

Review

Knee injury rating scales

Jack Lysholm^{1,2} and Yelverton Tegner³

¹Winternet Research Centre, Intendenturvägen 11, SE-961 36 Boden, ²Department of Surgery and Perioperative Sciences, Umeå University, Umeå, ³Department of Health Sciences, Luleå University of Technology, SE-971 87 Luleå, Sweden
Correspondence JL: jack.lysholm@ull.se
Submitted 06-08-16. Accepted 06-10-17

The effects of injury or disease can be evaluated in terms of their effect on either health-related quality of life, or disability and handicap. For evaluation of health-related quality of life, generic rating scales are used. The most widely used is the SF-36, which is used in different fields of orthopedics but has only been used in a few studies on ligament injuries of the knee (Katz et al. 1992, Ware 1993, Vangsness et al. 1995, Shapiro et al. 1996, Ferrari et al. 2001, Nyland et al. 2002, Sekiya et al. 2003, Stannard et al. 2003, Von Porat et al. 2004). Recently, the less comprehensive EQ-5D has been increasingly used (Szende and Williams 2004). It has been recommended that a generic scale should be used together with a disability-specific instrument (Bombardier et al. 1995, Stucki et al. 1995).

The effects of different treatments on disability can be translated into a numerical functional score. D'Aubigne and Postel (1954) used the items pain, mobility and the ability to walk for evaluation of the results of hip operation. Larson (1963), Lazansky (1967), and Harris (1969) developed scores for hip disease. Geens et al. (1969), Freeman et al. (1977), and Kettelkamp and Thompson (1975) developed early rating scales for osteoarthritis of the knee. O'Donoghue (1955) was the pioneer when he constructed his scale for knee ligament injuries. Later on, Larson (1972), Marshall et al. (1977), and Lysholm and Gillquist (1982) all developed rating scales for evaluation of knee ligament injuries. All

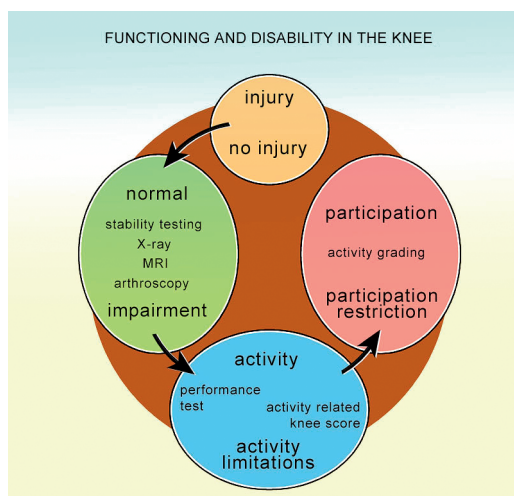
of these scales, and many of those that followed, represent so-called disease-specific rating scales.

The International Classification of Impairment, Disability and Handicap (ICIDH) (WHO 1980) defines the effects of illness or injury on 3 levels: (1) loss of anatomical structure or function (impairment), (2) departure from the norm in terms of performance of the individual (disability), and (3) limitation in activity for the individual (handicap). It is reasonable to evaluate the condition of the patient with knee injury in these terms (Tegner 1985).

In 2001 a new classification of health—the International Classification of Functioning, Disability and Health (ICF)—replaced the old classification (WHO 2001). Here, health is grouped in 2 different parts: functioning and disability, and contextual factors. The latter includes environmental and personal considerations. In a socioeconomic homogeneous cohort, these can be considered reasonably uniform. In this respect, knee-injured patients in the western world can be regarded as a uniform group. According to the ICF, no method of evaluating contextual factors has been described to date.

In turn, functioning and disability includes two different components that should both be evaluated: (1) body functioning and structure, and (2) activities and participation.

Significant deviation from the norm or loss of body function or structure—that is, problems



The role of different methods in the evaluation of functioning and disability in the injured knee. In this model, contextual factors are not included.

involving the physiological functioning of body systems—are called impairment (WHO 2001). After knee injury, the loss of ligament integrity (body structure) can be evaluated by arthroscopy and MRI, for example, and the loss of stability (body function) by KT1000 (see Figure). Activity limitations are difficulties that an individual may have in performing activities and participation restrictions are problems an individual may experience during his or her involvement in situations that happen in everyday life (WHO 2001). These can be expressed on a scoring scale, by a functional test, or by grading of activity. Disability is the combined effect of impairment, activity limitations and participation restriction, and functioning is the absence of disability (Figure).

For knee-injured patients, a vast number of different outcome measures exist, all of which attempt to evaluate the disability. The object of this review is to critically evaluate commonly used knee ligament scoring scales regarding requirements on a score, such as validity, reliability, responsiveness.

Definitions

There are some basic requirements that must be fulfilled before a scale can be accepted. A scale should have good validity, reliability, and responsiveness. There should be no ceiling or floor effect. It should also be clear whether the score is intended for patient or examiner administration.

Validity is a way of describing whether an instrument measures what it claims to measure. Several different types of validity exist (Liang and Jette 1981). Content validity reflects the degree to which an instrument represents a specified sphere of concept, i.e. the opinion of experts or patients. Content validity depends on judgments and should thus not be the only criterion of validity. The simplest form of content validity is called face validity, which may involve the opinion of a single expert.

Criterion validity reflects how well the instrument corresponds to a gold standard that measures the criterion of interest. This also means that criterion validity can be calculated, e.g. as a correlation. Concerning knee scores, a true golden standard does not exist. Concurrent validity shows how well the instrument corresponds to other measurements that are meant to measure the same function. Concurrent validity is expressed as a correlation.

Construct validity shows how well the instrument measures the theoretical construct that it was designed to measure. Construct validity can be either divergent or convergent and can be expressed as a correlation.

Reliability may be defined as the degree to which a measure is free from random error (Johnston et al. 1992). Reliability reflects how consistent or reproducible the instrument is when administered properly.

Internal consistency reliability is calculated with Cronbach's alpha and is based on the average inter-item correlation (SPSS 1998).

Test-retest reliability assesses the degree of stability of a measurement, either over time or between different observers. This can be expressed either as intra- or interpersonal reliability.

Responsiveness (sometimes referred to as sensitivity to changes over time) refers to the ability of a measure to reflect an underlying change or true difference.

A ceiling or floor effect is considered to exist if more than one-third of the patients receive the highest or lowest possible score (Marx et al. 2001). An excellent review of the concepts of validity, reliability and responsiveness was written by Marx et al. (2003).

Literature search

We searched PubMed up to July 2006 with the

following MeSH terms: knee score, reliability, validity, knee evaluation, knee and activity grading. 1,035 abstracts dealing with a knee score were found and reviewed. Of these, only abstracts dealing with knee injuries were selected, i.e. all those on degenerative joint disease were excluded. In the remaining abstracts, the following five knee rating scales were used more frequently than the others: Lysholm-Tegner (Lysholm and Gillquist 1982, Tegner 1985, Tegner and Lysholm 1985), IKDC (International Knee Documentation Committee) (Irrgang and Anderson 2002, Irrgang et al. 1998a, 1998b, 2001), Cincinnati knee rating system (Barber-Westin et al. 1999, Noyes et al. 1984, 1989, 1991), KOOS (Knee Osteoarthritis Outcome Score) (Roos et al. 1998a, b), and Marshall-HSS (Hospital of Special Surgery) (Marshall et al. 1977).

Number of abstracts

The number of abstracts was as follows: Lysholm-Tegner, 498; IKDC, 173; Cincinnati, 73; KOOS, 35; and Marshall/HSS, 22.

Of the 498 abstracts that employed the Lysholm-Tegner knee rating system, 324 used only the knee score and 174 used both the knee score and the activity grading. In addition, another 34 used only the activity grading, but not the knee score. Several abstracts used 2 or more scores simultaneously: 85 used the Lysholm-Tegner and IKDC scores; 10 used the Lysholm-Tegner, IKDC and Cincinnati scores; and 1 used the Lysholm-Tegner and KOOS scores.

The criteria for further analysis were that the abstract should deal with the construction or evaluation of one or several scores intended for knee injuries.

87 abstracts fulfilled our criteria justifying close scrutiny of the full article. 33 articles dealt with 23 different rating scales for knee injury and they were all written by individuals who had participated in the development of the scale. 54 additional articles by other researchers involved analysis of one or (usually) several different scales.

Apart from the most frequently used scores, the work of Flandry et al. (1991) and of Mohtadi (1998) deserve to be mentioned. Although these were well documented in terms of validity and reliability, they had not come into use more than occasion-

ally. The anterior cruciate ligament quality of life (ACL-QOL) scale by Mohtadi (1998) has recently been translated into a Swedish version, and also modified and evaluated with respect to validity, reliability, internal consistency, and floor and ceiling effect (Kvist 2006). ACL-QOL is an interesting concept, as it is a pure quality of life score adapted to patients with anterior cruciate ligament injury.

The remaining scores had neither documented validity nor documented reliability and had not been cited more than occasionally.

Evaluation of scores

The analysis of 5 scores (Lysholm-Tegner, IKDC, Cincinnati, KOOS and Marshall/HSS) included evaluation in relation to the ICF classification and requirements on a score, such as validity, reliability, responsiveness, and mode of administration, etc. The analysis was based on the complete documentation of the actual score at the date of analysis, i.e. it included the original papers and also later documentation.

Results of evaluation of scores (Table)

Lysholm-Tegner rating system

The Lysholm score was first presented in 1982 (Lysholm and Gillquist 1982). It was further developed and refined to include only subjective items (Tegner and Lysholm 1985). The score now consists of 8 different items on a 100-point scale with 25 points each attributed to instability and pain. An activity-grading scale was added (Tegner and Lysholm 1985). Different activities put different demands on the knee, and different patients strive to carry out different activities. Thus, it was considered necessary to grade activities in a standardized way. 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 pre-injury level and the present and desired activity levels can be defined.

The score should be regarded in relation to the activity level. Patients who have reached the desired high activity level and have a high score may have better function than patients with a high score but a low activity level, for example patients

The different evaluated properties for Lysholm-Tegner, IKDC, Cincinnati, KOOS and Marshall/HSS. “+”: good; “(+)”: acceptable; “(–)”: questionable; and “–”: not acceptable. The numbers relate to the references as they appear in the reference list

Score	Patient or examiner administrated	Content validity	Concurrent validity	Construct validity	Internal consistency	Reliability	Responsiveness	Floor or ceiling effect	Simple	Normal material
Lysholm-Tegner	Originally examiner administrated. Documented patient administrated by: 7, 8, 18, 20, 30, 37, 57, 61, 63	+ : 46, 49, 73 (+) : 8, 36, 65 (–) : 38	+ : 49, 57, 73, 79 (+) : 8, 36	+ : 7, 36, 46, 57, 64, 79 (+) : 8, 10	+ : 57 (+) : 30	+ : 4, 10, 46, 57, 73 (+) : 8, 36, 47	+ : 46 (+) : 8, 10, 36, 79	+ : 8, 12, 46, 57, 62	+ : 1, 32	9, 12
IKDC	Originally examiner administrated. The later introduced IKDC subjective questionnaire is patient administrated (27, 28, 30)	+ : 24, 27, 28, 38	+ : 27, 28, 30 – : 57, 59 (variable; symptoms and ligament exam = +, but subjective, ROM and total = –)	+ : 27, 57 – : 10	+ : 28, 30	+ : 10 (subj. questionnaire), 27, 28, 30, 57 – : 10 (original)	+ : 28, 30, 31 (–) : 10, 59	+ : 27 (–) : 57		2, 9
Cincinnati	Examiner administrated	+ : 3, 46, 51, 52, 65		+ : 3, 7, 46, 53, 64 (+) : 10		+ : 3, 10, 47 (–) : 46	+ : 3, 46, 47, 59 (+) : 10	+ : 3, 12, 46		12
KOOS	Patient administrated	+ : 61, 62	+ : 61	+ : 61, 62 (+) : 10	+ : 61	+ : 10, 61, 62	+ : 10, 61, 62	+ : 61	+ : 61	
Marshall/HSS	Examiner administrated			+ : 45						9

who are not fully rehabilitated or those who have adapted to their disability. The Lysholm-Tegner rating system is well documented according to all the analyzed properties.

The IKDC (International Knee Documentation Committee) rating system

This rating scale was developed by a panel of internationally well-recognized orthopedic surgeons. It initially included 7 parameters related to the knee, reflecting both impairment and disability. Patients were graded in 4 different grades—normal, nearly normal, abnormal and severely abnormal, for each of these parameters, and the worse grading determined the final outcome (Hefti et al. 1993). Later

on, the IKDC system was supplemented with a questionnaire with different subjective factors such as symptoms, sports activities, and ability to function. The reliability, validity and responsiveness were found to be good (Irrgang et al. 2001). The IKDC rating system is well documented according to all the analyzed properties.

The Cincinnati knee-rating system

This first Cincinnati knee-rating scale was published in 1983 (Noyes et al. 1983). With a number of modifications, it has been developed for scoring of occupational and athletic activities, symptoms, and functional limitations in sports and daily life (Barber-Westin et al. 1999). The Cincinnati knee-

rating system has 11 components including sections that measure physical examination, instrumented knee stability, testing and radiographic findings. The Cincinnati rating system is also well documented according to all the analyzed properties.

The knee osteoarthritis outcome score (KOOS)

This score was developed in a rigorous manner to assess patient-relevant evaluation of knee injuries as well as posttraumatic osteoarthritis (Roos 1999). It was developed in part from the Western Ontario and McMaster Universities osteoarthritis index (WOMAC). Furthermore, a literature review was done and an expert panel comprising patients, orthopedic surgeons, and physiotherapists was consulted. In the KOOS, 5 dimensions are scored separately (with 42 questions)—pain, symptoms, function in daily living, function in sport and recreation, and knee-related quality of life (Roos et al. 1998b). It presents the results in a profile based on 5 different values, and not as a combined score. By including knee-related quality of life, KOOS differs from Lysholm-Tegner, IKDC, Cincinnati and Marshall-HSS. In contrast to IKDC and Cincinnati, but in accordance with Lysholm-Tegner, KOOS does not include clinical findings. KOOS had validity, reliability, responsiveness, internal consistency and no floor or ceiling effect. Contrary to the Lysholm-Tegner, IKDC and Cincinnati rating systems, which have all been modified and documented since they were first presented, KOOS was thoroughly documented before it came into use for the first time.

The Marshall/HSS (Hospital of Special Surgery) score

In 1977, Marshall et al. presented their first standardized evaluation system for knee ligament injuries. Related to standards at that time, they made an ambitious attempt to evaluate validity. This evaluation system was later developed stepwise into the Hospital for Special Surgery (HSS) score (Warren and Marshall 1978, Freeman et al. 1982, Hanley and Warren 1987). Unfortunately, in the further development of the Marshall/HSS score validity and reliability were not documented. Until this is done, it cannot be recommended.

Discussion

We did not find an indisputable “gold standard” for evaluation of knee function after traumatic knee injuries.

We suggest that a modern knee-rating system should at least fulfill the following criteria:

It should evaluate the knee according to the ICF.

It should be valid and reliable.

It should be sensitive to clinically important changes.

It should have internal consistency.

It should not have any floor or ceiling effects.

It should have been evaluated in both patients and a relevant reference population.

It should be simple to use.

It should not include a composite score, i.e. it should only include symptoms and a subjective evaluation of function, but not clinical findings, results of a functional test, or activity level. Such parameters should be registered separately and combined with a score in an evaluation system.

It should include an injury-specific score.

The Lysholm-Tegner, IKDC, Cincinnati, and KOOS are all reasonably injury-specific. The Lysholm-Tegner score summarizes activity limitations and symptoms related to activity in one score and activity limitations in another. The Cincinnati score, like the IKDC, sums up several different aspects of the ICF in one result, but it can also be presented as several subscores. We suggest that their summed scores should not be used, as we advise against the use of composite scores. The KOOS presents the result in a profile based on symptoms, activity limitations, and health-related quality of life.

In order to allow independent analysis and better discrimination, separate scores for symptoms, subjective functions, and objective results should be used (Anderson et al. 1993, Sgaglione et al. 1995, Neeb et al. 1997). We suggest that the result is best presented as one value for each part of the ICF. Only the Lysholm-Tegner rating system is clearly related to the ICF (ICIDH) by the authors (Tegner 1985).

Whether a score should be filled in by the examiner or by the patient himself has been a matter of discussion (Roos 1999). Both ways have advantages and disadvantages. The older scores (such as

the Lysholm score) were not developed for patient administration. Even so, several authors have used it as a questionnaire (Table). In a recent study of meniscus injuries by Briggs et al. (2006), it was shown that in a patient-administered questionnaire the Lysholm score and Tegner activity scale had acceptable test-retest reliability, floor and ceiling effect, criterion validity, construct validity, and responsiveness to change. In the modern IKDC, the subjective part is developed as a patient-administered questionnaire with documented validity and reliability (Irrgang and Andersen 2002). The Cincinnati knee rating system remains examiner-administered, however. Roos (1999) has shown that careful analysis of questions and development of guidelines are necessary for a score to be patient-administered. The lack of this may be one explanation for the finding by Hoher et al. (1997) that patients achieved a lower score with a self-administered Lysholm score than when it was completed by the examiner. Another explanation may be the effect of interview bias (Hoher et al. 1997).

Although the patient is the best expert on his or her own knee (Roos 1999), the matter of mode of administration is not uncomplicated. Whose judgment about the knee is closest to the “truth”, the patient’s or the examiner’s? In patients who have had a hip arthroplasty, it has been shown that both patients and doctors have a relatively similar perception of outcome, with the exception of patients with a low score, co-morbidity in other joints, or other health problems (Liebermann et al. 1996, McGee et al. 2002). These patients rated their outcome as being worse than their doctor. Unrealistic expectations about the result can also make the patient less satisfied (Haworth et al. 1981). However, we agree with Roos (1999) that a modern score should preferably be developed for patient administration.

Several authors have found different results using different scoring scales for the same patient (Bollen and Seedholm 1991, Anderson et al. 1993, Peters et al. 1997, Brinker et al. 1999, Hrubesch et al. 2000). Thus, results cannot be transferred from one score to another.

Which score is best?

Each of the 4 scores (Lysholm-Tegner, IKDC, Cincinnati and KOOS) has its advantages and disad-

vantages. The Cincinnati and IKDC are comprehensive and evaluate many aspects of the knee; on the other hand, the Lysholm-Tegner system is much simpler and mainly evaluates symptoms and activity. This makes the latter the easiest one to use.

In addition, the Lysholm-Tegner and the KOOS do not summarize objective results and subjective functions in the same result. Kocher et al. (2002) made a comprehensive analysis of determinants of patient satisfaction with the outcome after ACL reconstruction. They concluded that subjective variables are more important for evaluation of patient satisfaction than objective findings. They found 7 “key” symptoms that together accounted for 83% of the variability in patients’ satisfaction with the outcome. Stability testing correlates poorly with the subjective outcome after knee ligament reconstruction (Strand et al. 2005). This is in favor for Lysholm-Tegner and KOOS. We emphasize, however, that objective findings must be recorded as well, but separately.

Johnson and Smith (2001) stated that the Lysholm score and the Tegner activity rating had been adequately tested, and were easy to use, making them ideal as “golden standards” to which future measures can be compared. In a structured review of 16 patient-assessed knee evaluation instruments, Garrat et al. (2004) stated that KOOS presented good evidence of reliability, content and construct validity, and responsiveness. This review has shown that the Lysholm-Tegner rating scale is the most widely used evaluation system. Consequently, score results in different types of knee injuries are easy to find for purposes of comparison.

As different diagnoses cause different symptoms, it is not logical to use the same score for injuries that are substantially different from each other. An instrument that has demonstrated satisfactory measurement properties in one population is not necessarily appropriate for use in other populations (Fitzpatrick et al. 1998). It is better to use an injury-specific score and combine it with a generic score. The generic score can be used for comparisons with other diagnoses. The KOOS is the only score that includes assessment of health-related quality of life. This part of the KOOS was developed specifically for the knee, however. For comparison with other diagnoses outside the knee,

it is still necessary to combine it with a generic score.

Future perspectives

An increasing number of methods to evaluate the results of treatment are being published. This is true for almost all fields of orthopedics. We feel that a common strategy is needed. We suggest that this includes documentation of clinical parameters that are valid for a successful treatment and for complications. This should be combined with an estimation of the result from the patient's point of view and an evaluation of health-related quality of life. For health-economic purposes, an estimation of the cost of the treatment may be included. Currently, there is no tradition of health-economic analysis in the orthopedic community, but it is likely that these types of studies will become more common in the future. Depending on the purpose all three or four different perspectives of the result can be evaluated either with simple methods or thoroughly. For example, estimation of the result from the patient's point of view might include a scoring scale and an activity grading scale, or a simple global assessment of the result. Such a simple assessment may have validity that is as good as that of a more comprehensive score (Williams et al. 2000).

No competing interests declared.

- 1 Andersson A F, Federspiel C F, Snyder R B. Evaluation of knee ligament rating systems. *Am J Knee Surg* 1993; 6 (2): 67-73.
- 2 Andersson A F, Irrgang J J, Kocher M S. The International Knee Documentation Committee Subjective Knee Evaluation Form. Normative data. *Am J Sports Med* 2006; 34 (1): 128-35.
- 3 Barber-Westin S D, Noyes F R, McCloskey J W. Rigorous statistical reliability, validity, and responsiveness testing of the Cincinnati knee rating system in 350 subjects with uninjured, injured, or anterior cruciate ligament-reconstructed knees. *Am J Sports Med* 1999; 27 (4): 402-16.
- 4 Bengtsson J, Mollborg J, Werner S. A study for testing the sensitivity and reliability of the Lysholm knee scoring scale. *Knee Surg Sports Traumatol Arthrosc* 1996; 1 (4): 27-31.
- 5 Bollen S, Seedhom B B. A comparison of the Lysholm and Cincinnati knee scoring questionnaires. *Am J Sports Med* 1991; 2 (19): 189-90.
- 6 Bombardier C H, Melfi C A, Paul J E [alla namn]. Comparison of a generic and a disease-specific measure of pain and physical function after knee replacement surgery. *Med Care (Suppl)* 1995; 33: AS131-44.
- 7 Borsa P A, Lephart S M, Irrgang J J. Comparison of performance-based and patient-reported measures of function in anterior-cruciate-ligament-deficient individuals. *J Orthop Sports Phys Ther* 1998; 6 (28): 392-9.
- 8 Briggs K K, Kocher M S, Rodkey W G, Steadman R J. Reliability, validity and responsiveness of the Lysholm knee score and Tegner activity scale for meniscus injuries of the knee. *J Bone Joint Surg (Am)* 2006; 88 (4): 698-705.
- 9 Brinker M R, Garcia R, Barrack R L, Timon S, Guinn S, Fong B. An analysis of sports knee evaluation instruments. *Am J Knee Surg* 1999; 1 (12): 15-24.
- 10 Chaory K, Poiraudau. Rating scores for ACL ligamentoplasty. *Ann Réadaptation Med Phys* 2004; 47: 309-16.
- 11 D'Aubigne R M, Postel M. Functional results of hip arthroplasty with acrylic prosthesis. *J Bone Joint Surg (Am)* 1954; 3 (36): 451-75.
- 12 Demirdjian A M, Petrie S G, Guanche C A, Thomas K A. The outcomes of two knee scoring questionnaires in a normal population. *Am J Sports Med* 1998; 1 (26): 46-51.
- 13 Ferrari J D, Bach B R, Jr., Bush-Joseph C A, Wang T, Bojchuk J. Anterior cruciate ligament reconstruction in men and women: An outcome analysis comparing gender. *Arthroscopy* 2001; 6 (17): 588-96.
- 14 Fitzpatrick R, Davey C, Buxton M J, Jones D R. Evaluating patient-based outcome measures for use in clinical trials. *Health Technol Assess* 1998; 2: 1-74.
- 15 Flandry F, Hunt J P, Terry G C, Hughston J C. Analysis of subjective knee complaints using visual analog scales. *Am J Sports Med* 1991; 2 (19): 112-8.
- 16 Freeman B L, Beatty J H, Haynes D B. The pes anserinus transfer a long term follow up. *J Bone Joint Surg (Am)* 1982; (64): 202-7.
- 17 Freeman M A, Todd R C, Cundy A D. The presentation of the results of knee surgery. *Clin Orthop* 1977; (128): 222-7.
- 18 Garrat A M, Brealy S, Gillespie W J. Patient-assessed health instruments for the knee. a structured review. *Rheumatology* 2004; 11 (43): 1414-23.
- 19 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; 4 (51): 626-42.
- 20 Hamberg P, Gillquist J. Knee function after arthroscopic meniscectomy. A prospective study. *Acta Orthop Scand* 1984; 2 (55): 172-5.
- 21 Hanley S T, Warren R F. Arthroscopic meniscectomy in the anterior cruciate ligament deficient knee. *Arthroscopy* 1987; (3): 59-65.
- 22 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; 4 (51): 737-55.

- 23 Haworth R J, Hopkins J, Ells P, Ackroyd C E, Mowat A G. Expectation and outcome of total hip arthroplasty. *Rheum Rehab* 1981; 2 (20): 65-70.
- 24 Hefti F, Muller W, Jakob R P, Staubli H U. Evaluation of knee ligament injuries with the IKDC form. *Knee Surg Sports Traumatol Arthrosc* 1993; 3-4 (1): 226-34.
- 25 Hoher J, Bach T, Munster A, Bouillon B, Tiling T. Does the mode of data collection change results in a subjective knee score? Self-administration versus interview. *Am J Sports Med* 1997; 5 (25): 642-7.
- 26 Hrubesch R, Rangger C, Reichkendler M, Sailer R F, Gloetzer W, Eibl G. Comparison of score evaluations and instrumented measurement after anterior cruciate ligament reconstruction. *Am J Sports Med* 2000; 6 (28): 850-6.
- 27 Irrgang J J, Anderson A F. Development and validation of health-related quality of life measures for the knee. *Clin Orthop* 2002; (402): 95-109.
- 28 Irrgang J J, Anderson A F, Boland A L, Harner C D, Kurosaka M, Neyret P, Richmond J C, Shelborne K D. Development and validation of the international knee documentation committee subjective knee form. *Am J Sports Med* 2001; 5 (29): 600-13.
- 29 Irrgang J J, Ho H, Harner C D, Fu F H. Use of the International Knee Documentation Committee guidelines to assess outcome following anterior cruciate ligament reconstruction. *Knee Surg Sports Traumatol Arthrosc* 1998a; 2 (6): 107-14.
- 30 Irrgang J J, Snyder-Mackler L, Wainner R S, Fu F H, Harner C D. Development of a patient-reported measure of function of the knee. *J Bone Joint Surg (Am)* 1998b; 8 (80): 1132-45.
- 31 Irrgang J J, Andersson A F, Boland A L, Harner C D, Neyret P, Richmond J C, Shelbourne K D. Responsiveness of the International Knee Documentation Committee Subjective knee form. *Am J Sports Med* 2006; 34 (10): 1567-1563.
- 32 Johnson D S, Smith R B. Outcome measurement in the ACL deficient knee--what's the score? *Knee* 2001; 1 (8): 51-7.
- 33 Johnston M V, Keith R A, Hinderer S R. Measurement standards for interdisciplinary medical rehabilitation. *Arch Phys Med Rehab* 1992; 12-S (73): S3-23.
- 34 Katz J N, Harris T M, Larson M G, Krushell R J, Brown C H, Fossel A H, Liang M H. Predictors of functional outcomes after arthroscopic partial meniscectomy. *J Rheumatol* 1992; 12 (19): 1938-42.
- 35 Kettelkamp D B, Thompson C. Development of a knee scoring scale. *Clin Orthop*. 1975; 107 93-9.
- 36 Kocher M S, Steadman J R, Briggs K, Zurakowski D, Sterett W I, Hawkins R J. Determinants of patient satisfaction with outcome after anterior cruciate ligament reconstruction. *J Bone Joint Surg (Am)* 2002; 9 (84): 1560-72.
- 37 Kvist J. The Swedish ACL-QOL questionnaire on quality of life after anterior cruciate ligament tear - validity and reliability. Swedish Society on Sport Medicine Annual Congress, Orebro, 2006, abstract (in Swedish).
- 38 Labs K, Paul B. To compare and contrast the various evaluation scoring systems after anterior cruciate ligament reconstruction. *Arch Orthop Trauma Surg* 1997; 1-2 (116): 92-6.
- 39 Larson C B. Rating scale for hip disabilities. *Clin Orthop*. 1963; (31): 85-93.
- 40 Larson R L. Rating sheet for knee function. 1972. In *Smillie: Diseases of the knee joint*. Churchill, Livingstone, Edinburgh.
- 41 Lazansky M G. A method for grading hips. *J Bone Joint Surg (Br)* 1967; 4 (49): 644-51.
- 42 Liang M H, Jette A M. Measuring functional ability in chronic arthritis: a critical review. *Arthritis Rheum* 1981; 1 (24): 80-6.
- 43 Liebermann J R, Frederick D, Shekelle P, Schumacher L, Thomas B J, Kilgus D J, Finerman G A. Differences between patient's and physician's evaluations of outcome after total hip arthroplasty. *J Bone Joint Surg (Am)* 1996; 78: 835-8.
- 44 Lysholm J, Gillquist J. Evaluation of knee ligament surgery results with special emphasis on use of a scoring scale. *Am J Sports Med* 1982; 3 (10): 150-4.
- 45 Marshall J L, Fetto J F, Botero P M. Knee ligament injuries: a standardized evaluation method. *Clin Orthop* 1977; (123): 115-29.
- 46 Marx R G, Jones E C, Allen A A, Altchek D W, O'Brien S J, Rodeo S A, Williams R J, Warren R F, Wickiewicz T L. Reliability, validity, and responsiveness of four knee outcome scales for athletic patients. *J Bone Joint Surg (Am)* 2001; 83: 1459-69.
- 47 Marx R G, Menezes A, Horovitz L, Jones E C, Warren R F. A comparison of two time intervals for test-retest reliability of health status instruments. *J Clin Epidemiol* 2003; 8 (56): 730-5.
- 48 McGee M A, Howie D A, Ryan P, Moss J R, Holubowycz O T. Comparison of patient and doctor responses to a total hip arthroplasty clinical evaluation questionnaire. *J Bone Joint Surg (Am)* 2002; 84 (10): 1745-52.
- 49 Mohtadi N. Development and validation of the quality of life outcome measure (questionnaire) for chronic anterior cruciate ligament deficiency. *Am J Sports Med* 1998; 3 (26): 350-9.
- 50 Neeb T B, Aufdemkampe G, Wagener J H, Mastenbroek L. Assessing anterior cruciate ligament injuries: the association and differential value of questionnaires, clinical tests, and functional tests. *J Orthop Sports Phys Ther* 1997; 6 (26): 324-31.
- 51 Noyes F R, Mooar P A, Matthews D S, Butler D L. The symptomatic anterior cruciate-deficient knee. Part I: the long-term functional disability in athletically active individuals. *J Bone Joint Surg (Am)* 1983; 2 (65): 154-62.
- 52 Noyes F R, McGinniss G H, Mooar L A. Functional disability in the anterior cruciate insufficient knee syndrome. Review of knee rating systems and projected risk factors in determining treatment. *Sports Med* 1984; 4 (1): 278-302.
- 53 Noyes F R, Barber S D, Mooar L A. A rationale for assessing sports activity levels and limitations in knee disorders. *Clin Orthop* 1989; (246): 238-49.

- 54 Noyes F R, Moar L A, Barber S D. The assessment of work-related activities and limitations in knee disorders. *Am J Sports Med* 1991; 2 (19): 178-88.
- 55 Nyland J, Johnson D L, Caborn D N, Brindle T. Internal health status belief and lower perceived functional deficit are related among anterior cruciate ligament-deficient patients. *Arthroscopy* 2002; 5 (18): 515-8.
- 56 O'Donoghue D H. An analysis of end results of surgical treatment of major injuries to the ligaments of the knee. *J Bone Joint Surg (Am)* 1955; 37: 1-13.
- 57 Paxton E W, Fithian D C, Stone M L, Silva P. The reliability and validity of knee-specific and general health instruments in assessing acute patellar dislocation outcomes. *Am J Sports Med* 2003; 4 (31): 487-92.
- 58 Peters G, Wirth C J, Kohn D. Comparison of knee ligament scores and rating systems. *Z Orthop Ihre Grenzgeb* 1997; 1 (135): 63-9.
- 59 Risberg M A, Holm I, Steen H, Beynnon B D. Sensitivity to changes over time for the IKDC form, the Lysholm score, and the Cincinnati knee score. A prospective study of 120 ACL reconstructed patients with a 2-year follow-up. *Knee Surg Sports Traumatol Arthrosc* 1999; 3 (7): 152-9.
- 60 Roos E. Knee injury and knee osteoarthritis. *Lunds University, Lund, Swede*, 1999.
- 61 Roos E M, Roos H P, Ekdahl C, Lohmander L S. Knee Injury and Osteoarthritis Outcome Score (KOOS)—validation of a Swedish version. *Scand J Med Sci Sports* 1998a; 6 (8): 439-48.
- 62 Roos E M, Roos H P, Lohmander L S, Ekdahl C, Beynnon B D. Knee Injury and Osteoarthritis Outcome Score (KOOS)—development of a self-administered outcome measure. *J Orthop Sports Phys Ther* 1998b; 2 (28): 88-96.
- 63 Sekiya J K, Giffin J R, Irrgang J J, Fu F H, Harner C D. Clinical outcomes after combined meniscal allograft transplantation and anterior cruciate ligament reconstruction. *Am J Sports Med* 2003; 6 (31): 896-906.
- 64 Sernert N, Kartus J, Kohler K, Stener S, Larsson J, Eriksson B I, Karlsson J. Analysis of subjective, objective and functional examination tests after anterior cruciate ligament reconstruction. A follow-up of 527 patients. *Knee Surg Sports Traumatol Arthrosc* 1999; 3 (7): 160-5.
- 65 Sgaglione N A, Del Pizzo W, Fox J M, Friedman M J. Critical analysis of knee ligament rating systems. *Am J Sports Med* 1995; 6 (23): 660-7.
- 66 Shapiro E T, Richmond J C, Rockett S E, McGrath M M, Donaldson W R. The use of a generic, patient-based health assessment (SF-36) for evaluation of patients with anterior cruciate ligament injuries. *Am J Sports Med* 1996; 2 (24): 196-200.
- 67 SPSS. SPSS Base 9.0. User's guide. SPSS Inc, 1998.
- 68 Stannard J P, Sheils T M, McGwin G, Volgas D A, Alonso J E. Use of a hinged external knee fixator after surgery for knee dislocation. *Arthroscopy* 2003; 6 (19): 626-31.
- 69 Strand T, Mölster A, Hordvik M, Krukhaug Y. Long term follow-up after primary repair of the anterior cruciate ligament: clinical and radiological evaluation 15-23 years postoperatively. *Arch Orthop Trauma Surg* 2005; (125): 217-21.
- 70 Stucki G, Liang M H, Fossel A H, Katz J H. Realitive responsiveness of condition-specific and generic health status measurements in degenerative lumbar spinal stenosis. *J Clin Epidemiol* 1995; 48: 1369-79.
- 71 Szende A, Williams A. Measuring self-reported population health: an international perspective based on EQ-5D. 2004. Spring Med Publishing Ltd, Hungary.
- 72 Tegner Y. Cruciate ligament injuries in the knee - evaluation and rehabilitation. Linköping University Medical Dissertation, Linköping, 1985.
- 73 Tegner Y, Lysholm J. Rating systems in the evaluation of knee ligament injuries. *Clin Orthop* 1985; (198): 43-9.
- 74 Vangsness C T Jr., Mac P, Requa R, Garrick J. Review of outcome instruments for evaluation of anterior cruciate ligament reconstruction. *Bull Hosp Jt Dis* 1995; 1 (54): 25-9.
- 75 Ware J. The SF-36 Health Survey. Manual and Interpretation Guide. Nimrod Press, Boston, 1993.
- 76 Warren R F, Marshall J L. Injuries of the anterior cruciate and medial collateral ligaments of the knee. A long term follow-up of 86 cases - part 2. *Clin Orthop* 1978; (136): 198-211.
- 77 WHO. International classification of impairments, disability and handicap. World Health Organisation, Geneva. 1980.
- 78 WHO. International classification of functioning, disability and health. World Health Organisation, Geneva. 2001.
- 79 Williams G N, Taylor D C, Gangel T J, Uhorchak J M, Arciero R A. Comparison of the single assessment numeric evaluation method and the Lysholm score. *Clin Orthop* 2000; (373): 184-92.
- 80 von Porat A, Roos E M, Roos H. High prevalence of osteoarthritis 14 years after an anterior cruciate ligament tear in male soccer players: a study of radiographic and patient relevant outcomes. *Ann Rheum Dis* 2004; 63 (3): 269-73.