



## Isolated anterior cruciate ligament deficiency, knee scores and function

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The aim of this study was to ascertain whether there was a correlation between commonly used scoring scales used for follow-up study of management of knee problems and whether age, gender, and time interval between injury and management and type of management affect the assessment of outcome in the management of ACL insufficiency. One hundred and twelve patients who had received ACL reconstruction were identified from hospital records. Each of them received a package containing three questionnaires, namely the Lysholm knee score, Mohtadi-QoL, and the Modified Cincinnati Rating Scale. The overall response rate was 55%. There was a relatively strong relationship between all three scores, with a very strong correlation between Cincinnati and Mohtadi questionnaires. The Lysholm score showed significant correlation between the method of treatment and outcome. Our study shows a good relationship between the three scoring systems, and helps to understand what questions should be asked to the patient with an ACL injury to elicit a true representation of their knee function.

**Keywords:** anterior cruciate ligament injury ; scoring systems ; patients' administered questionnaire ; long term outcome.

### INTRODUCTION

Anterior cruciate ligament (ACL) injuries are among the most common conditions of the knee in the young adults (3). An isolated ACL rupture is found in up to 70% of patients with acute knee haemarthrosis (14,24).

ACL insufficiency may lead to disability and changes in lifestyle (19,20). Post-injury assessment involves both objective and subjective tools. Objective tests do not depend on, and are not influenced by, patients' personal opinion or prejudices. In contrast, subjective tests are based on patients' personal opinions or feelings. Subjective assessment portrays the patients' perception of their knee function in sporting as well as daily activities, and satisfaction level. Irrespective of the method used to assess the effectiveness and success of a therapeutic intervention, there is a poor correlation between

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clinical signs, knee assessment scores and patients' satisfaction and functional abilities (13,28,29). Several factors have been thought to influence outcome following ACL injuries, including age, gender, and time interval between injury and management (17,21).

Three commonly used scoring scales used for follow-up study of management of knee problems are the Lysholm Questionnaire (23), the Modified Cincinnati Knee Rating Score (22), and the Mohtadi Quality of Life Questionnaire (27). Each of these questionnaires uses a different approach to assess function.

We wished to ascertain whether there was a correlation between these questionnaires, and whether age, gender, and time interval between injury and management affect outcome.

## PATIENTS & METHODS

Ethical approval was obtained from the Grampian Research Ethics Committee. All patients with isolated ACL injury who were managed under the care of two fellowship trained knee and sports trauma surgeons at Woodend Hospital, Aberdeen, in the period 1996-2001 were included. All patients who had received ACL reconstruction were identified from the personal logbook of the two surgeons, patients' records, and operating theatre books. The Physiotherapy Out-Patient Department patient's records were searched to identify patients with the same injury who had been managed conservatively. All ACL-deficient patients managed conservatively had received an arthroscopy or magnetic resonance imaging.

None of the conservatively managed patients had associated injuries to the same knee, had surgery other than diagnostic arthroscopy on the knee, and had injuries to the contralateral knee. We recruited to this study the 81 patients who had received isolated ACL reconstruction, as the others were recruited to a different study. We also identified the 31 patients who received conservative management for ACL insufficiency in this period. We posted to each of these 112 patients a package containing an introductory letter, explaining the purpose of the study, an information sheet explaining what the project entailed and the three questionnaires, namely, Lysholm knee score, Mohtadi-QoL, and the Modified Cincinnati Rating Scale.

Of the 112 packages, 21 were returned with an 'addressee unknown' notice. After an extensive search, we were unable to locate these subjects. After 6 weeks from the original mailing, the package was re-sent to the non-responders. If there was still no response, a follow-up telephone call attempted to encourage completion of the questionnaire. If this attempt failed, this was counted as a non-response (10).

The data obtained from the returned questionnaires were analysed using descriptive statistical tests. The questionnaire data are reported using the median value, the mode, the range, the minimum and maximum value and the 25<sup>th</sup> and 75<sup>th</sup> percentile. Two-tailed Spearman's Rank Correlation was calculated to ascertain the correlation between the three questionnaires. Multiple regression analysis was performed on each of the questionnaires to ascertain whether age, gender, management method, and time interval between injury and management have an effect on knee function (9). Significance was set at  $p < 0.05$ .

## RESULTS

### Patient Factors

Of the 112 questionnaires, 21 were returned as addressee unknown. After an extensive search, we were unable to locate these subjects. Of the remaining 91, 55 questionnaires were returned, an overall response rate of 55% (50/91), with no differences in age, sex, time interval between injury and onset of management between responders and non-responders and between patients managed conservatively and operatively. Five questionnaires were spoilt, and we did not include them in our analysis.

Table I. — Scores recorded by the three questionnaires

| Parameter   | Lysholm |       | Cincinnati |       | Mohtadi |           |
|-------------|---------|-------|------------|-------|---------|-----------|
| Mean        |         | 66.00 |            | 79.16 |         | 65.82     |
| Median      |         | 74.50 |            | 85.00 |         | 72.00     |
| Mode        |         | 95    |            | 100   |         | 82 and 87 |
| Range       |         | 85    |            | 67    |         | 90        |
| Minimum     |         | 15    |            | 33    |         | 10        |
| Maximum     |         | 100   |            | 100   |         | 100       |
| Percentiles | 25      | 40.00 | 25         | 67.75 | 25      | 47.00     |
|             | 75      | 95.00 | 75         | 94.00 | 75      | 87.00     |

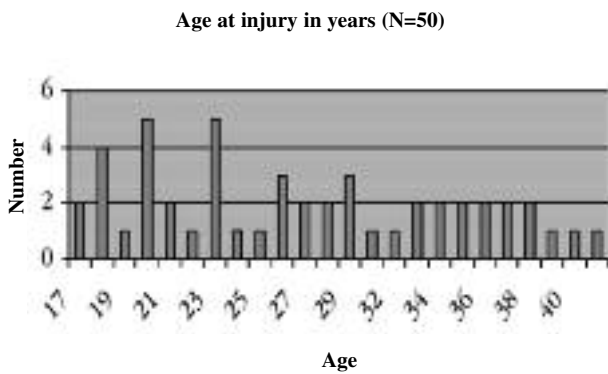


Fig. 1

Of the patients who had been managed for an ACL injury during the period under study, there were 94 males and 18 females, a male to female ratio of 5.2:1. Forty male and 10 female patients returned the questionnaire, a male to female ratio of 4:1.

The average age at injury was  $27 \pm 7.23$  years (range : 17 to 42). The age distribution at the time of injury was bimodal, with a peak at 20 and another at 23 years. The mean age at surgery (28.10 years) was lower than the mean age of those receiving conservative management (36.86 years), although the oldest patient in our study was operated upon (fig 1). Our patients injured their ACL in one of six major mechanisms : soccer, skiing, basketball, rugby, road traffic accidents, and falling,

with soccer [60% (54/91)] accounting for most injuries (fig 2).

The median time interval between initial injury and management was similar in both the conservatively and surgically managed groups (15 and 15.5 months, respectively).

**Questionnaires**

In the present study, none of the scores followed a normal distribution (table I). The Lysholm Questionnaire scores ranged from 15-100. The median score was 74.5, and the most frequent score was 90. The percentile values show us that 50% of the scores lay in the range of 40 to 95.

The Modified Cincinnati Score scores ranged from 33-100, and the mean was 79.16. The median value was 85, and the mode was 100. Fifty percent of the scores lay between 67.75 and 94.

The Mohtadi Quality of Life Questionnaire scores ranged from 15-100. The mean value was 65.82, and the scores ranged from 10 to 100. The median value was 72 and the mode lay between 82 and 87. In addition, 50% of the results lay within the range 47-87.

**Relationship between the Questionnaires**

*Lysholm v Cincinnati*

There was a relatively strong relationship between the two scores (Spearman's' Rank



Fig. 2

Table IIa. — Lysholm v Cincinnati Spearmans' Rank Correlation

|            |                         | Lysholm | Cincinnati |
|------------|-------------------------|---------|------------|
| Lysholm    | Correlation Coefficient | 1.000   | 0.674      |
|            | Sig. (2-tailed)         | .       | <.001      |
|            | N                       | 50      | 50         |
| Cincinnati | Correlation Coefficient | 0.674   | 1.000      |
|            | Sig. (2 tailed test)    | .000    | .          |
|            | N                       | 50      | 50         |

Correlation is significant at the .01 level (2-tailed).

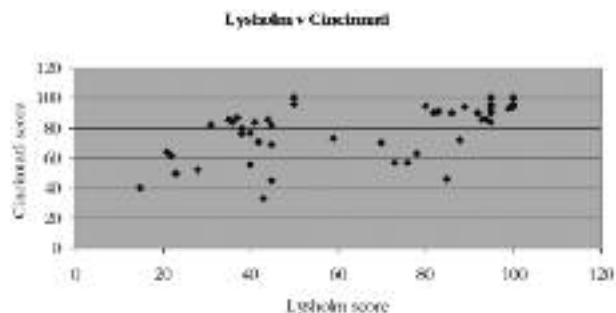


Fig. 3

Table IIb. — Lysholm v Mohtadi Spearmans' Rank Correlation

|         |                         | Lysholm | Mohtadi |
|---------|-------------------------|---------|---------|
| Lysholm | Correlation Coefficient | 1.000   | 0.674   |
|         | Sig. (2-tailed)         | .       | .000    |
|         | N                       | 50      | 50      |
| Mohtadi | Correlation Coefficient | 0.674   | 1.000   |
|         | Sig. (2 tailed test)    | .000    | .       |
|         | N                       | 50      | 50      |

Correlation is significant at the .01 level (2-tailed).

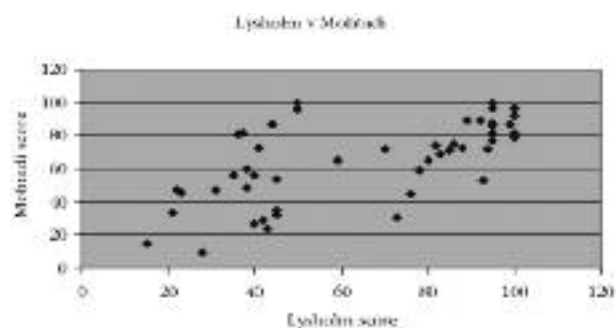


Fig. 4

Table IIc. — Cincinnati v Mohtadi Spearmans Rank Correlation

|            |                         | Cincinnati | Mohtadi |
|------------|-------------------------|------------|---------|
| Cincinnati | Correlation Coefficient | 1.000      | 0.864   |
|            | Sig. (2-tailed)         | .          | .000    |
|            | N                       | 50         | 50      |
| Mohtadi    | Correlation Coefficient | 0.864      | 1.000   |
|            | Sig. (2 tailed test)    | .000       | .       |
|            | N                       | 50         | 50      |

Correlation is significant at the .01 level (2-tailed).

#### *Cincinnati v Mohtadi*

There was a very strong relationship between the two scores (Spearmans' Rank Correlation Coefficient  $W = 0.864$ ;  $p = 0.01$ ] (table IIc and fig 5).

#### **Relationship between Scoring methods and Patient Factors**

We studied whether the above-mentioned factors influenced the evaluation of knee function as assessed by the three scoring systems. In the three questionnaires, the higher the score, the better the knee function, with the maximum score of 100 indicating a perfectly normal functioning knee. There were no statistically significant findings between the Cincinnati Score and the patient factors ( $r^2 =$

Correlation Coefficient  $W = 0.674$ ;  $p = 0.01$ ] (table IIa and fig 3).

#### *Lysholm v Mohtadi*

There was a relatively strong relationship between the two scores (Spearmans' Rank Correlation Coefficient  $W = 0.674$ ;  $p = 0.01$ ] (table IIb and fig 4).

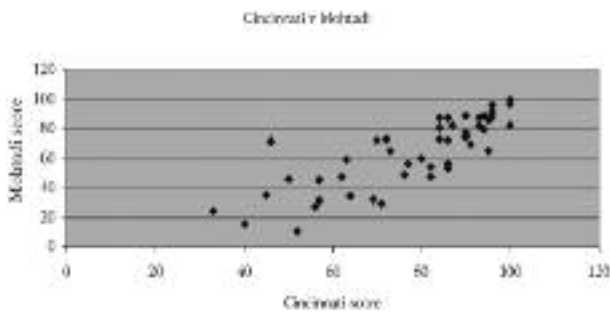


Fig. 5

Table III. — Multiple Regression : Cincinnati Score

|       |                                      | Unstandardized Coefficients | p value |
|-------|--------------------------------------|-----------------------------|---------|
| Model |                                      | B                           |         |
| 1     | (Constant)                           | 76.675                      | 0.000   |
|       | Gender                               | 7.119E-0.2                  | 0.991   |
|       | Management method                    | -3.808                      | 0.658   |
|       | Time in between injury and treatment | 0.112                       | 0.264   |
|       | Age at treatment                     | 2.641E-0.2                  | 0.951   |

Dependant Variable : Cincinnati score,  $r^2 = 0.43$ .

Table IV. — Multiple Regression : Lysholm Score

|       |                                      | Unstandardized Coefficients | p value |
|-------|--------------------------------------|-----------------------------|---------|
| Model |                                      | B                           |         |
| 1     | (Constant)                           | 61.442                      | 0.001   |
|       | Gender                               | 2.6700.042                  | 0.785   |
|       | Management method                    | -29.339                     | 0.025   |
|       | Time in between injury and treatment | 7.278E-0.2                  | 0.607   |
|       | Age at treatment                     | 0.241                       | 0.703   |

Dependant Variable : Lysholm score,  $r^2 = 0.135$ .

Table V. — Multiple Regression : Mohtadi QoL

|       |                                      | Unstandardized Coefficients | p value |
|-------|--------------------------------------|-----------------------------|---------|
| Model |                                      | B                           |         |
| 1     | (Constant)                           | 59.278                      | 0.000   |
|       | Gender                               | 0.0422.307                  | 0.794   |
|       | Management method                    | 0.124-10.387                | 0.365   |
|       | Time in between injury and treatment | 5.365E-0.2-0.169            | 0.686   |
|       | Age at treatment                     | 0.244                       | 0.668   |

Dependant Variable : Mohtadi QoL score,  $r^2 = 0.031$ .

0.43) (table III). However, with the Lysholm score, there appears to be statistical evidence that the method of treatment, i.e. surgery or conservative management after an ACL injury, had a bearing on knee function. As the correlation is negative, those patients who received surgery have a higher Lysholm score, i.e. a better knee function (table IV). The Mohtadi QoL Questionnaire produced no statistically significant findings (table V).

## DISCUSSION

### Patients' Factors

ACL tears are commonly caused by sports activities. Most patients are 18-25 years old, and are active in a sport for a number of years, usually soccer, skiing or a jumping sport such as basketball.

Many patients with a torn ACL usually have very limited, if any, symptoms in normal daily life (25). Eventually, the instability that may follow a torn ACL manifests itself, especially when the patients attempt to return to their sporting activities, resulting in recurrent subluxations (2). At this point, most of our patients sought medical advice.

Our patients injured their ACL between the ages of 17 and 42 years, and 82% (41/50) of them injured their ACL through sports. The time between initial injury and receiving treatment for their torn ACL varied from four months to 16 years, a result of the delayed diagnosis of the ACL injury (24). Most of our patients were diagnosed after being referred to a knee specialist by their general practitioner. The two patients who injured their knee whilst skiing abroad received immediate correct diagnosis and received treatment in our setting

within five months. On the other hand, four patients who had injured their knees while skiing in Scotland were not immediately diagnosed as having an ACL tear at their initial consultations at either the local Accident and Emergency Department or their GPs, and did not receive treatment for several months after the injury. The median time interval between initial injury and management was surprisingly similar in both conservatively and surgically managed patients.

ACL reconstruction in young active patients is more successful than rehabilitation and use of a brace (1,6,28). Older patients may be more willing to undergo activity modification, which would result in a good prognosis. Despite the lack of an association between age at the time of reconstruction and decreased postoperative function (28), some surgeons are concerned that operative reconstruction of the ACL in older individuals can be associated with a higher rate of arthrofibrosis, and thus a decrease in range of motion (12). However, studies on patients over 40 years at ACL reconstruction reported that all had a satisfactory outcome after the procedure. In addition, the range of active and passive motion was excellent, with no evidence of arthrofibrosis (30). The rates of re-injury were also substantially lower than those reported in studies of similar but younger patients, who had been managed conservatively (5,7). It has been postulated that patients who undergo ACL reconstruction have a higher risk of developing degenerative arthritis compared to patients managed conservatively (8). Patients in the age group of 40-59 years managed conservatively can have a substantially lower physical activity level when compared to those who had been treated operatively (35).

One of our objectives was to ascertain whether there were any common factors which may result in a poorer quality of knee function, as assessed by the three questionnaires. From our results, only the type of management, when correlated with the Lysholm score, was statistically related to higher knee score. Patients who received surgery had higher scores, i.e. better knee function, than those who had received conservative management. Gender, time from initial injury to treatment, and age at treatment had no bearing on the score attained. Therefore,

these factors appear to have no effect on the function of the knee after an ACL injury in our patients.

The statistically significant finding of surgery producing higher scores, and therefore a higher level of knee function, is similar to other studies (7,30). The issue that age at treatment has no effect on a patient's knee outcome is also corroborated by other studies (18,28).

### The Questionnaires

Outcome measures have gained much importance in orthopaedics, and have increasingly become a measure of patients' satisfaction (4). In a review of outcome measurements for ACL deficient knees, Johnson and Smith recommended the use of validated instruments, including the Lysholm, IKDC (International Knee Documentation Committee), and KOOS (Knee Injury and Osteoarthritis Outcome Score) scores. However, they thought that the KOOS and the IKDC score were not the ideal scoring systems (31).

The Lysholm Questionnaire was proposed by Lysholm and Gillquist as a knee rating score for ligament injuries, directed at the young, athletic patients' evaluation of their symptoms and knee function, and with an emphasis placed on knee instability. Importance was attributed to evaluation of patients' perception of function in the activities of daily living most important to the patient, and to the patient's functional level in various intensities of athletic activities (23). The questionnaire consists of eight questions, with three to six statements after each question. Patients answering the questionnaire place a tick in the box next to the best fitting statement. Patients should give their opinion on their knee function in everyday activities and sporting activities, and symptoms of pain, instability and swelling.

The Modified Cincinnati Knee Rating Score places emphasis on patients' symptoms and their perception of knee function. It is more concise than the original version, was validated in our setting, and highlights the important aspects of symptoms and functioning in daily as well as athletic activities. Li *et al* (22) demonstrated high validity, reliability and responsiveness for the Cincinnati rating

scale. The questionnaire is divided into two sections, the first assessing symptoms, the second function. There are eight questions, each with statements underneath. Each of the statements has a score next to it, and the patient is asked to circle the relevant score in each category.

The Mohtadi Quality of Life Questionnaire, or Mohtadi-QoL, aims to ascertain the quality of life of patient who suffered an ACL injury. It was designed as a disease-specific outcome measure and is indeed different in design to the other two questionnaires. Firstly, it is much longer, with 34 questions. Secondly, the questions are answered by placing a mark on a 10 cm line, using a visual analogue scale approach. The questionnaire consists of five weighted sections, covering symptoms and physical complaints, work-related concerns, recreational activities and sports participation, life style, and social and emotional issues. The Mohtadi quality-of-life instrument has been found to be very accurate for ACL injuries (32).

There are marked differences in the way data are weighted in these questionnaires. For example, pain accounts for 30% in the Lysholm and 20% in the Cincinnati questionnaire. Similarly, in the Lysholm questionnaire, return to walking, running or jumping accounts for 70% of the score, while in the Cincinnati score overall activity level account for 30% only. Our study shows a high correlation among the three knee scoring systems used, especially between the Lysholm and Mohtadi QoL Scores. Bollen and Seedholm (4) found a good correlation between the Lysholm and the Cincinnati questionnaire. Interpreting our results in the light of the findings of Bollen and Seedholm (4), we feel that these three scores are likely to explore similar aspects of knee function, and evaluate the knee functions independently and reliably.

The relatively high correlations between the scores are similar to a study, which found a good correlation when comparing Lysholm scores with the Single Assessment Numeric Evaluation (34). A correlation between the Tegner and Lysholm scores and the SANE score (Single Assessment Numeric Evaluation) has been described, indicating that both scores were ultimately measuring knee function (33). However, despite this correlation, there

was a discrepancy between the scores. The “content” of the scoring systems might have been the reason behind the discrepancy. One of the scores focussed on the stability, and disregarded other factors such as muscular strength and meniscal status. Studies trying to ascertain a relationship between scoring systems should be conducted with great caution. Some authors feel that the relationship between different scoring methods remains the same within one patient sample, but, depending on the patients’ characteristics, they may change, thus making comparison between scores in different settings unreliable (15).

A weakness of our study was the response rate to the questionnaires, and thus the size of our sample. As ACL injuries are common in young athletic individuals, and as Aberdeen is a university city, it was inevitable, that a large proportion of patients, who injure their ACL, come from this student population and has moved away from Aberdeen. Also, we do not know whether the patient population who responded had an inherent selection bias, as it is difficult to judge which group of patients are more likely to reply to a questionnaire – those with poor results or those satisfied with their knee function.

To our knowledge, no study has compared the Mohtadi QoL questionnaire and the Modified Cincinnati Knee Score with other scoring scales. As our study shows a good relationship between the three scoring systems, it helps us to understand what questions should be asked to the patient with an ACL injury to elicit a true representation of their knee function.

More research should ascertain the relationships between the multitudes of knee scoring systems available to clinicians, and multicentre studies should be organised to develop a uniformly acceptable scoring system (26). From this study, the Mohtadi QoL probably gives a truer representation of knee function. In addition, we need to ascertain exactly why there is such a poor relationship between clinical findings, patient satisfaction, and knee scores. Knee scoring systems correlate better with patient’s perception of outcome as compared to measuring knee laxity with an arthrometer. Many authors have described this phenomenon, but few have any plausible explanations for it (16). However,

Fremerey *et al* (13) did suggest a reason for this poor relationship, namely, proprioception, showing that poor position sense related negatively with patient satisfaction. Further investigations should be performed in this direction to formulate clearer guidelines for management of ACL deficiency and their postoperative management.

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