

Are Kinematic and Kinetic Analyses Useful to Evaluate Patellofemoral Disorders in the Clinical Practice?

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Abstract

Current methods for the assessment of the outcome after anterior knee pain or lateral patellar instability treatment have several limitations, for example their subjectivity. Therefore, new technologies are needed to objectively evaluate the outcomes of treatments for patellofemoral disorders. Kinematic and kinetic analyses during dynamic activities under realistic loading conditions that trigger or aggravate the symptoms can: (1) evaluate the patellofemoral patient in an objective way before surgery; (2) analyse the defense mechanisms the patient develops in order to reduce pain and/or instability; (3) improve our knowledge of the aetiopathogeny and therefore of a suitable treatment for patellofemoral disorders; and (4) objectively evaluate the result of the treatment. However, the kinetic and kinematic analyses are not diagnostic tools.

Keywords: Patellofemoral; Kinetic; Kinematic

Introduction

Current methods for the assessment of the outcome after anterior knee pain (AKP) or lateral patellar instability treatment have several limitations, for example their subjectivity. Therefore, new technologies are needed to objectively evaluate the outcomes of treatments for patellofemoral disorders and also to compare different methods of treatment. The ideal situation would be to evaluate these patients during dynamic activities that trigger or aggravate the symptoms (i.e., pain and/or instability), under realistic loading conditions. We believe that this objective could be reached by means of kinematic and kinetic analysis. The aim of this paper is to analyze the two main reasons for consultation in patellofemoral disorders (i.e., pain and instability) in our daily clinical practice from a kinematic and kinetic point of view emphasizing on the clinical relevance of our biomechanical findings.

Anterior knee pain

AKP is the most frequent cause of consultation among knee pathologies [1]. There are many causes of AKP. Although not frequent, one of these causes is the medial patellar instability (MPI). MPI is an objective pathological entity with its own personality that causes severe AKP and great disability [2]. In most cases, this entity is a sequela of a previous lateral retinacular release, either incorrectly indicated or poorly performed [2]. This pathologic condition sets off many changes in the knee's biomechanics and many defense strategies. Moreover, these patients have been evaluated by multiple physicians until reaching the final diagnosis, and quite frequently legal issues and compensations are involved. Therefore, it would be interesting to establish an objective baseline prior to a new surgery. Moreover, an objective assessment during the post-operative follow-up would also be interesting. All of the aforementioned reasons have led us to

choose this clinical entity as the paradigm of biomechanical evaluation in the patient with AKP.

Our preferred test to evaluate AKP patients is the stair descending test; because this activity is the most demanding of all the daily living activities for patients with patellofemoral pathology since it requires considerable control in the quadriceps contraction excentric phase [3]. This test can trigger pain, aggravate it and also set off defense mechanisms. In this test, kinetic and kinematic analyses are combined.

In patients with MPI, kinematic analysis shows typically a stair descending pattern with knee extension, which can be interpreted as a strategy to avoid instability and therefore pain. How can we explain from a clinical point of view this kinematic finding? In MPI patients there is a sudden giving way much more disabling than a true lateral subluxation that is the result of the patella going from medial to lateral with knee flexion. Therefore, the patient will avoid knee flexion. After a successful treatment the knee flexo-extension pattern is corrected [4,5]. In some cases of MPI patients this knee extension pattern has been also found with less demanding activities such as gait [4]. But this kinematic finding is not specific to MPI, it is also observed in other AKP patients. The knee extension pattern will also make the posterior chain muscles of the lower limb work chronically in an excentric mode, which will lead to pain in the posterior aspect of the knee. This finding is quite frequent in AKP patients. On the other hand, the stair descending with knee extension will reduce the extensor moment of the knee, as it has been shown by kinetic analysis, with the subsequent reduction in quadriceps contraction (i.e., quadriceps avoidance gait pattern) and therefore a reduction of the patellofemoral reaction force [6]. The goal would be to reduce pain. After a successful treatment the extensor moment is also corrected [5]. But this kinematic finding is not specific of MPI, it is also observed in other patients with patellofemoral disorders. Last but not least, another factor for the reduction of the knee's extensor moment is the reduction of the stance phase or the decrease of the vertical ground reaction force compared to the healthy

limb [7,8]. We have found that when a patient goes down the stairs using his/her strategy for maximum comfort the extensor moment is lower than when the stair descent is performed following standard protocol [8].

Another kinetic finding is the reduction of the abductor moment which could be interpreted as a defense mechanism reducing the valgus vector and therefore reducing lateral patellar translation [8]. This reduction of the external abductor moment translates into a reduction of the strength exerted proximally by the medial collateral ligament [9]. This causes a reduction of the tibiofemoral compression forces both laterally and medially [9]. We have found this in almost all cases in patients with AKP. We have found that when the patient goes down the stairs with his/her best comfort strategy the abduction moment is lower than when he does it following a standard protocol, thus confirming that the decrease in the abductor moment is a defense strategy [8]. The final goal of these defense mechanisms is to reduce pain. After a successful treatment the abduction moment is corrected [8]. However, in some AKP patients, we have found an increment of the abductor moment. The increment of the knee abduction moment would cause a lateral tibiofemoral overload.

But the more relevant question is: Is there a good correlation between normalization of the kinetic and kinematic parameters and the clinical improvement? After reconstruction of the lateral retinaculum in MPI patients we have observed a progressive increment of the extensor moment [5]. However this correction is not complete, which could be interpreted as a defense mechanism preventing patellofemoral osteoarthritis. But this defense mechanism can be harmful in the long-term since the loss of load absorption by the quadriceps due to its atrophy will produce an overload of the tibiofemoral joint [8]. This could contribute to the development of a tricompartmental arthrosis of the knee. We can conclude that biomechanical analysis helps us to understand some of the mechanisms behind the development of knee osteoarthritis in patellofemoral disorders.

Chronic lateral patellar instability

For a long time the Fairbanks patellar apprehension test has been used from a clinical standpoint to reproduce the patella's dislocating process and its subsequent symptoms in patients with chronic lateral patellar instability. However, Sallay et al. [10] found that only 39% of patients who sustained chronic lateral patellar instability had a positive apprehension test. To help achieve greater diagnostic accuracy Ahmad et al. [11] described the "moving patellar apprehension test", a dynamic provocative test similar in concept to the pivot shift test for anterior cruciate ligament (ACL)-deficient knee. This test has a sensitivity of 100%, a specificity of 88.4%, a positive predictive value of 89.2%, a negative predictive value of 100%, and an accuracy of 94.1% [11].

But another way to evaluate this problem would be to analyse the "avoidance behaviors" the patients use as protection strategies against dislocation, when we ask him to perform a movement that may produce a lateral patellar dislocation [12]. As we have demonstrated in a previous study, kinetic analysis using dynamometric platforms, allows us to evaluate under realistic loading conditions the "avoidance behavior" of the knee in patients with a rotational instability secondary to an ACL-deficient knee [13]. Moreover, we have shown that the rotational moment at the knee nearly coincides with the moment calculated at the dynamometric platform, which validates the use of dynamometric platforms for this type of studies [14]. The method that we are proposing to evaluate lateral patellar instability, is similar to the

one previously used to evaluate rotational instability in the patient with a chronic ACL tear [13]. The test we have used to trigger an "avoidance behavior" is the jumping with pivoting with external tibial rotation task, because the pivoting phase of this test reproduces the pathomechanics of a lateral patellar dislocation. Therefore during this phase of the test the patient with chronic lateral patellar instability in theory will develop "avoidance behaviour". In Figure 1 we can see the curve representing the normalized moments produced on the dynamometric platform during a pivoting with external tibial rotation task. In theory, as occurs in the ACL-deficient knee, the patient with chronic lateral patellar instability will avoid reaching a high pivoting moment (torque generated during the pivoting phase), high pivoting slope (speed with which the torque is developed during the pivoting phase), and a high pivoting impulse. Moreover, the patient will avoid reaching a high body twist angle. The patient's goal is to avoid instability.

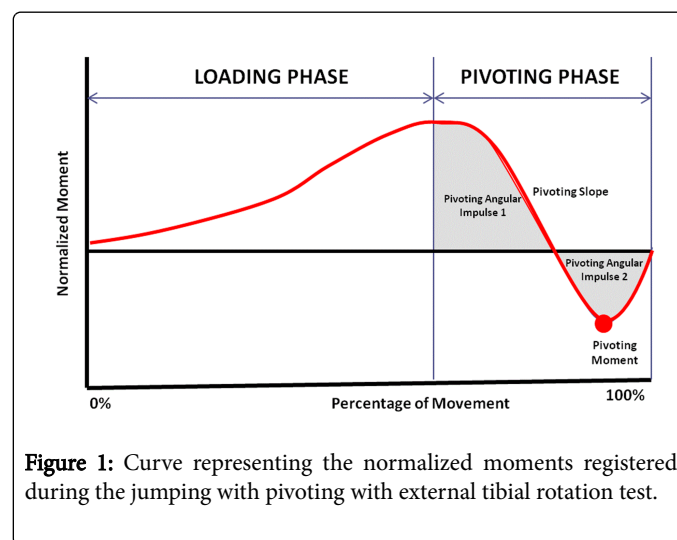


Figure 1: Curve representing the normalized moments registered during the jumping with pivoting with external tibial rotation test.

In a preliminary study performed in patients with chronic lateral patellar instability, with at least two episodes of patellar dislocation, we have observed that our hypothesis is correct; there is a significant decrease of the pivoting moment, pivoting slope and pivoting impulse in the medial patellofemoral ligament (MPFL) deficient knee compared with the healthy, contralateral knee [15]. Moreover, there is a significant decrease of the body twist angle. Furthermore, MPFL reconstruction restores these kinetic parameters to normal levels during extreme rotation conditions such as monopodal jumping with pivoting with external tibial rotation. Finally, in our preliminary study we have found an excellent correlation between clinical results and normalization of kinetic parameters [15].

Conclusions

Kinematic and kinetic analysis can: (1) evaluate the patellofemoral patient in an objective way before surgery; (2) analyse the defense mechanisms the patient develops in order to reduce pain and/or instability; (3) improve our knowledge of the aetiopathogeny and therefore of a suitable treatment for patellofemoral disorders; and (4) objectively evaluate the result of the treatment. However, we must insist that the kinetic and kinematic analyses are not diagnostic tools.

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