Evaluation of cruciate ligament injuries

A review

Yelverton Tegner[1], Jack Lysholm[1], Magnus Odensten[2] and Jan Gillquist[2]

A good system for evaluating the degree of impairment, disability, and handicap of the patient with a cruciate ligament injury includes functional score, activity grading, stability testing, and measurements of performance and strength, all of which are relevant to different aspects of knee function. The symptom-related knee score gives a more differentiated picture of the disability than does a binomial rating of symptoms. A way of grading the disability in an objective way is to use a performance test. This test could also be used for monitoring rehabilitation before full activity has been resumed. The activity grading scale is very useful for grading the handicap.

A total tear of a cruciate ligament always results in instability of the knee joint, which can be static or static and functional. Static instability is a sign identified by stability testing. Functional instability is experienced by the patient, and is thus a symptom. The term *functional* is the symptom of giving way that patients with an anterior cruciate ligament injury often complain about. In assessing the results of surgery and conservative treatment, the lack of full correlation between static and functional instability (1, 2) makes it necessary to include evaluation of functional instability and other symptoms in the follow-up. One way in which this can be done is by using a rating scale, of which several of different design have been devised (3–10). Some embrace symptoms and signs, stability testing, activity grading, and performance in simple tests, whereas others include only the patient's complaints. It remains unclear which features should be included to obtain a well-differentiated picture of the disability.

Resumption of sports or work has been considered to indicate a good result (11–18), but can easily be influenced by unrelated factors. Further, different sports and occupations place different types of stress on the knee joint. Numerical grading of the activity level based on a ranking of different activities according to how troublesome they are to perform could be a better way of defining the activity level. The performance level can be assessed objectively by a function test. Daniel et al. (19) used a function test to evaluate the results of knee ligament surgery. We have devised a system to evaluate the degree of disability and handicap in patients with a cruciate ligament injury. The evaluating system consists of several different parts: a functional score, a performance test, activity grading, strength measurements, and stability testing.

Departments of Orthopedics, [1]Central Hospital, Boden, and [2]University Hospital, Linköping, Sweden

Correspondence: Dr. Yelverton Tegner, Department of Orthopedics, Central Hospital, S-961 85 Boden, Sweden

Methods of evaluation

Score

The functional score presented by Lysholm and Gillquist in 1982 (7) was designed to evaluate functional disability in the knee joint resulting from ligamentous instability and was a modification of the Larson scale (3). The items included were arbitrarily ranked and scored on the basis of clinical experience of patients with a knee injury. The new score proved to tally with the patients' own opinions about their knee function. It also emerged that patients in whom the knee had become stable after ligament surgery achieved a higher score than those in whom the knee was still unstable.

Table 1. The Lysholm knee score

Limp	none	3	Pain (25 points)	none	25
	severe and/or constant	0		inconstant and slight, during heavy exertion	20
Support (5 points)	none	5		marked, during heavy exertion	15
	cane or crutch,	2		marked, on or after walking more than 2 km	10
	weight bearing impossible	0		marked, on or after walking less than 2 km	5
Locking (15 points)	no locking and no catching sensations	15		constant	0
	catching sensations, but no locking	10	Swelling (10 points)	none	10
	locking occasionally	6		on heavy exertion	6
	frequently	2		on normal exertion	2
	locked joint upon examination	0		constant	0
Instability (25 points)	no giving way	25	Stair-climbing (10 points)	no problems	10
	rarely, during athletics or other heavy exertion	20		slightly impaired	6
	frequently, during athletics or other heavy exertion (or unable)	15		one step at a time	2
	occasionally, in daily activities	10		impossible	0
	often, in daily activities	5	Squatting (5 points)	no problems	5
	at every step	0		slightly impaired	4
				not beyond 90°	2
				impossible	0

Significantly lower scores were achieved with the Lysholm than with the Larson score by patients with an anterior cruciate ligament injury, suggesting that the former score evaluates functional instability due to a ligamentous injury better than does the latter.

Because meniscus lesions are common in patients with a cruciate ligament injury, we wanted to adapt the score more closely to their circumstances, and a new item, "locking," was introduced. The item "atrophy of thigh" was excluded because a tape measurement of the thigh circumference is a poor way of assessing muscular strength (20–22). The total points for the items "instability" and "pain" were reduced by 5 each. After this modification the maximum score was still 100 points (Table 1). When tested on patients with isolated meniscus lesions, the modified score nicely matched the patient's own opinion (23). Close correlation between the old and new scales existed in patients with ligament injuries.

Performance test

Our performance test consists of four different items: running a figure-of-8, one-leg long hop, running up and down a spiral staircase, running up and down a slope.

The performance test is a refinement of the one published by Daniel et al. (19). Their test consisted of a 40-yard "shuttle run" in time, and a one-leg hop for distance. Before our test reached its present design, other items were tested. Instead of a figure-of-8, we tried zigzag running between four cones placed 5 meters apart and a shuttle run as described by Daniel. We have also tried sideways running to evaluate coordination. All these tests proved to depend more on general skill and training than on knee function. The reproducibility (reliability) was thus poor, and they were excluded. All the features of the present test seem useful, because they subject the knee to different forms of stress. The figure-of-8 and down-slope runs and the hop test were included to stress the anterior cruciate ligament-deficient knee, running up the slope to stress the posterior cruciate ligament deficient knee, and the staircase run to evaluate coordination.

Activity grading

The activity grading scale (Table 2) was constructed by letting patients with an anterior cruciate ligament injury grade a number of activities, in 10 different steps, according to how troublesome they were. The median value for each activity was then determined, and a ranking was made from the median values.

Table 2. The activity scale

10 Competitive sports soccer – national or international level	5 Work heavy labor (e.g., construction, forestry) Competitive sports cycling cross-country skiing Recreational sports jogging on uneven ground at least twice weekly
9 Competitive sports soccer – lower divisions ice hockey wrestling gymnastics	4 Work moderately heavy work (e.g., truck driving, scrubbing floors) Recreational sports cycling cross-country skiing jogging on even ground at least twice weekly
8 Competitive sports bandy squash or badminton athletics (jumping etc) downhill skiing	3 Work light work (e.g., nursing) Competitive and recreational sports swimming Walking in rough forest terrain
7 Competitive sports tennis athletics (running) motorcross or speedway handball or basketball Recreational sports soccer bandy or ice hockey squash athletics (jumping) crosscountry track findings (orienteering), both recreational and competitive	2 Work light work Walking on uneven ground
6 Recreational sports tennis or badminton handball or basketball downhill skiing jogging, at least 5 times weekly	1 Work sedentary work Walking on even ground
	0 Sick leave or disability pension because of knee problems

Strength measurements

Patients with quadriceps atrophy always have reduced strength, but patients with no detectable thigh atrophy may also have reduced strength (22). The inclusion of isokinetic strength measurements in the evaluation of cruciate ligament injuries thus seems appropriate. With an isokinetic device, strength can be measured at many different speeds; we used 30° and 180°/second. Isometric strength was determined at 60° of knee flexion.

Stability testing

The instability owing to injury to different ligaments is determined by standard stability tests: viz., varus, valgus, anterior, posterior, and rotational tests. Instability is thus graded 0 = no difference between the injured and uninjured knees, 1+ = 1–5 mm difference, 2+ = 6–10 mm difference, 3+ = > 10 mm difference. The pivot shift sign is graded as follows: 0 = no pivot shift, 1+ = mild, 2+ = moderate, 3+ = gross.

Lately, measurements of the anteroposterior laxity with a laxity tester have been added.

Discussion

In 1980, WHO (24) published a manual of classification relating to the consequence of disease: 1) loss of anatomic structure or function – impairment, 2) departure from the norm in terms of performance of the individual – disability, and 3) limitations in activity for the individual – handicap. In the patient with a cruciate ligament injury, there is a loss of an anatomic structure resulting in impairment of knee function. He is disabled because he experiences symptoms of the loss of function; this results in a handicap because the patient can no longer fulfill his normal activities.

Our evaluation system aims at assessing the condition of the patient in these terms. The anatomic loss is determined by arthroscopy and stability testing. The performance test and the functional score both evaluate disability – the

performance test gives an objective measurement and the score a subjective measurement. The activity scale can be considered as a grading of the handicap.

In many fields of orthopedics, attempts have been made to assess the results of different forms of treatment by translating the symptoms into a functional score. D'Aubigné and Postel (25) used the items pain, mobility, and ability to walk in a functional grading scale for evaluation of hip operations. Larson (26), Lazansky (27), and Harris (28) developed rating scales for hip disease. Geens et al. (29) and Freeman et al. (30) used rating scales for evaluation of arthritis of the knee. Kettelkamp and Thompson (4) used goniometric measurements of stance phase flexion-extension during walking as a measurable characteristic of gait against which the clinical variables in a knee-scoring scale were graded.

The Marshall evaluation system (5) was devised to assess, in a standardized way, any persistent disability after a knee ligamentous injury. In the Marshall score, binary rating of symptoms is used. In a study concerning different rating systems, we could show that binary ratings give a less well-differentiated picture than does a symptom-related score (31), because binary rating evaluates the symptoms in an all-or-none manner. The definition of a symptom will thus depend on the level at which the symptom is judged significant. If a symptom is defined as significant only when it occurs during nonstrenuous activities, many patients will be regarded as asymptomatic even though they meet considerable problems in sports activities. With a score such as the one we use, the more often the symptoms occur and the lower the load that causes them, the lower the score will be. Binary ratings visualized in a Venn diagram can provide useful information about how different symptoms occur in combination. Moreover, to include the findings of a specific knee examination in a score that grades the disability may hazard a more functional evaluation. Such a score evaluates both impairment and disability at the same time, and this seems inappropriate. The static instability is important; but, as we have shown, reduction in disability can occur without change of static stability (32, 33).

Recently, Noyes et al. (10) have presented a functional evaluation system that in many instances resembles ours. Their functional score consists of two parts – one symptom-related score and one overall-activity rating. Accordingly, the final score reflects a mixture of disability and handicap, which in our opinion is a major disadvantage.

A symptom-related score should be used before treatment has begun, and again at the end of treatment when the patient is fully rehabilitated and full activities are allowed. It is less useful during the rehabilitation period, which often involves restriction of activity.

A performance test evaluates the disability in specific test situations. The test activities should be relevant to the group of patients the test is intended for. Macnicol et al. (34) used walking speed to evaluate function after hip arthroplasty. A performance test for athletes with a cruciate injury should include sport-simulating test activities that place stress on the knee. The test used by Daniel et al. (19) included a shuttle run, which they considered to approximate an athletic activity. In our performance test a feeling of confidence in the knee and good muscle strength are necessary (33, 35, 36) if normal performance is to be achieved in the one-leg long hop; this was also the experience of Daniel et al. (19). Running the figure-of-8 and the down-hill slope involves acceleration, deceleration, and "cutting". In particular the running time in the turn seems to be useful in determining the disability, because it does not depend on skill (37). The performance test probably reflects both concentric and eccentric strength, because running and hopping include both eccentric and concentric actions. To be able to perform normally in the staircase run, good coordination is probably needed. Before resuming sports, restoration of muscle strength has been considered essential. Restoration of muscle strength is only one of the components in the rehabilitation of the athlete after a knee injury (38). The performance test allows more functional monitoring of rehabilitation. We suggest that the test would be useful for evaluating function and rehabilitation in soccer players and other athletes for whom running and jumping are essential features.

Ability to resume sports or work has been regarded as an important factor when judging the results of treatment of a knee ligament injury. Such a criterion is readily biased by irrelevant factors, such as social or economic advantages or disadvantages. The activity grading scale (31) was

constructed because different actions place different demands on the knee joint, and because different patients strive to carry out different activities. Grading of activity in a standardized way thus seems desirable. Naturally, other factors also influence the patient's activity level. The main advantage of the activity scale is not to compare different patients, but to note changes in activity level in the same person at different times. With this scale the preinjury, present, and desired activity levels can easily be defined. The functional score should be regarded in relation to the activity level. Patients who have reached the desired high activity level and have a high score probably have better function than patients with a high score, but who have a low activity level, for example, patients who are yet not fully rehabilitated to their desired activity level.

The score and the activity rating scale have been widely accepted and used in several studies (39–48). Further, the activity rating scale is recommended by the U.S. Food and Drug Administration for assessing results after ligament reconstruction with a ligament prosthesis.

In two studies (32, 33), we examined the effects of strength training in order to define the lowest degree of disability for patients with an unstable knee due to a cruciate ligament injury. We thus established a norm with which the results of ligament surgery should be compared. Operations that do not reach the norm should therefore probably be abandoned, because the functional result they give can be achieved by strength training alone. Because strength training results in good function that lasts at least 2 years (32), it seems justifiable to let the patient undergo a strength training program before resorting to surgery.

References

1. Dandy D J, Pusey R J. The long term results of unrepaired tears of the posterior cruciate ligament. J Bone Joint Surg (Br) 1982;64(1):92–4.
2. Lysholm J, Tegner Y, Gillquist J. Functional importance of different clinical findings in the unstable knee. Acta Orthop Scand 1984;55:472.
3. Larson R L. Rating sheet for knee function. In: Diseases of the Knee Joint (Ed. Smillie I). Churchill Livingstone, Edinburgh 1974:29.
4. Kettelkamp D B, Thompson C. Development of a knee scoring scale. Clin Orthop 1975(107):93–9.
5. Marshall J L, Fetto J F, Botero P M. Knee ligament injuries: a standardized evaluation method. Clin Orthop 1977;(123):115–29.
6. Arnold J A, Coker T P, Heaton L M, Park J P, Harris W D. Natural history of anterior cruciate tears. Am J Sports Med 1979;7(6):305–13.
7. Lysholm J, Gillquist J. Evaluation of knee ligament surgery results with special emphasis on use of a scoring scale. Am J Sports Med 1982;10(3):150–4.
8. Feagin J A Jr, Blake W P. Postoperative evaluation and result recording in the anterior cruciate ligament reconstructed knee. Clin Orthop 1983;(172):143–7.
9. Walla D J, Albright J P, McAuley E, Martin R K, Eldridge V, El Khoury G. Hamstring control and the unstable anterior cruciate ligament deficient knee. Am J Sports Med 1985;13(1):34–9.
10. Noyes F R, McGinniss G H, Grood E S. The variable functional disability of the anterior cruciate ligament deficient knee. Orthop Clin North Am 1985;16(1):47–67.
11. O'Donoghue D H. Surgical treatment of fresh injuries to the major ligaments of the knee. J Bone Joint Surg (Am) 1950;32:721–8.
12. Jones K G. Reconstruction of the anterior cruciate ligament. J Bone Joint Surg (Am) 1963;45:925–32.
13. Lam S J S. Reconstruction of the anterior cruciate ligament using the Jones procedure and its Guy's Hospital modification. J Bone Joint Surg (Am) 1968;50:1213–24.
14. Collins H R, Hughston J C, Dehaven K E, Bergfeld J A, Evarts C M. The meniscus as a cruciate ligament substitute. J Sports Med 1974;2(1):11–21.
15. Drez D Jr. Modified Eriksson procedure for chronic anterior cruciate instability. Orthopedics 1978; 1(1):30–6.
16. Ellison A E. Distal iliotibial band transfer for anterolateral rotatory instability of the knee. J Bone Joint Surg (Am) 1979;61(3):330–7.
17. Clancy W G Jr, Nelson D A, Reider B, Narechania R G. Anterior cruciate ligament reconstruction using one third of the patellar ligament, augmented by extra-articular tendon transfers. J Bone Joint Surg (Am) 1982;64(3):352–9.
18. Insall J N, Hood R W. Bone block transfer of the medial head of the gastrocnemius for posterior cruciate insufficiency. J Bone Joint Surg (Am) 1982;64(5):691–9.
19. Daniel D, Malcom L, Stone M L, Perth H, Morgan

J, Riehl B. Quantification of knee stability and function. Cont Orthop 1982;5:83–91.
20. Nilsson B E, Westlin N E. Muscle dysfunction following injury to the semilunar cartilage. Ann Phys Med 1970;10(6):281–5.
21. Cooper H, Dodds W N, Adams I D, DeDombal F T, Steele V A. Use and misuse of the tape measure as a means of assessing muscle strength and power. Rheumatol Rehabil 1981;20(4):211–8.
22. Tegner Y. Cruciate ligament injuries in the knee evaluation and rehabilitation. Thesis, Linköping University, Linköping Sweden1985:203.
23. Hamberg P, Gillquist J. Knee function after arthroscopic meniscectomy. A prospective study. Acta Orthop Scand 1984;55(2):172–5.
24. WHO International classification of impairments, disabilities, and handicap. World Health Organization, Geneva 1980.
25. d'Aubigné M, Postel M. Functional results of hip arthroplasty with acrylic prosthesis. J Bone Joint Surg (Am) 1954;36:451–75.
26. Larson C B. Rating scale for hip disabilities. Clin Orthop 1963;31:85–93.
27. Lazansky M G. A method for grading hips. J Bone Joint Surg (Br) 1967;49(4):644–51.
28. Harris W H. Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty. An end result study using a new method of result evaluation. J Bone Joint Surg (Am) 1969;51(4):737–55.
29. Geens S, Clayton M L, Leidholt J D, Smyth C J, Bartholomew B A. Synovectomy and debridement of the knee in rheumatoid arthritis. II. Clinical and roentgenographic study of thirty-one cases. J Bone Joint Surg (Am) 1969;51(4):626–42.
30. Freeman M A, Todd R C, Cundy A D. The presentation of the results of knee surgery. Clin Orthop 1977;(128):222–7.
31. Tegner Y, Lysholm J. Rating systems in the evaluation of knee ligament injuries. Clin Orthop 1985; (198):43–9.
32. Tegner Y, Lysholm J, Gillquist J, Öberg B. Two-year follow-up of conservative treatment of knee ligament injuries. Acta Orthop Scand 1984;55(2): 176–80.
33. Tegner Y, Lysholm J, Lysholm M, Gillquist J. Strengthening exercises for old cruciate ligament tears. Acta Orthop Scand 1986;57(2):130–4.
34. Macnicol M F, McHardy R, Chalmers J. Exercise testing before and after hip arthroplasty. J Bone Joint Surg (Br) 1980;62(3):326–31.
35. Odensten M, Tegner Y, Lysholm J, Gillquist J. Knee function and muscle strength following distal ileotibial band transfer for antero-lateral rotatory instability. Acta Orthop Scand 1983;54(6):924–8.
36. Tegner Y, Lysholm J. Derotation braces and knee function in patients with anterior cruciate ligament tears. Arthroscopy Rel Surg 1985;1:264–7.
37. Tegner Y, Lysholm J, Lysholm M, Gillquist J. A performance test to monitor rehabilitation and evaluate anterior cruciate ligament injuries. Am J Sports Med 1986;14(2):156–9.
38. Allman F L. Rehabilitation of the injured athlete. In: Ryan A J, Allman F L: Sports Medicine, Academic Press, New York 1974:307–46.
39. Strand T, Mölster A O, Engesæter L B, Raugstad T S, Alho A. Primary repair in posterior cruciate ligament injuries. Acta Orthop Scand 1984; 55(5):545–7.
40. Ferkel R D, Davis J R, Friedman M J, Fox J M, Del Pizzo W, Snyder S J, Berasi C C. Arthroscopic partial medial meniscectomy: an analysis of unsatisfactory results. Arthroscopy 1985;1(1):44–52.
41. Georgoulis A, Laise A, Hertel P. Arthroscopic meniscectomy on patients with untreated rupture of the anterior cruciate ligament. (Abstract). 2nd European Congress of Knee Surgery and Arthroscopy, Basel 1986.
42. Hertel P, Leis E, Georgoulis A. Results of posterior horn resection of medial meniscus. (Abstract). 2nd European Congress of Knee Surgery and Arthroscopy, Basel 1986.
43. Mansat C. Basic elements, biomechanics, preliminary clinical results with Proflex in the replacement of the anterior cruciate ligament. (Abstract). 2nd European Congress of Knee Surgery and Arthroscopy, Basel 1986.
44. Mellanotte P L, Baldovin M. Surgical repair of chronic meniscus injury: plastic meniscus surgery. (Abstract). 2nd European Congress of Knee Surgery and Arthroscopy, Basel 1986.
45. Sandberg R, Bakur M. Surgical versus non-surgical treatment of knee ligament injuries. (Abstract). 2nd European Congress of Knee Surgery and Arthroscopy, Basel 1986.
46. Strand T, Mölster A. 5–10 year follow up of primary suture of anterior cruciate ligament tears. (Abstract). 2nd European Congress of Knee Surgery and Arthroscopy, Basel 1986.
47. Wredmark T, Theander C. Short term results of ACL reconstruction with high strength Dacron ligament. (Abstract). 2nd European Congress of Knee Surgery and Arthroscopy, Basel 1986.
48. Lukianov A V, Gillquist J, Grana W A, DeHaven K E. An anterior cruciate ligament (ACL) evaluation format for assessment of artificial or autologous anterior cruciate reconstruction results. Clin Orthop 1987;(218):167–80