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Review Article

Integration of Postural Alterations in the Assessment and Neuromotor Rehabilitation after Anterior Cruciate Ligament Surgery: A Narrative Review

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Abbreviations

ACL: Anterior Cruciate Ligament

EO: Eyes Opened

EC: Eyes Closed

COM: Center of Mass

Abstract

Vision is one of the main systems used to control movement and posture. However, ACL injury can lead to changes in motor control which can then entail risks which compromise the chances of patients having undergone ACL reconstruction to return to competition. Current data from the international literature highlight postural disorders associated with visiodependence after ACL surgery and agree that it is essential to assess this type of deficit. There is however no up to date consensus on the evaluation methods. Neuromotor rehabilitation must take into account these disorders which can persist over time in order to optimize the return to the field of patients.

Taking postural disorders and visiodependence into and therefore reduce the incidence of iterative ACL tears.

Keywords: Neuromotor rehabilitation; Visiodependence; ACL; Postural disorders

1. Introduction

Vision is one of the main systems controlling movement and posture, along with the integration of proprioceptive information. Numerous studies have shown that neuromotor control depends on this visual system, and so any disturbance of vision automatically results in an alteration of posture [1]. However, in the case of ACL injury, the visual system seems to compensate for proprioceptive alterations and therefore disturbs neuromotor control. With a goal of returning to the field as optimally as possible, it is necessary to be able to assess the postural disorders associated with the reconstruction of the ACL and to develop a rehabilitation strategy aimed at reducing the risks of iterative rupture linked to sports practice.

2. Visual System and ACL Injury

In the context of an ACL injury, the proprioceptive system linked to the various local mechanoreceptors finds itself damaged, and also leads to a deficit in neuromotor control of the knee and of the posture as a whole [2, 3]. This deficit is partially compensated by the integration of visual information, we can then speak of an increase in visiodependence in this population. This visiodependence is mostly noticed on a postural evaluation by comparing the stabilometric parameters on a test with open eyes and closed eyes, account makes it possible to limit the factors and risks with a more significant difference in subjects with an ACL lesion or repair compared to a healthy control population [4, 5]. Since ACL damage is mainly linked to sports practice, it is therefore important to take into account this visiodependence and its impact in return to sport: if the visual field is blocked, as it is very often the case in a sport context, neuromotor control of the player then loses the main sensory system to ensure stability and movement, in a situation where these two components are essential (contact with another player, shooting or pivot phase etc ...) [6]. Where vision plays a lesser role on knee stability in a healthy population [7], this same situation then becomes a risk of injury for players who have had an ACL injury, and dependence on vision presents itself as an additional factor which could partly explain the significant number of iterative ACL tears after initial injury [8]. It is therefore essential to take this factor into account in the neuromotor rehabilitation of these patients [9, 10].

3. Postural Alterations and ACL Surgery

Soltani and et al [11] studied the impact of an ACL ligamentoplasty on postural balance treated either by surgery or by functional treatment. The study highlighted the effect of the lesion on the static postural balance in bipodal for the two types of treatment compared to a control group, but showed no difference between the two treatments offered. The effect of the rupture is also found in unipodal but it would seem that the group having undergone a surgical operation has a more important postural imbalance. However, this study does not specify how long after injury or surgery the measures were taken.

The reconstruction of the ACL by hamstring graft or Kenneth-Jones leads to muscular, neuromuscular, proprioceptive repercussions. These changes will have an impact in the regulation of bipodal [11-14] and unipodal [11, 13-21] posture in static and dynamic, which enlightens the importance of measuring and quantifying this imbalance via, for example, force platforms.

4. What Protocols in the Assessment of Postural ACL Disorders?

In their protocols Zouita Ben Moussa and et al [15] and Parus and al [12] offer patients a training session on the platform before measurements, while the other protocols do not offer it. It should be noted that there are some differences in the protocols for carrying out the measurements. First, the positioning of the patient on the platform may change. Indeed, the patient can perform the knee test in extension [12, 15, 17] or knee unlocked in flexion at 20 ° [12, 15, 18, 19, 21]. The flexed position at 20 ° adds an eccentric - isometric contraction of the quadriceps to accentuate the knee's destabilization. In addition, the exercises can either be done with EO [11-13, 16-19, 22] or EC [12, 13, 17, 18, 20]. Four studies performed the same exercises with both EO and EC. In his study Dauty and et al [5] reveals that in bipodal support EC, the values of the displacements of the COM in the sagittal and frontal planes, the size of the ellipse and the total value of the displacement of the COM are greater compared to the EO bipodal support test in patients with ACL but also in healthy patients. Tookuni and et al [17] and Pahnabi and et al [18] also highlight this point. Visual control would then be important to allow patients with ACL injury or healthy patients to maintain their stability. The time required to maintain the position to acquire the measurements on a stabilometric balance varies according to the study protocols. Generally, the exercises are maintained between twenty and thirty seconds [10, 11, 12, 16, 18, 19] but some articles propose a duration of ten seconds [15, 17] or as long as possible [13]. To allow a relevant acquisition, it is necessary to have a sufficient hold time but not too important so as not to have the impact of fatigue during the measurement. To limit the onset of fatigue, break times are made between each exercise (between 30s and 1 min) [11, 13, 15].

5. Long-Term Postural Changes

Different articles deal with postural balance at different stages after ACL ligamentoplasty. Dauty and et al [13] studied postural balance two weeks after ACL surgery in unipodal and bipodal. His study evokes a greater ellipse and variation of the COM in bipodal. However, unipodal tests reveal a higher failure rate and the results must be analyzed with caution. In addition, failure to test highlights the difficulty of performing the exercise after a short period of time following a ligamentoplasty and could mean an altered unipodal balance. Pahnabi and et al [18] studied unipodal postural balance in footballers with or without an ACL rupture. His study highlights that at seven months after surgery remains a postural imbalance on the operated but also non-operated leg in subjects with ligamententoplasty. Henriksson and et al [21] also studied the static postural equilibrium three years after rupture of the ACL. The study highlights a greater postural imbalance in the sagittal plane than a control group without ACL rupture. These different studies highlight the effects of

ligamentoplasty in the more or less long term on aspect into account in postoperative rehabilitation seems important to allow recovery of a good balance and therefore return to a sporting activity identical to the one before the injury.

6. Impact on Rehabilitation after ACL Surgery

Studies have been carried out to enable various rehabilitation criteria to be proposed in order to find the most optimal sports recovery possible. Postoperative rehabilitation includes three distinct phases [10] where different conditions will have to be met in order to move from one phase to another. The second phase is often seen as the end of rehabilitation for patients (after five months). As seen above, there remains a postural imbalance several months or even years after the injury. Melick and et al [22] and Kruse and et al [23] highlight in their writings the main axes of rehabilitation after ligamentoplasty. The rapid loading and eccentric muscle work from the third week seem to improve the recovery of muscle strength and the improvement of neuromotor parameters. Neuromuscular rehabilitation must be carried out in conjunction with other rehabilitation techniques. The resumption of sport must be done gradually by combining rehabilitation adapted to the sport practiced. Rehabilitation exercises linked to resumption of sport must use the visual system postural balance. Thus, the importance of taking this wisely. Neuromotor practice with eyes closed seems archaic given the current data in the international literature. It is necessary to use the gaze without it becoming a means of postural control. Thus, the use of stroboscopic glasses, blackout, or exercises aimed at excluding the articulation of the visual field seem to decrease the visiodependency of patients having undergone an ACL reconstruction. Gokeler and et al [10] proposes in his analysis various criteria including the use of high-performance technological materials such as gait analysis with cameras, electromyography or even the use of pressure plates. However, the use of these tools is not standardized and would require a large database of healthy patients to better analyze the results of patients with ligamentoplasty.

7. Conclusion

If the various studies agree on the fact that postural disorders are associated with visiodependence after reconstruction of the ACL, it seems difficult for the moment to obtain a standardized evaluation of practices. On the other hand, it seems appropriate to build neuromotor rehabilitation around these disorders, even in the early phases of rehabilitation, in order to reduce the risk of iterative ruptures and allow a resumption of competition in optimal conditions.

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