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Lower Limb Kinematics Factors in Patellofemoral Pain Syndrome

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Abstract

The scientific literature brings us new elements on the management of femoropatellar pain syndrome in rehabilitation. Indeed, the modification of the functional axes of the knee induced by neuromotor deficits (hip abductor moment) make it a systemic pathology of the lower limb. The disruption of the dynamic alignment (malalignment) of the lower limb associated with patches of maltracking causes us to think about a more objective evaluation in order to determine the factors responsible for patellar pathologies and thus to optimize our holistic approach of patient.

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Introduction

The patellofemoral syndrome (PFS) is a very common physical therapist consultation and affects the sedentary as well as the sporting person. For foot runners [1], for example, it represents 16 to 25% of injuries and more generally it accounts for 25 to 40% of knee pathologies in sports medicine with an increased risk for women (RR: 1,6) [2]. The PFS evolves towards a chronic pathology in 70 to 90% of the cases [3].

Etiology

Many authors agree on the establishment of intrinsic and extrinsic risk factors. Among these, there are three main categories of risk factors namely bone, tissue and muscle [3-5].

Among the bone factors, dysplasias of the femoral trochlea or patella are observed. In this case, it is sometimes difficult for the practitioner to obtain results given the improper repair of stresses and biomechanical pathophysiological phenomena of involvement of the patella in the femoral troche (found in the literature under the term maltracking).

Tissue factors are often evidenced by hypoextensibility of lateral retinaculum leading to patellar mobility deficit. Hyper-laxity of the ligament and fascial complex of the knee are also objectified and then at the origin of pathological patellar hyper-mobility. The practitioner cannot have a direct effect on these tissue factors, but rather an effect of active compensation developed further.

As for the muscular factors, they constitute, according to the authors, a preponderant part in the origin of the PFSs. There are deficits in strength of the muscles of the anterior and posterior compartments of the thigh as well as the posterolateral hip area [6]. In addition, the subjects have muscle hypo-extensibility of the polyarticular muscles of the lower limb such as the right femoral muscle, the hamstrings and the triceps sural. Authors have described neuromuscular disorders with delayed contraction of the vast medial oblique to the vast lateral quadriceps. This same contraction delay is also present at the hip lateral box.

These different factors do not allow the correct alignment of the patellofemoral joint, as evidenced by the measurement of an increased Q angle greater than 20°, knowing that an increase of 10° increases the patellofemoral stresses 45% [4,7]. An imbalance in the biomechanical alignment of the lower limb, which is not centered on the knee joint but rather in its entirety, can also generate a patellofemoral syndrome. A dynamic assessment should therefore be considered in order to objectively highlight patellofemoral pathology.

Patellar Movements

Recent advances in the quantified analysis of motion (QAM) allow us to establish by functional methods (more reliable and reproducible than predictive methods) axes in 3 dimensions; these make it possible to model the movement within a joint. If the patellar movements are made of flexion, inclination and rotation, the studies of Yao [8] make it possible to highlight in a precise way the quantification of the patellar movements with respect to a movement of flexion / extension of the knee.

These results highlight two angular sectors that correspond to the involvement of the patella in the femoral trochlea (0-40°) and the patella slip within this trochlea. These two areas make it possible clinically to determine whether it is a patellar defect and / or hyperpressure of the patella on the cartilaginous zone of the femur.

In addition, the "L-Shaped" modeling of the helical axes (functional axis) of the patella shows a change of plane from 40° of knee flexion. The plane changes of the helical axes are often correlated with maximum stresses at the joint. It is therefore understood that the patellofemoral stresses will be maximal from the end of patellar engagement up to 90° and that any alteration of patellar engagement will potentially increase the constraints on this articulation.

The work of Van Den Bogaert [9] and Robinson / Vanrenterghem [10] shows that during a movement of flexion / extension of the knee in healthy individuals' helical femoro-tibial axes is parallel to the

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patellofemoral axes in all respects movement. The modification of the femoro-tibial helical axes will consequently disturb the movement of the femoro-patellar helical axes justifying the increase of the mechanical stresses during the rotatory moment peaks (between 40° and 90° for the patellofemoral and 35° and 80° for the femoro-tibial). The study of Glaviano and Saliba [11] shows an alteration of the femoro-tibial helical axes in the frontal plane with an increase of the adductor moment, which will confirm the work highlighting the patellofemoral syndrome as a pathology before any femoral and not patellar, secondary to deficit of the hip abductor.

Isokinetic Muscle Profile

A quadriceps force deficit of 20 to 30% is usually found in relation to the asymptomatic side. This deficit of force can be explained either by a painful inhibition (which does not correspond to a loss of objective force) or by a non-painful inhibition (loss of objective force) [12,13].

The fatigability tests performed on a series of 15-20 contractions at 240°/s show a resistance index (percentage of loss of strength between the last and the first contraction of the test for the muscle considered) which collapses. The quadriceps thus has deficiencies in strength and endurance that will be detrimental to the patellofemoral joint during the sporting effort. Similarly, the subject has difficulty maintaining a concentric contraction of the quadriceps with crepituses present during the eccentric contraction of the quadriceps.

Hip Abductors and Hip Extensors

If the gold standard in rehabilitation was the strengthening of the vast medial, the fact remains that many authors have shown a deficit of hip abductors in patellofemoral pathologies.

Lack [6] shows a 55% decrease in the strength of the hip extensors compared to an asymptomatic population after 400 ms, this decrease in the strength of the extensors would reach 67% around 1500 ms. Similarly, there is a 33% decrease in hip abductor strength from 150ms.

In addition, De Sousa [16], Powers [4,7] and Pattyn [17] disassembled the contraction delay of hip abductors compared to a control group in a population with PFS. On the other hand, this delay is not demonstrated for the vast medical oblique.

This significant muscular deficit would then lead to a dynamic valgus with lateralization of the pelvis, adduction and medial rotation of the femur, abduction and lateral rotation of the tibia and pronation of the hindfoot [18-22]. Associated with this kinematics, one finds in most cases a patella alta, and a recurvatum of knee testifying of a hypoextensible quadriceps [23,24].

Foot Influence

Recent studies highlight a link between foot kinematics and PFS. Indeed, the femur adduction peak that we evoked above is correlated with the e-version of the hindfoot [25]. Similarly, wearing orthopedic insoles for 6 weeks improves the walking regimen in patients with PFS [26]. The orthopedic insoles modify the resultant of the forces during the support on the ground and consequently modify the moment of force in the sagittal plane of the knee [27]. The Tan study [28] also shows a decrease in foot mobility in PFS patients. The mobility gain of the foot will therefore be an element to be taken into account in the rehabilitation of the PFS.

Crepitus

During the interrogation, the crepitus is a complaint often mentioned by the patient. Crepitus representations are often wrong. The latter are perceived as a danger for the patellofemoral joint and considered as cartilaginous destruction, early osteoarthritis phenomenon or impotence to sports activity.

However, the state of the art of literature tells us something else. Indeed, Robertson's study [29] does not establish a significant link between pathology and crepitus. This study confirms the results obtained by Mc Coy [30] who showed that 99% of patients whose knees cracked did not present pathology. This crepitus is linked to a gaseous vacuum in the synovium during articular displacement. In no case would it increase the risk of osteoarthritis [31] and would even be a positive sign of mobility and lubrication [30,32].

Rehabilitation Indications

The recent publication of Collins [33] based on an international scientific consensus reviews the techniques that have shown their effectiveness in the PFS. Among the favorable elements are muscle strengthening of the hip (middle and upper buttocks) and knee (quadriceps, hamstrings, triceps sural), increased mobility of the foot and patella, and neuromotor rehabilitation. Electrotherapy (analgesic or muscle strengthening), mobilizations isolated from the spine and knee, acupuncture, dry needling and splints (flexible or rigid) have not shown efficacy in the PFS to date.

Conclusion

The rehabilitation of the PFS remains a rather controversial topic. The evidence from the clinical research and the QAM show, however, the important role of muscle control played by the hip on the kinematics of the lower limb. The rehabilitation of the PFS is based on a holistic approach of the patient aiming to improve the kinematics of the lower limb as a whole (hip, knee, foot) while trying to regulate kinesiophobia related to daily activities and sports.

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Competing Interests

The author declares that they have no competing interests.

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