

ORIGINAL ARTICLE

Evidence based medicine in clinical practice: how to advise patients on the influence of age on the outcome of surgical anterior cruciate ligament reconstruction: a review of the literature

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Objective: To determine, using a literature search, whether patient age influences the outcome of surgical reconstruction of a torn anterior cruciate ligament.

Methods: Medline (1966 to present) was searched using the PubMed interface, Embase (1974 to present) using the Datastar system, and the Cochrane Library at the Update Software web site. Papers retrieved from the three databases were independently assessed by two reviewers using preliminary inclusion criteria. Reference lists of papers satisfying the preliminary criteria were then scanned and appropriate papers reviewed. Any new papers in turn had their reference lists scanned, this process continuing until no new papers were identified. Final inclusion criteria were then applied to all papers satisfying the preliminary inclusion criteria.

Results: The initial search identified 661 papers. Exclusion of duplicates produced 536 unique papers. Medline contained 445, Embase 185, and the Cochrane Library 31. Of the 536, 523 were assessed by abstract and 12 by full text; one paper was not retrieved. Application of the preliminary inclusion criteria produced 33 papers. Their reference lists contained 950 references. Scanning of these added six new papers to the dataset. These six had their reference lists assessed; no new papers were identified. Four of the 39 papers in the completed dataset satisfied the final inclusion criteria. There was wide variation in the total number of subjects in the four studies, ranging from 22 to 203 patients. The total number of different outcome measures was 17; only one measure was used by all four studies. None of the objective outcome measures showed any significant difference between age groups, and the subjective measures, which did show differences, were contradictory. A total of 108 interlibrary loans were requested, by a full time researcher, at a total cost of IR£432.00 over a 10 week period.

Conclusions: When advising patients on the outcome of anterior cruciate ligament reconstruction, age should not be considered in isolation. In the absence of relevant guidelines, meta-analyses, or systematic reviews, the application of evidence based medicine to clinical practice has significant resource implications.

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During a clinical undergraduate general practice attachment in a sports oriented general practice in the west of Ireland, one author (PAS) encountered a number of patients with torn anterior cruciate ligaments. Most were young men, the majority of which had torn their anterior cruciate ligaments while participating in one of the Irish national sports of Gaelic football or hurling. Owing to the nature of these high speed contact sports, the knee is subjected to a great deal of hyperextensive rotatory stress and disruptive external force, the two principal mechanisms of rupture of the anterior cruciate ligament.¹⁻³ The activity most commonly associated with hyperextensive rotatory knee stress, and as a result torn anterior cruciate ligaments, is skiing. A few older patients with ruptured ligaments were also seen, the most common cause of their ruptures being skiing. All patients came to seek advice about their treatment options.

There are two treatment options: surgical and non-surgical. In the course of advising patients about these alternatives, many factors are taken into consideration. These include the type of anterior cruciate ligament rupture, the presence of associated injuries, a patient's requirement of their knee, perceived potential patient compliance, and age.⁴⁻¹¹ Older patients are less likely than younger patients to be involved in sport at a competitive level, and will therefore tend to have less strenuous knee requirements. Doctors in the practice were, however, unsure of how patient age by itself influences the

outcome of surgery and believed that the quality of advice given to patients would improve if they were able to comment specifically on patient age. Therefore we set out to determine whether patient age influences the outcome of surgical reconstruction of a torn anterior cruciate ligament.

METHODS

Studies of anterior ligament surgery were identified from three databases in July 2000. Medline was searched using the Pubmed interface (<http://www.ncbi.nlm.nih.gov/PubMed>), Embase using the Datastar system (<http://www.dialog.com>), and the Cochrane Library at the Update Software web site (<http://www.update-software.com/clibhome/clib.htm>).

In Medline (1966 to present), papers published in 1992 or later were retrieved using the search strategy [(anterior cruciate ligament) AND age AND outcome*]. For earlier material, when the term treatment outcome was not used as a MeSH term, the amended search [(anterior cruciate ligament) AND age AND (surgery OR outcome*)] was used. The search of Embase (1974 to present) used the same search string, except that, because the index term treatment outcome was not introduced in this database until 1994, the amended strategy was used for material published before 1994. In the Cochrane Library, papers were retrieved using the search strategy [(anterior cruciate ligament) AND age AND outcome*].

All papers retrieved from the three databases (set A) were independently assessed by two reviewers (PAS and HB), to identify those that satisfied the following preliminary inclusion criteria:

- (a) paper in English, French, German, or Italian, or with abstract in English;
- (b) reports of the outcome of anterior cruciate ligament surgery in adult humans;
- (c) apparently includes a comparison between two or more age groups.

Where an abstract was available in one of the databases, assessment was based on this. In the absence of an abstract, the full paper was obtained. Full text assessment was only carried out when no abstract was available with the paper. Disagreement at any point was resolved by discussion. This review yielded set B.

The reference lists of papers in set B were also independently scanned by PAS and HB using the preliminary inclusion criteria. Papers already in set A were excluded, as were methodological and statistics papers, textbooks, conference abstracts, theses, and items published before 1966. Abstracts of other papers were obtained from Medline. References with no available abstract were independently assessed by the two reviewers on the basis of their titles, and, if a reference was felt to be potentially relevant, the full text was obtained for assessment. Any new papers identified were added to set B. These new papers in turn had their reference lists scanned, this process continuing until no new papers were identified.

Once set B was complete, the full text of each paper was obtained and independently assessed by PAS and HB using the following final inclusion criteria:

- (a) full text in English, French, German, or Italian;
- (b) the study includes a comparison between two or more age groups;
- (c) uniform criteria were used in the selection of patients for treatment, regardless of age;
- (d) patients received uniform treatment, regardless of age;
- (e) objective criteria were used in the assessment of treatment outcome.

Disagreement at any point was resolved by discussion. This review yielded set C, the final set of studies included in this review.

RESULTS

Search results

The initial search identified 661 papers. Exclusion of duplicates (identical papers located in more than one

database) gave set A, containing 536 unique papers. Of the initial 661 papers, 445 were available in Medline, 185 in Embase, and 31 in the Cochrane Library. Full reference lists are available on request from the authors. Of the 536, 523 were assessed by abstract and 12 by full text. One paper that had no abstract could not be located in the British Isles, and was therefore excluded. Thirty three papers were included in set B, 32 after abstract review and one after full text assessment.

The reference lists of these 33 papers contained 950 references (including duplicates) and these were then reviewed. References of methodological papers, textbooks, conference abstracts, theses, pre-1966 publications, and those already in set A were excluded. Five of those with abstracts were added to set B. Having ordered 33 of the papers without abstracts, we obtained the full text of 28. Of the other five, three were unavailable within the time constraints of this study and two had no locations within the British Isles. These five were therefore excluded. The 28 yielded one further paper for set B. The six new papers added to set B had their reference lists scanned. From a total of 120 references, no new relevant papers were identified. Set B was therefore complete, containing a total of 39 papers. On the basis of a full text review, four papers¹²⁻¹⁵ satisfied the final inclusion criteria and were accepted into set C. Three of these¹³⁻¹⁵ were available in Medline, two^{13, 15} in Embase, and none in the Cochrane Library. One paper¹² was identified only by means of the search of reference lists. These four papers subsequently underwent detailed analysis.

Description of studies

Of these four studies, three¹³⁻¹⁵ were full papers and one¹² was a "mini-paper" of a single page. All four specifically evaluated whether or not age is an influencing factor in the outcome of anterior cruciate ligament reconstruction surgery. Table 1 shows some basic details of the patients in the four studies. There is wide variation in the total number of subjects, ranging from 22 to 203 patients. The oldest subject was 63, and the youngest was 15. The vast majority were male; the management implications of this for female patients are unclear.

Table 2 shows the outcome measures used. The total number of different measures was 17. Each study used between five and 12 measures. Although only one measure was used by all four studies, the three studies published as full papers all used the Lysholm score, the Tegner activity scale, and KT-1000 arthrometry in their outcome assessments.

Deakon and Zarnett¹²

Patients under the age of 40 were matched with those over 40 on the basis of injury type and acuity. No mention is made of the population from which the older group of patients was

Table 1 Basic details of subjects in four studies on the influence of patient age on the outcome of anterior cruciate ligament surgery

	Deakon ¹² (1996)		Barber ¹³ (1996)		Viola ¹⁴ (1999)		Brandsson ¹⁵ (2000)	
	Group I	Group II	Group 1	Group 2	Group I	Group II	Group A	Group B
Number of subjects	40	40	33	170	11	11	30	37
Age (years)								
Ave/med/mean	45 (ave)	25 (ave)	44 (ave)	27 (ave)	42.6 (ave)	20.3 (ave)	43 (med)	23 (med)
Range	40-63	15-37	40-52	16-39	40-47.	17-24.	40-51	20-24
Male:female ratio			19:14	119:51	9:2	9:2	20:9	24:13
Time from index injury to surgery (months)								
Ave/med/mean			50 (ave)	28 (ave)	12.9 (mean)	13.7 (mean)	36 (med)	23 (med)
Range			5 days-373	5 days-265			6-360	9-108
Period of follow up (months)								
Ave/med/mean	26 (ave)	26 (ave)	21 (ave)	21 (ave)	29 (ave)	29 (ave)	31 (med)	38 (med)
Range	12-67	12-67	11-36	12-39	12-24.	12-24.	22-60	24-60

Table 2 Postoperative outcome measures in four studies of the influence of patient age on the outcome of anterior cruciate ligament surgery

	Deakon ¹² (1996)	Barber ¹³ (1996)	Viola ¹⁴ (1999)	Brandsson ¹⁵ (2000)
Laxity testing				
Manual/clinical				
Lachman	**	**	**	
Pivot shift	**	**	**	
Instrumented (objective) KT-1000 arthrometer (various measurements)	**	**	**	**
Range of motion (goniometer)	**		**	**
One leg hop quotient (functional evaluation)				**
Radiographic			**	**
Return to sports participation	**			
Subjective				
Lysholm score		**	**	**
Tegner activity scale		**	**	*Y (p=0.032)
Knee walking ability				**
Patellofemoral symptoms			**	**
Slight impairment in stair climbing/squatting			**	
Continuing symptoms			**	
Incidence of joint effusion				**
Final outcome (IKDC evaluation system)			**	**
Clinical results (based on Lysholm score)			**	
Overall result at 2 year follow up (subjective patient satisfaction)				*O (p<0.05)

** = outcome measure applied; *Y = outcome measure applied, younger age group performed significantly better***; *O = outcome measure applied, older age group performed significantly better***; ***Using p values only if stated by authors.
IKDC, International Knee Documentation Committee.

originally chosen. Before surgery, in the under 40 age group, 97.5% played competitive or recreational pivotal sports, compared with 92.5% in the over 40 age group. No preoperative evaluation is detailed. It is stated that the surgical intervention and rehabilitation programme were identical in the two groups, although no details are supplied. There is far less detail of postoperative assessment than in the three full papers. The authors report that at follow up, 87.5% of those under 40 years of age returned to competitive or recreational sports, compared with 80% of patients over 40. It is not clear how the authors derived these figures.

Barber *et al*¹³

Detailed inclusion and exclusion criteria were applied to a series of patients undergoing anterior cruciate ligament reconstruction between 1992 and 1994. Subjects were then divided into two groups, using 40 years of age as the cut off point. Patients were assessed before surgery by a wide variety of measures including the Lysholm knee scoring scale, Tegner activity level scale, KT ligament testing at 15 lb and 20 lb, manual maximum side to side difference, and active displacement, clinical and radiographic examinations. No significant difference was found between the two patient groups in terms of instability before the operation or other intake data, except that younger patients were found to have significantly less patellofemoral crepitus. The authors thought that this reflected normal age variation. A large amount of detail is supplied about the surgery, in terms of the technique used, materials used, and the rehabilitation programme. Although different types of grafts were used, the variation in graft type was not based on subject group. Otherwise there were no differences between the two groups with respect to the surgery or postoperative management. Extensive and thorough postoperative follow up was performed, including use of the Lachman and Pivot shift tests, KT-1000 arthrometry, the Lysholm score, and the Tegner activity scale. Each of the more important examinations was carried out at more than one specified point in time. No statistically significant differences were found between the two age groups at any of the follow up examinations.

Viola and Vianello¹⁴

Strict inclusion and exclusion criteria were applied to all patients over the age of 40 who underwent arthroscopic

bone-patellar tendon-bone autograft reconstruction between 1991 and 1994. A control group of patients was chosen at random from among a population of 694 patients operated on in the same period. Before surgery, a standard radiographic study of both knees was performed, and Tegner activity scale scores were assessed. However, only the Tegner activity scores were given, and the results of statistical analysis were given for neither. In terms of surgery, few details are provided, but it is stated that there was no difference between the groups with regard to patient preparation, surgeon, surgical technique, postoperative care or rehabilitation programme, or recovery. In terms of postoperative assessment, no statistically significant differences were shown between the two groups of patients.

Brandsson *et al*¹⁵

Patients over 40 years of age were extracted from a database of 604 patients operated on between 1991 and 1994. The control group was made up of patients aged 20–24 years. The only preoperative assessment detailed was the Tegner activity score. A significant difference was found between the groups (p<0.001). Although the range of Tegner activity scores was the same for both groups (4–9), younger patients had a higher median score (9) than the older group (6). Few details are given about the surgery carried out or the rehabilitation used. It is stated that the same surgeon carried out all the operations and that the same technique was used for the two groups of patients. Both “outside-in” and “all-inside” techniques were used, and the same percentages of patients in each group were operated on using the two techniques. The authors carried out a range of postoperative evaluations, with the group of younger patients having a significantly longer period of follow up. The time of examination was not specified, but all examinations were carried out by independent observers. Postoperative assessment showed a Tegner activity scale that was significantly higher in the younger age group (p = 0.032). In the context of the preoperative Tegner scores, this is not of significance. However, it was found that middle aged patients were subjectively more pleased with the overall results at the final follow up examination than were the younger patients (p<0.05). There was no significant difference between the two groups for all other outcome measures.

Take home message

- When advising patients on the outcome of anterior cruciate ligament reconstruction, we believe that age should not be considered in isolation
- Using an EBM approach to arrive at this conclusion had significant resource implications
- The evidence on the impact of age on anterior cruciate ligament reconstruction was limited both in quality and quantity

Workload

PAS worked as a full time researcher on this project for 10 weeks. A total of 108 interlibrary loans were requested during this period, costing a total of IRE432.

DISCUSSION

The purpose of this review was to establish whether age is an influencing factor in the outcome of surgical reconstruction of a torn anterior cruciate ligament. Our comprehensive review found little literature on this subject. Only four papers satisfied our inclusion criteria of an analysis of outcome of anterior cruciate ligament surgery by age, using uniform criteria in the selection of patients in each age group, uniform treatment, and objective outcome measures. Each of the four papers indicates that patients were selected in such a way as to ensure two groups that were as similar as possible in all respects, apart from age. However, the level of detail about patient selection, preoperative evaluation, surgery, and rehabilitation varies considerably. Caution is therefore appropriate in the interpretation of our results.

Many measures are available for evaluating the outcome of knee surgery.¹⁶⁻²⁰ As a result, there is substantial interstudy variation in assessment of outcomes, although all four studies used widely accepted measures such as Lachman, Tegner, and KT 1000 arthrometry. Again, there is considerable variation in the amount of detail given about postoperative assessment. Nevertheless, the results of all four studies match closely. None of the objective outcome measures showed any significant difference between age groups. The only subjective measurement examined, patient satisfaction, was higher in older patients. This is possibly because they had lower expectations of treatment outcome.

Thus, there is no evidence in the literature that patient age, considered as an independent factor, influences the short to medium term outcome in anterior cruciate ligament surgery. It is not possible to comment on the long term outcome as the longest period of follow up was 67 months. Continuing work on anterior cruciate ligament reconstruction by various authors, including a recent paper by Noyes and Barber-Westin²¹ which reports on experience over 11 years, should help to provide information about the longer term outcome in both younger and older patients.

Provision of advice to patients is recognised as a crucial role for general practitioners.²² In the absence of relevant evidence based medicine (EBM) guidelines, meta-analyses, or systematic reviews, applying EBM principles to answering this simple clinical question had significant resource implications in terms of time and finance. Lack of personal time has been highlighted as a problem by general practitioners.²³ The relative value of applying EBM principles compared with traditional approaches of asking a colleague or specialist, or looking up a textbook, needs to be confirmed.

We hope that our provisional conclusion on patient age and surgical outcome will improve the quality of advice given to patients with torn anterior cruciate ligaments who are considering their treatment options. Although there are many factors to be taken into account when considering the options,

the age of the patient cannot be considered in isolation. How best to individualise such advice to patients of various ages, sporting background, and expectations remains the domain of the responsible doctor.

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..... **COMMENTARY**

This is an important paper for several reasons. Firstly, the authors have taken an evidence based approach to determine whether age influences the outcome from surgical reconstruction of a torn anterior cruciate ligament. Surprisingly, there is a paucity of literature on this topic, which should caution us to pause when seeing and advising these patients in clinic. As we understand more about the science of aging and its influence on the mechanical and biological properties of soft tissues, we will hopefully be able to provide patients with treatment alternatives that take these factors into consideration. In the

mean time, this paper provides us with some evidence that we should probably not consider age in isolation when counselling patients on optimal prevention and treatment of anterior cruciate ligament injuries. This conclusion should probably not be too surprising for clinicians seeing a lot of these injuries in active older populations. An important problem that cannot be addressed at this point concerns the use of our medical resources and who will make the decisions on how to treat these people.

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EDUCATION PROGRAMME.....

British Association of Sport and Exercise Medicine in association with the National Sports Medicine Institute

Education programme 2002

Intermediate Sports Injury Management and Medicine—Lumbar Spine, Thorax, Groin, Pelvis, & Hip
Lilleshall National Sports Centre, 7–12 July.

General Sports Medicine

Lilleshall National Sports Centre, 22–27 September.

Practical Sport and Medicine Meeting

Club La Santa, Lanzarote (families & non-delegates welcome; deadline 17 July, 2002), 3–10 October.

Diploma Preparation

Location and date to be confirmed, October.

The Queen's Golden Jubilee & Post Commonwealth Games BASEM Congress

The Low Wood Hotel and Conference Centre, Windermere, 10–13 October.

Intermediate Sports Injury Management and Medicine—Lower Limb

Lilleshall National Sports Centre, 17–22 November.

Current Concepts

Topic, location, and date to be confirmed, December.

Education programme 2003

Intermediate Sports Injury Management and Medicine—Head, Neck, and Upper Limb
Lilleshall National Sports Centre, 23–28 February.

General Sports Medicine

Lilleshall National Sports Centre, 27 April–2 May.

Diploma Preparation Course

Sheffield Centre of Sports Medicine, May.

Current Concepts

Topic, location, and date to be confirmed, May.

Intermediate Sports Injury Management and Medicine—Lumbar Spine, Thorax, Groin, Pelvis, and Hip

Lilleshall National Sports Centre, 6–11 July.

General Sports Medicine

Lilleshall National Sports Centre, 21–26 September.

For further details of these courses please contact Mr Barry Hill, The National Sports Medicine Institute, 32 Devonshire Street, London W1G 6PX, UK. Tel: 020 7908 3642; Fax: 020 7908 3635; email: barry.hill@nsmi.org.uk; www.nsmi.org.uk