Return to sport after patellar dislocation or following surgery for patellofemoral instability

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Abstract Patellofemoral instability may occur in a young population as a result of injury during sporting activities. This review focuses on return to sport after one episode of dislocation treated operatively and as well after surgery for chronic patellofemoral instability. With or without surgery, only two-thirds of patients return to sports at the same level as prior to injury. A high-quality rehabilitation programme using specific exercises is the key for a safe return to sporting activities. To achieve this goal, recovery of muscle strength and dynamic stability of the lower limbs is crucial. The focus should be directed to strengthen the quadriceps muscle and pelvic stabilizers, as well as lateral trunk muscle training. Patient education and regularly performed home exercises are other key factors that can lead to a successful return to sports. The criteria for a safe return to sports include the absence of pain, no effusion, a complete range of motion, almost symmetrical strength, and excellent dynamic stability.

Level of evidence IV.

Keywords Patellofemoral · Return to play · Rehabilitation · Dislocation · Dynamic stability

Introduction

Patellar dislocation and patellofemoral instability may occur in a young population with varying activity levels. The overall recurrence rate of patellar dislocation after an initial event is close to 40 % [23]. In fact, patients who have a primary patellar dislocation have a 17 % recurrence rate, and patients who sustain repeat patellofemoral joint dislocation have a 49 % recurrence rate [13]. Therefore, surgical treatment is generally recommended after a second dislocation [14]. It is obvious that athletic patients have as a goal resumption of their sports activities at the same high level as prior to the episode of dislocation. For less active patients, an increase in their level of activity could be an attractive goal, as strength and stability of the lower limb can prevent re-injury [18]. Information about the functional capacity that allows for a safe return to sports after either primary dislocation or surgical stabilization is sparse. It is known that medial patellofemoral ligament (MPFL) reconstruction and rehabilitation improves the ability to perform routine activities of daily living [8, 13], but it is less evident as regards the ability to resume sports participation safely. Testing protocols are requested after patellar dislocation to assure a safe return to sport (RTS), but information on this issue is currently limited in the literature. Thus far, quantitative assessment was recommended, but as it will be shown in this article, qualitative measurement with a systematic video analysis has to be considered to better evaluate the dynamic stability of the knee.
This article focuses on objective patellofemoral instability and return to sport, addressing only those situations where one or more episodes of dislocation have occurred or in cases where surgery for instability has been performed. It was attempted to answer the following two questions: (1) How and when can patients safely return to sport after primary or recurrent patellar dislocation, or after patellofemoral stabilization? (2) What validated evaluations can be utilized to determine readiness to return to sport? In our experience, return to sport can be compromised by pain, instability, weakness, and poor motor control.

Return to sport after nonsurgical treatment

A safe return to sport implies that lesions of the knee have healed and the injured lower limb has adequately recovered to face the demands of sporting activities. Successful return to sport implies: (1) no early re-injury; (2) no further damage to the knee; (3) return to the preinjury or higher level; (4) no limiting pain; (5) still playing after 5 years; and (6) no early osteoarthrosis. A comprehensive return to sport decision-making process should be based upon: (1) clinical examination; (2) evaluation of laxity; (3) strength measurement; (4) neuromuscular evaluation; and (5) counselling with the physical conditioner and coach for professional athletes. As regards the patellofemoral joint, the challenge is that the patella is a sesamoid bone enclosed within the extensor mechanism of the lower limb. Its function is closely associated with dynamic muscle activity while retaining its osseous and soft tissue static elements [26].

Atkin et al. [3] followed 74 patients (37 men, 37 women) after a first dislocation that was treated conservatively. Preinjury sports activity was similar to that of patients with primary anterior cruciate ligament (ACL) injury [10]. Patients were authorized to return to sports after they regained full passive range of motion, had no effusion, and when quadriceps muscle strength was at least 80% of the noninjured limb. Patients regained range of motion after 6 weeks. Sports participation was limited during the first 6 months after injury, with difficulties in squatting and kneeling. At 6 months, 58% of patients noted limitations in strenuous activity, but no recurrence was recorded. Sillampaa et al. [32] reported that the return to preinjury activity level varied between 44% and 60% regardless of the modality of treatment after the first dislocation.

Critical points in the rehabilitation for achieving a proper return to sport

There are few high-quality studies concerning rehabilitation after patellar dislocation [33], especially as regards the last phase of treatment before return to sport. There are no published randomized clinical trials, but only thoughts and recommendations as summarized in the review by Fisher et al. [13]. However, since the objectives are similar, a parallel situation exists with the information available in the literature concerning return to sport after ACL reconstruction. In order to achieve a proper and safe resumption of sports activities, there are critical points to achieve during rehabilitation. The strength of the lower limb muscles, especially the quadriceps [6, 36], and the gluteus medius is one key point [5]. Core strength is also crucial as it plays an important role in the stability of the lower limb. Indeed, if the trunk is not stable during cutting manoeuvres, the loads applied to the knee are in valgus, thus generating a situation where the patellofemoral joint is at risk of dislocation [13, 18].

To avoid re-injury, the stability of the lower limb must be mastered at the end of the rehabilitation programme. Cutting manoeuvres, change of direction, and running on uneven ground are the three activities perceived to be the greatest risk factors for patellar dislocation [34]. Therefore, the final goal of the rehabilitation programme should be to focus on the stability of the lower limb by the use of specific exercises on different surfaces, including cutting manoeuvres, side hops, and sudden change of direction.

During the final phase of the rehabilitation programme, another important factor to consider for a proper return to sport concerns sport-specific activities. While this may seem obvious, it is often overlooked. The athlete should be prepared for the specific loads and demands to be experienced in their specific sport, including: (1) cutting manoeuvres and pivoting exercises, performed for most of the team sports; (2) plyometric and landing strategies, emphasized in any sports with jumps; (3) one-leg stability, particularly exercised for martial arts; and (4) proprioception, side stability, and landing capacities, which are stressed with skiers. As previously mentioned, a parallel can be made with return to sport after ACL reconstruction. Specific exercises to be implemented for patients involved in soccer, basketball, alpine skiing, and American football have been described [7, 20, 37, 38].

Return to sports after surgery for chronic patellofemoral instability

The same principles as mentioned above can be applied to patients after surgery for instability, regardless of the procedure performed. With respect to return to sport after medial patellofemoral ligament (MPFL) reconstruction, Fisher et al. [13] reviewed postoperative rehabilitation and the incidence of return to sport. They
reported on only two studies [11, 25] concerning the rate of return to a specific level of sports and found that 77 % of patients were able to resume sports at their pre-injury level of performance. In a study by Ntagiopoulos et al. [29], 87 % of patients returned to their previous activities after isolated trochleoplasty, but the level of activity was not specified. Nelitz et al. [27] studied the outcome after combined trochleoplasty and MPFL reconstruction for recurrent dislocation in patients with severe trochlear dysplasia. Twenty-eight patients at a minimum follow-up of 2-years were included in the study. One patient returned to sport at a higher level than preoperatively, sixteen returned at the same preoperative level, and only six patients reported a return to a lower level of activity than before surgery. Overall, 60 % of patients returned to their previous activities. Unfortunately, there is no information in the literature about validated timelines for a safe return to sport after patellofemoral surgery, especially after tibial tubercle osteotomy. However, common sense recommends to wait until the osteotomy is healed, and to delay the return until maximum recovery of muscle strength and dynamic stability.

Cartilage lesions represent a critical factor when functional recovery is considered. Treatment can vary according to the size of the lesion and the intrinsic stability of the patellofemoral joint [12]. Factors to consider include size of the lesion, intrinsic healing capacity of the cartilage, and residual pain. Cartilage lesions are certainly not a favourable factor for a safe return to high-impact and high-demanding sports activities. Clearly, a large cartilage lesion (>2 cm²) influences the prognosis for return to sport. However, there is no specific data in the literature that allows for solid recommendations.

Based on the current literature, the return to previous level of sports activities after an objective episode of instability is limited to two-thirds of patients with or without surgery.

Discussion

Criteria for a safe return to sport

There is little in the current literature about return to sport after objective patellar instability, and thus, no clear criteria can be as yet endorsed. However, as already mentioned, one can draw a parallel with the literature dedicated to return to sport post-ACL reconstruction [7, 20, 37, 38]. Based upon this literature and our experience, we propose six clinical criteria to support our return to sport decision-making process. As regards timing, it is no longer a matter of weeks or months, but rather a matter of clinical and testing requirements that the patient should fulfil. These criteria are as follows: (1) no pain; (2) no effusion; (3) no patellofemoral instability; (4) a full range of motion; (5) nearly symmetrical strength (85–90 %); and (6) excellent dynamic stability. These criteria can be applied in patients treated with or without surgery. Ideally, patients should satisfy these criteria at 6 weeks after a dislocation, and 3 months after surgery. Our protocol and criteria for return to sport are currently under evaluation. In 2013, the ISAKOS Sports Medicine Committee also defined criteria for return to sport after surgery, and their criteria are very similar to ours (Table 1). Initially, the first 4 criteria listed above are assessed by the surgeon, followed by measurement of quadriceps and hamstring muscle strength in both legs with an isokinetic dynamometer. At this point, dynamic stability is assessed with the use of several functional tests and video

Table 1 From the ISAKOS Sports Medicine Committee, ISAKOS Consensus Meeting on Return-to-Play, London 2013. With the permission of Elisabeth Arendt, MD and François Kelberine, MD

| Criteria for a safe RTS after patellofemoral instability ISAKOS |
|---------------------------------------------------------------|
| If bony surgery is involved, complete radiographic healing of bone |
| No complaints of knee pain or knee instability |
| Full or near full range of motion |
| No knee effusion |
| Completed neuromuscular training/propioreception |
| Satisfactory core strength and endurance |
| Acceptable control with dynamic activities (e.g., Star Excursion Balance Test) |
| Limb Symmetry Index > 85 % on hop tests, especially if resuming pivoting sports |
| Adequate performance with physiotherapist during sport-specific drills simulating the intensity and movement patterns of the athlete’s given sport |
| Athlete demonstrates a psychological readiness to return to sport (e.g., SANE score > 80/100) |
These tests typically use the patient's contralateral limb as the control or "normal", and a limb symmetry index (LSI) is thus calculated by computing side-to-side differences in the results. And finally, in light of the results, the surgeon and patient can make a well-documented decision with regards to return to sport. For strength evaluation, especially in high-demanding sports (e.g., alpine skiing, football, basketball, and handball), the patient should reach a LSI of at least 90% in order to be cleared for return to sports [7, 20, 37, 38].

Testing exercises are mandatory to evaluate recovery and the competence of the injured or operated limb. There are many functional tests for the knee that have been used [17, 22, 31, 39] and appear to be reliable and valuable tools [40]. After a thorough evaluation of the different tests that have been validated in the literature, we have selected the "single-leg squat", the "Star Excursion Balance Test" (SEBT), the "drop jump test", and the "side-hop test". These tests are always performed after isokinetic measurements of the strength in both limbs.

Dynamic stability can be evaluated with the single-leg squat (Fig. 1a) and the SEBT (Fig. 1b). In the single-leg squat, the knee must stay above the foot without going into a valgus movement, and the pelvis has to remain stable without dropping or turning. This exercise is part of the rehabilitation programme and should be perfectly mastered [24]. In the SEBT, the knee has to stay aligned as the pelvis is moving [35]. The patient stands on one foot and reaches points around him like a clock quadrant [18, 28]. The results obtained are qualitative on the video analysis and also quantitative since distances reached during the SEBT can be noted and reported. This test is very useful for the evaluation of lower limb stability [9, 16, 21].

Many sports demand change in direction and landing from jumps. If the limb cannot be maintained in good alignment and as well properly decelerate, this may result in pain and risk re-injury [30]. It is therefore important to assess these parameters during the phase of return to sport. Drop and jump is a simple test that provides valuable information about control of landing. The patient drops from a box 35 cm high, lands on both feet, and immediately jumps as high as possible before landing a second time. The symmetry of the reception, the alignment of both knees, deceleration, and the capacity for absorbing the shock are evaluated using video recording [4, 15, 19, 30]. In this case, the results are qualitative, but highly valuable. The side-hop test consists in jumping on one leg between two lines at a distance of 40 cm as
often as possible in 30 s (Fig. 2). During this test, many aspects of physical conditioning can be observed, including speed, agility, muscle coordination, limb alignment, trunk stability, and control in change of direction. Here, the results are qualitative (video analysis) as well as quantitative (number of jumps). All these tests are recorded and analysed using video analysis software. They are then shown to the patient, and the results discussed in order to outline a new set of exercises aimed at correction of any deficits noted. In this way, the training may evolve over time towards more sport-specific exercises with the aim to prepare the patient for return to sport. Arendt et al. have also described a series of tests that can be used to evaluate patients with patellofemoral problems or following corrective patellofemoral surgery [1, 2, 26]. They assessed core and trunk stability using prone plank, side plank, and single-limb exercises. For patients with patellofemoral problems, lower limb physical performance was evaluated with the stand and reach balance test, SEBT, single-limb squat test, and retro step-up/down test.

Fig. 3 Home exercise programme: a Gluteus and hamstrings strengthening, b Myofascial release of ITB, c Rotational core stability, d Lunges with trunk rotation, e Single-leg squat
From our point of view, patient education is a key point. Very often, the patient has no idea about the importance of whole limb stability and is overly focused on the patellar problem. The use of video feedback is a very powerful tool for education. It is strongly recommended that patients regularly perform home exercises (Fig. 3a–e). Experience has shown that these self-administered exercises have been very useful to return the patient to sports.

With all, we have presented there still remains a lack of solid evidence about the criteria to determine a safe return to sports after patellofemoral dislocation or surgery. Further work needs to be conducted in this field to better understand the true capability of our functional testing, rehabilitation programme, and surgical procedures, to safely and durably bring our patient back to sports.

Conclusion

Patellar instability is a pathology that concerns a young active population. Even after a single dislocation, return to sports at the same level of performance as before injury appears to be compromised. Analysis of the literature reveals that only two-thirds of patients return to sports at the same level. This can be considered a poor result with respect to the young age of the affected population. Return to sport may be encouraged and promoted using home self-administered exercises and by educating the patient about the importance of regaining muscle strength and dynamic stability. Finally, testing protocols for the RTS should include quantitative and qualitative criteria.

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References

1. Arendt EA, Dejour D, Farr J (2012) Patellofemoral instability. Sports Med Arthrosc 20:127
2. Arendt EA, Moeller A, Agel J (2011) Clinical outcomes of medial patellofemoral ligament repair in recurrent (chronic) lateral patella dislocations. Knee Surg Sports Traumatol Arthrosc 19:1909–1914
3. Atkin DM, Fithian DC, Marangi KS, Stone ML, Dobson BE, Mendelsohn C (2000) Characteristics of patients with primary acute lateral patellar dislocation and their recovery within the first 6 months of injury. Am J Sports Med 28:472–479
4. Barber-Westin SD, Smith ST, Campbell T, Noyes FR (2010) The drop-jump video screening test: retention of improvement in neuromuscular control in female volleyball players. J Strength Cond Res 24:3055–3062
5. Barton CJ, Lack S, Malliaras P, Morriss E (2013) Gluteal muscle activity and patellofemoral pain syndrome: a systematic review. Br J Sports Med 47:207–214
6. Bennell K, Duncan M, Cowan S, McConnell J, Hodges P, Crossley K (2010) Effects of vastus medialis oblique retraining versus general quadriceps strengthening on vasti onset. Med Sci Sports Exerc 42:856–864
7. Bizzini M, Hancock D, Impellizzeri F (2012) Suggestions from the field for return to sports participation following anterior cruciate ligament reconstruction: soccer. J Orthop Sports Phys Ther 42:304–312
8. Buckens CF, Saris DB (2010) Reconstruction of the medial patellofemoral ligament for treatment of patellofemoral instability: a systematic review. Am J Sports Med 38:181–188
9. Dallinga JM, Benjaminse A, Lemmink KAPM (2012) Which screening tools can predict injury to the lower extremities in team sports? A systematic review. Sports Med 42:791–815
10. Daniel DM, Stone ML, Dobson BE, Fithian DC, Rossman DJ, Kaufman KR (1994) Fate of the ACL-injured patient: A prospective outcome study. Am J Sports Med 22:632–644
11. Doporak R, Adamany D, Bickel B, Steensen R (2008) Reconstruction of the medial patellofemoral ligament using a quadriceps tendon graft: a case series. Orthopedics 31:217
12. Farr J, Covell DJ, Lattermann C (2012) Cartilage lesions in patellofemoral dislocations: incidents/locations/when to treat. Sports Med Arthrosc 20:181–186
13. Fisher B, Nyland J, Brand E, Curtin B (2010) Medial patellofemoral ligament reconstruction for recurrent patellar dislocation: a systematic review including rehabilitation and return-to-sports efficacy. Arthroscopy 26:1384–1394
14. Fithian DC, Paxton EW, Stone ML, Silva P, Davis DK, Elias DA, White LM (2004) Epidemiology and natural history of acute patellar dislocation. Am J Sports Med 32:1114–1121
15. Ford KR, Shapiro R, Myer GD, Van Den Bogert AJ, Hewett TE (2010) Longitudinal sex differences during landing in knee abduction in young athletes. Med Sci Sports Exerc 42:1923–1931
16. Gordon AT, Ambegaonkar JP, Caswell SV (2013) Relationships between core strength, hip external rotator muscle strength, and Star Excursion Balance Test performance in female lacrosse players. Int J Sports Phys Ther 8:97–104
17. Grindem H, Logerstedt D, Eitzen I, Moksnes H, Axe MJ, Snyder-Mackler L, Engbreten L, Risberg MA (2011) Single-legged hop tests as predictors of self-reported knee function in nonoperatively treated individuals with anterior cruciate ligament injury. Am J Sports Med 39:2347–2354
18. Hewett TE, Myer GD (2011) The mechanistic connection between the trunk, hip, knee, and anterior cruciate ligament injury. Exerc Sport Sci Rev 39:161–166
19. Hewett TE, Myer GD, Ford KR, Slauterbeck JR (2006) Participation physical examination using a box drop vertical jump test in young athletes: the effects of puberty and sex. Clin J Sport Med 16:298–304
20. Kokmeyer D, Wahoff M, Myremn M (2012) Suggestions from the field for return-to-sport rehabilitation following anterior cruciate ligament reconstruction: Alpine skiing. J Orthop Sports Phys Ther 42:313–325
21. Lockie RG, Schultz AB, Callaghan SJ, Jeffriess MD (2013) The effects of isokinetic knee extensor and flexor strength on dynamic stability as measured by functional reaching. Isokinet Exerc Sci 21:301–309
22. Logerstedt D, Grindem H, Lynch A, Eitzen I, Engbreten L, Risberg MA, Axe MJ, Snyder-Mackler L (2012) Single-legged hop tests as predictors of self-reported knee function after anterior cruciate ligament reconstruction: the Delaware-Oslo ACL cohort study. Am J Sports Med 40:2348–2356
23. Mannepa H, Huhtala H, Lehto MU (1997) Recurrence after patellar dislocation. Redislocation in 37/75 patients followed for 6-24 years. Acta Orthop Scand 68:424–426
24. McConnell J, Man Ther GD (2007) Rehabilitation and nonoperative treatment of patellar instability. Sports Med Arthrosc Rev 15:95–104
25. Mikashima Y, Kimura M, Kobayashi Y, Miyawaki M, Tomatsu T (2006) Clinical results of isolated reconstruction of the medial patellofemoral ligament for recurrent dislocation and subluxation of the patella. Acta Orthop Belg 72:65–71
26. Monson J, Arendt EA (2012) Rehabilitative protocols for select patellofemoral procedures and nonoperative management schemes. Sports Med Arthrosc 20:136–144
27. Nelitz M, Dreyhaupt J, Reichel H, Woelfle J, Lippacher S (2013) Anatomic reconstruction of the medial patellofemoral ligament in children and adolescents with open growth plates surgical technique and clinical outcome. Am J Sports Med 41:58–63
28. Norris B, Trudelle-Jackson E (2012) Hip- and thigh-muscle activation during the Star Excursion Balance Test. J Sport Rehabil 20:428–441
29. Ntagiopoulos PG, Byn P, Dejour D (2013) Midterm results of comprehensive surgical reconstruction including sulcus-deepening trochleoplasty in recurrent patellar dislocations with high-grade trochlear dysplasia. Am J Sports Med 41:998–1004
30. Paterno MV, Schmitt LC, Ford KR, Rauh MJ, Myer GD, Huang B, Hewett TE (2010) Biomechanical measures during landing and postural stability predict second anterior cruciate ligament injury after anterior cruciate ligament reconstruction and return to sport. Am J Sports Med 38:1968–1978
31. Reinke EK, Spindler KP, Lorring D, Jones MH, Schmitz L, Flanigan DC, An AQ, Quiram AR, Preston E, Martin M, Schroeder B, Parker RD, Kaeding CC, Borzi L, Pedroza A, Huston LJ, Harrrell FE Jr, Dunn WR (2011) Hop tests correlate with IKDC and KOOS at minimum of 2 years after primary ACL reconstruction. Knee Surg Sports Traumatol Arthrosc 19:1806–1816
32. Sillanpaa PJ, Arendt E (2012) Reconstruction of the medial patellofemoral ligament using the adductor magnus tendon. Arthroscopy 28:1749
33. Smith TO, Davies L, Chester R, Clark A, Donell ST (2010) Clinical outcomes of rehabilitation for patients following lateral patellar dislocation: a systematic review. Physiotherapy 96:269–281
34. Smith TO, Donell ST, Chester R, Clark A, Stephenson R (2011) What activities do patients with patellar instability perceive makes their patella unstable? Knee 18:333–339
35. Steffen K, Nilstad A, Kristianslund E, Krosshaug T, Myklebust G, Bahr R (2011) A comparison between the Star Excursion Balance Test and subjective assessment of knee stability in a single-leg squat. Br J Sports Med 45:375
36. Syme G, Rowe P, Martin D, Daly G (2009) Disability in patients with chronic patellofemoral pain syndrome: a randomised controlled trial of VMO selective training versus general quadriceps strengthening. Man Ther 14:252–263
37. Verstegen M, Falsone S, Orr R, Smith S (2012) Suggestions from the field for return to sports participation following anterior cruciate ligament reconstruction: American football. J Orthop Sports Phys Ther 42:337–344
38. Waters E (2012) Suggestions from the field for return to sports participation following anterior cruciate ligament reconstruction: basketball. J Orthop Sports Phys Ther 42:326–336
39. Whatman C, Hume P, Hing W (2013) Kinematics during lower extremity functional screening tests in young athletes—are they reliable and valid? Phys Ther Sport 14:87–93
40. Whatman C, Hume P, Hing W (2013) The reliability and validity of physiotherapist visual rating of dynamic pelvis and knee alignment in young athletes. Phys Ther Sport 14:168–174