to femoral excessive anteversion, with tibial external rotation and a compensatory hind foot valgus, causing the forces to dislocate the patella laterally. Despite the different techniques to calculate the Q angle, the clinical utility cannot be supported [20]. It is not considered a risk factor to develop patellofemoral pain. The relation between sings is not consistent [21].

3.1.2.1.2 Limb Discrepancy

Assessment of limb discrepancy should be performed in the standing weightbearing position to identify any potential predisposing or compensatory pattern. Differences of leg length produce gait asymmetry and contribute to increase the stress of the joint [22]. Measure from both anterosuperior iliac spines into the corresponding medial malleolus. More than 1.5 cm of difference is pathologic and can be the cause of anterior knee pain [11, 12]. Measurement of limb discrepancy can also be done with the patient supine or using the Weber-Barstow method [11].

3.1.2.1.3 Supine Position

Start by palpating the knee to search for effusion or tenderness. With the knee flexed at 90 degrees, palpate quadriceps and patellar tendons. Tenderness over the tibial tubercle suggests osteochondritis in younger patients. Palpate the fat pad against the femoral condyles and pain is indicative of Hoffa's syndrome. Pain located in lateral or medial retinaculum may be indicative of previous dislocation (Fig. 3.3). Test the knee range of motion compared to the contralateral limb. Check for any extension deficit in active motion to evaluate any disorder of the extensor mechanism. Evaluate crepitus for chondral damage or impingement of the peripatellar soft tissues as anterior fat pad, plica, or synovial hypertrophy [23].

3.1.2.1.4 Sitting Position

When the patient is sitting a second inspection is made to examine the quadriceps bulk. Check again the tracking of the patella. A laterally tilted patella (grasshopper eye sign) [10] indicates weakness of the vastus medialis obliquus (Fig. 3.4). The patella height can be estimated in the seated position, with the proximal pole of the patella normally found at the same height as the anterior cortex of the distal femur (Fig. 3.5). The tibial tubercle sulcus angle is then determined by drawing a vertical line from the center of the patella tendon to the center of the tibial tubercle. An imagine line is then drawn perpendicular to the femoral epicondyle axis. The angle is determined where these two lines subtend each other. At 90 degrees of flexion, the patella should be centrally located in the femoral sulcus, and the tibial tubercle sulcus angle should be zero [24]. Always examine meniscus and ligaments to rule out associate injuries.

3.1.2.1.5 Foot Posture

Foot posture can be assessed with the patient standing and during gait. Excessive pronation can be cause by flatfoot, flattened medial longitudinal arch or a valgus hindfoot can be assessed. Feiss line and the medial longitudinal arch angle are other methods that have been described to identify a static pronated foot [11].

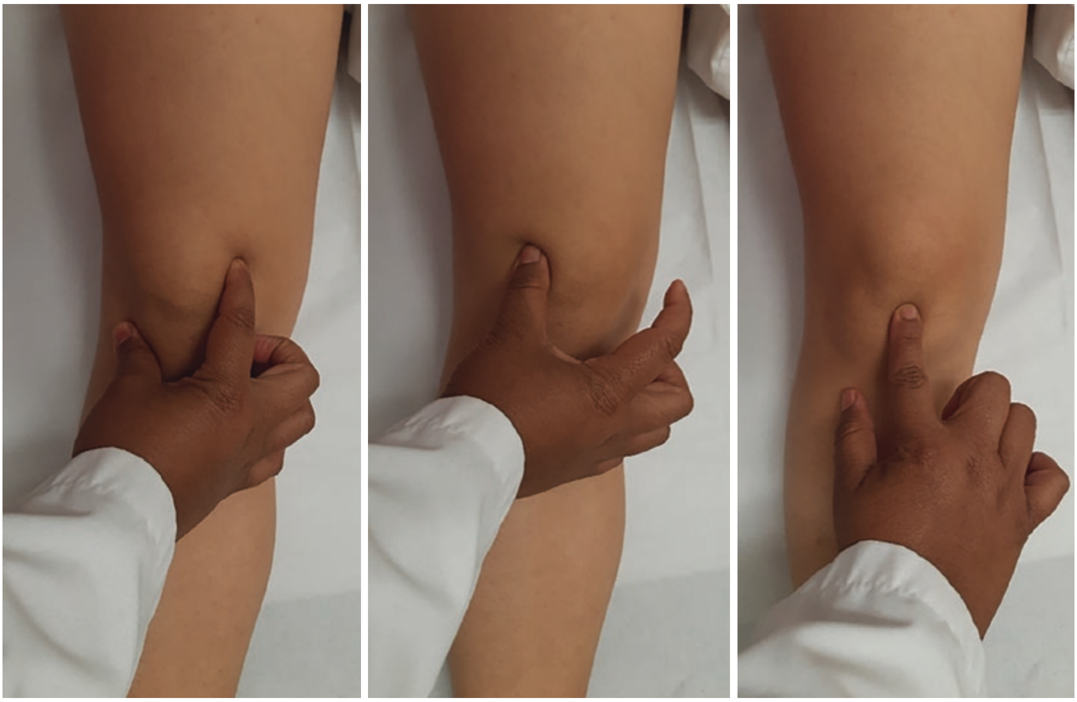

Fig. 3.3 Examine medial, lateral retinaculum, patellar tendon and fat pad

Fig. 3.4 Grasshopper eyes sign

3.1.2.2 Dynamic Evaluation

Ask the patient to walk naturally, and also backwards. Observe the gait and check any limping that can indicate pain, length discrepancy, or motor weakness. If the patient is an athlete, simulate running and jumping conditions.

> **Fact Box 2**
> The **dynamic evaluation** should include the assessment of:
>
> - Patellar tracking
> - Step-Down Test
> - Single-Leg Squat
> - Two-leg jump test
> - Single-leg hop test

3.1.2.2.1 Patellar Tracking

Evaluated passive and active knee range of motion. The patient is asked to extend the knee

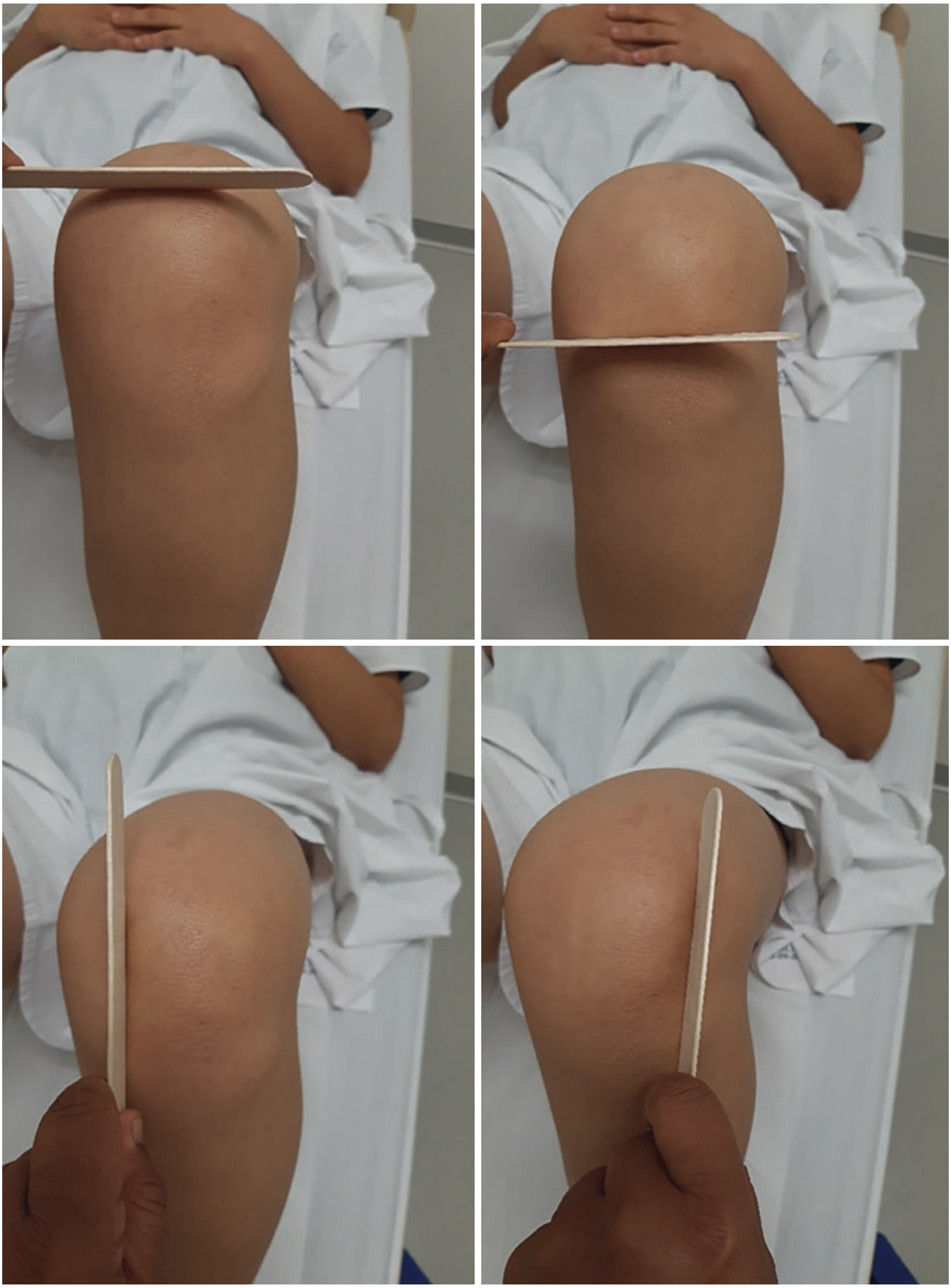

Fig. 3.5 Observe and palpate superior, inferior, medial and lateral border

from 90° to full extension. A normal patella has to move a little medial and then laterally back to the neutral position.

Observe the tracking for the presence of the J-sign. This is a pathological inverted J-path when the patella is in early flexion as the patella begins laterally subluxated and then shift medially to engage the femoral groove [25]. Occurs between 20 and 30 degrees of flexion to full extension which is the position that most subluxation events occur. A lateral J-sign or abrupt lateral deviation near terminal extension during an active quadriceps' contraction may be indicative of a dysfunctional vastus medialis obliquus muscle (Fig. 3.6).

3.1.2.2.2 Step-Down Test

To evaluate hip stability and lower-limb strength. The patient should stand in a box, with arms folded across the chest and squat down on one limb 5 to 10 times. The patient has to maintain the balance at least 1 squat per 2 s. Abnormal test can indicate decreased onset timing of the gluteus medius, decreased hip abduction torque, and decreased lateral trunk strength.

Fig. 3.6 "J" sign

3.1.2.2.3 Single-Leg Squat

The single-leg squat is one of the best tests for patellofemoral pain as 80% of these patients display positive sign [3]. It evaluates the dynamic hip and quadriceps strength [3] and can evidence abnormal movement/postural patterns such as increased ipsilateral trunk lean, contralateral pelvic drop, hip adduction, and knee abduction [26].

3.1.2.2.4 Two-Leg Jump Test

This test prepares the patient for the concentric propulsive push-off motion and the eccentric deceleration landing phase, performed in four gradients (25, 50, 75, and 100%) to prepare for the rest of the tests [11]. Observe any asymmetries during landing phase.

3.1.2.2.5 Single-Leg Hop Test

There are several single-leg hop tests that can be used, including single hop for distance, triple hop for distance, triple crossover hop test for distance, medial side triple hop test, 90° rotation hop test, and 6-m timed hop test. It is important to test both limb three times and check for any bilateral asymmetry.

3.1.2.3 Special Tests

There are many references regarding the evaluation of the best test for the patellofemoral disorders, with inconclusive results, Nunes et al. [3] describe in a meta-analysis that there is no test with good diagnostic accuracy which is able. Also, Smith et al. [7] describe about the interobserver reliability is poor and intra-observer is moderate, and suggest the standardization of physical exam assessment. In another systematic review, Cook et al. [27] conclude that the tests that demonstrated the best diagnosis accuracy were the active instability test, pain during stair climbing, Clarke's test, pain during prolonged sitting, inferior pole tilt, and pain during squatting. Nevertheless, this requires careful considerations. The majority of the studies demonstrate quality bias and the best test for PFPS is still unknown.

Fact Box 3

The **special tests** can help to reach a more accurate diagnosis and help to rule out some potential sources of pain, and these should comprise:

- Patella glide
- Apprehension or Fairbank test
- Patellar tilt test
- Compression test
- Clarke's test or patellar grind
- The gravity subluxation test
- Flexibility tests

3.1.2.3.1 Patella Glide

In this test, the patella is forced medially and laterally as its medial and lateral dislocations are evaluated. It is performed at full extension and then at 20 degrees of knee flexion to assess the integrity of the medial and lateral restraints. In full extension, the patella is out of the trochlea sulcus and at 20° of knee flexion is engaged within the sulcus. If it is positive at 20 degrees of flexion, it has to be retested at 45 degrees of flexion. Any instability is not normal and can be associated with patella alta.

The patella is divided horizontally into quadrants, moving the patella 50% of its width is two quadrants. A positive test is a movement of three quadrants or more in either direction. Less of a quadrant indicates tightness [18] (Fig. 3.7).

Fig. 3.7 Patellar Glide test

3.1.2.3.2 Apprehension or Fairbank Test

Is a test to detect patellar lateral instability. Performed in two parts, first (provocation) the knee in full extension, apply a lateral force with the thumb of the clinician, then move the knee from full extension to 90 degrees of flexion and then back while keeping the force. The second part (relief) is repeat the first part with the force applied medially [28]. Positive is the oral or facial expression of apprehension when the patient experiences a sense of undeniable dislocation or popping out of the position [28]. This test has a sensitivity of 100%, specificity of 88.4%, predictive positive value 89.2%, and predictive negative value 100% (Fig. 3.8).

3.1.2.3.3 Patellar Tilt Test

This test evaluates the lateral retinaculum tightness, represents a short retinaculum, and is related to an increased lateral tension. It is a negative test if the lateral border cannot be elevated above the medial one [24]. The patella at 30–40 degrees of flexion creates a tightness of the deep retinacular fibers that no tilt appears.

The test is performed with the knee in full extension, while the clinician is on the lateral side of the knee to be tested. The patella is pushed posteriorly on the medial border while pulling anteriorly with the thumbs under the lateral border to assess whether the patella corrects its tilt to at least neutral. If the patient's patella is unable to tilt back

Fig. 3.8 Apprehension or Fairbank test

to neutral, it is indicative of excessive lateral tightness and the potential to have excessive lateral pressure syndrome [11]. Normally, the patella should tilt 15°. Compare both limbs for symmetry.

3.1.2.3.4 Compression Test

To assess arthritis or chondral injuries, the knee in full extension and the patella are directly compressed as the knee is flexed. Positive test is when the compression elicits pain (Fig. 3.9).

Fig. 3.9 Compression patellar test

3.1.2.3.5 Clarke's Test or Patellar Grind

The patella is compressed against the trochlea while the patient contracts their quadriceps. A positive test is the exacerbation of the pain and is confirmatory for chondromalacia. However, it has low sensitivity and specificity and a high rate of false-positive cases [29].

3.1.2.3.6 The Gravity Subluxation Test

Performed with the patient in side lying with the suspected leg abducted in the air. Then the quadriceps contracts. A positive test is the inability to pull the subluxate patellar lateral in the trochlea groove and indicates laxity of the lateral retinaculum [30].

3.1.2.3.7 Flexibility Tests

Evaluate tightness of quadriceps and hamstrings (Fig. 3.10). Thomas test is used to evaluate the rectus femoris and iliopsoas tightness, Ely's test for quadriceps flexibility, and Ober's test for iliotibial band tightness. Keep on mind to evaluate hip and foot. During the exam the clinician has to determine which restraints are deficient or not.

Fig. 3.10 Evaluations of the tightness of quadriceps and hamstrings

Fig. 3.11 Evaluation of the iliotibial band and hip muscles

The exam has to be done in supine and prone position, in which the examiner can evaluate quadriceps tightness and abnormal rotation of the hip that sometimes could be the reason for the pain. Lying on the side can evaluate iliotibial band (Fig. 3.11).

3.1.2.4 Instrumented Assessment

Several instrumented laxity devices have been proposed for the patellofemoral joint, but showing heterogenous results [31]. In our experience we use the Porto Patella Testing Device (PPTD) to measure the patellofemoral joint laxity combined with magnetic resonance imaging or computed tomography scanning. The PPTD applies lateral-directed stress (at 30°) or a posterior-directed stress (at 70°) to test the lateral translation and external tilt laxity, respectively. The assessment using the PPTD has shown to be valid in assessing the patellofemoral joint laxity and more reliable than manual physical examination [5]. The device is a useful tool to assess patellar movement in patellofemoral conditions including patellofemoral pain [32, 33] and instability [33] .

Take Home Message

- The patellofemoral joint is the most complex area of the knee. It is important to know its anatomy and biomechanics in order to establish an adequate diagnosis.
- Understanding contributing risk factors, not only the local, but also the proximal and distal factors, can enhance the understanding of patellofemoral disorders causes and improve diagnostic.
- It is important to follow a systematic and structured examination and correctly identify the causes of pain.

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