Gender and age based differences in behavioural patterns following anterior cruciate ligament injury

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ABSTRACT

ACL injury can be clinically diagnosed prior to imaging, and therefore understanding any symptomatology differences between age-groups and genders is critical. Data gathered from 341 patients with ACL injuries over six years showed no gender-based difference in ability to continue playing sport post-injury. Fewer males required crutches (37.2% vs. 49.5%, $p = 0.04$) and more males returned to sports prior to treatment (24.4% vs. 14.1%, $p = 0.04$). There was no age based difference in play continuation post-injury, however more elderly patients fell post-injury (< 30 y: 91.9%, 30 y 83.8%, $p = 0.02$). Therefore, there are few differences in behavioural patterns following ACL injury based on age or sex.

1. Introduction

Anterior cruciate ligament (ACL) injury is a serious sports-related traumatic event, often resulting in hospital admission for surgery. In addition to the direct costs associated with the operative correction of ACL injury, there are indirect costs, including school and work absenteeism, the physical and psychological impact of injury as well as time away from elite sporting activities. ACL reconstruction in an unstable joint can improve the likelihood for return to sporting activities and may reduce the prevalence of early-onset osteoarthritis.^{1–4} Hence, prompt diagnosis and management of ACL injuries is important in improving short and long-term patient outcomes.⁵

The diagnosis of ACL injury can often be made prior to assessment with imaging modalities, by means of a thorough clinical history and examination. Approximately 80% of ACL injuries are sustained through non-contact mechanisms,^{6–9} with the knee in partial flexion and the tibia internally rotating against the femur,^{6,10,11} as would occur in sudden deceleration or pivoting manoeuvres. Typical features suggestive of ACL injury which may be reported by the patient include: a shifting sensation in the knee seen in 60% of cases, an audible popping sound in 30%, swelling around the joint in 92% of patients⁶ and pain seen in 85% of cases within the first hour of injury.⁸

However, the behavioural patterns of patients immediately following injury have not been examined, particularly examining the impact of age and gender on these patterns. Studies have shown that approximately 12–17% of patients are able to return to the sporting field immediately after injury.^{6,8} In addition, other important

behavioural patterns that have not been studied include falling at the time of injury, being carried off the field and the requirement of crutches for weight bearing.

Female ACL injury has been the focus of much study, as this population is at an increased risk due to a complex interplay of anatomical,^{12–16} hormonal^{17,18} and neuromuscular factors.^{19,20} Despite this, there have been no studies examining differential symptomatology of ACL injury presentations between genders. In addition, there is a paucity of literature on the effect of age on presentation of ACL injuries.

Therefore, this retrospective study aimed to determine whether age or gender affects the clinical presentation of anterior cruciate ligament injury with regards to capacity to continue play and other associated behavioural patterns. From his clinical experience, the senior author hypothesised that females and older patients tend to present with ACL injuries in a non-classical manner, in that this patient group had a greater capacity to continue to play sports immediately following the injury. If such a difference exists, this may enhance our understanding of ACL clinical presentation and assist in early diagnosis.

2. Materials and methods

2.1. Study design

A retrospective analysis was undertaken of a prospectively collected database from a private orthopaedic knee clinic. Over a six year period, 786 ACL reconstructions were entered in to a research database. All patients from this database were invited to complete a questionnaire. A

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total of 341 patients responded to the study questionnaire and formed the study cohort. Ethics approval to conduct the analysis was provided by the local ethics unit.

2.2. Data collection

Patient demographics were collected from the research database. This included age at the time of injury, gender, side of injury, and history of previous injuries or surgeries. All patients were then contacted via post and asked to respond to a series of questions about the circumstances surrounding their ACL injury.

The following questions were asked:

- 1 How did you initially rupture your ACL?
- 2 At the time of your injury,
 - A.) Did you attempt to continue playing?
 - B.) Did you fall over?
 - C.) Were you stretchered off the field?
 - D.) Did you need crutches to walk for a short time?
 - E.) Did you experience knee swelling?
 - F.) Did you go to the hospital emergency department?
 - G.) Did you return to sports after the initial injury settled (and prior to seeking definitive treatment)?

2.3. Outcomes

The primary outcome measure was continuation of playing immediately after injury (Question 2A). Secondary outcomes included whether patients fell over, the requirement to be carried off immediately, the presence of swelling, the requirement for crutches to walk and presentation to a hospital emergency department.

2.4. Data analysis

The cut-off age between the younger and older group was set at 30, as approximately half of patients were noted to be in each group at this age (median age in the population was 29). In addition, we felt that activity levels and modes of presentation may be inherently different between those younger and older than 30 years of age respectively. Means, standard deviations and ranges were recorded for each variable analysed. Fisher exact tests were used to compare age and gender based differences between groups with dichotomous variables. Student's t-tests were used to compare mean differences in data sets with continuous variables. A p-value of ≤ 0.05 was considered significant.

3. Results

Patient demographics are reported in Table 1. There were no gender or age based differences in key demographics. Fig. 1 shows the mechanism of injury throughout the population based on gender.

No gender-based differences were found in the capacity to continue to play sport immediately following injury (Table 2). A lower

Fig. 1. Mechanism of acl injury.

Table 2

Gender based differences in acl injury presentation.

Outcome	Males (n = 242)	Females (n = 99)	P-Value
Continued playing, % (n)	27.3 (66)	23.2 (23)	0.44
Fall, % (n)	87.6 (212)	88.9 (88)	0.75
Walked off, % (n)	38.4 (93)	39.4 (39)	0.86
Knee swelling, % (n)	70.3 (170)	70.7 (70)	0.93
ED, % (n)	26.0 (63)	26.3 (26)	0.59
Crutches, % (n)	37.2 (90)	49.5 (49)	0.04*
Return to sport, % (n)	24.4 (59)	14.1 (14)	0.04*

proportion of males reported the need for crutches to walk after the injury compared to females (Males: 37.2%, Females: 49.5%, $p = 0.04$) and a higher proportion of males returned to sporting activity following the initial injury and prior to seeking definitive treatment (Males: 24.4%, Females: 14.1%, $p = 0.04$). There were no other gender-based differences noted when assessing secondary outcomes.

Table 3 shows differences in clinical presentation based on age. A higher proportion of patients under thirty years fell over at time of injury compared to patients thirty years and older ($< 30y$: 91.9%, $\geq 30y$: 83.8%, $p = 0.02$). There were no other age-based differences noted when assessing secondary outcomes.

4. Discussion

There is a paucity of literature regarding differential presentation of ACL injury based on gender or age. In particular, no studies have examined key early behavioural patterns following injury such as continuation of play, the need to be carried off immediately, the need for crutches for walking or the rates of presentation to emergency departments. This study found no differences with regards to continuation of play based on gender. However, males exhibited a lower rate of use of crutches to ambulate during the recovery phase from injury and returned to sporting activities more frequently once the initial injury had settled. Patients greater than 30 years of age were less likely to fall compared to younger patients at the time of injury but once again, no

Table 1

Patient demographics.

Patient Parameter	Male n = 242	Female n = 99	Total n = 341
Age $\pm$ SD, y	30 $\pm$ 9.8	30.3 $\pm$ 10.8	30.1 $\pm$ 10.1
Range, y	14–62	13–59	13–62
Median, y	29	28	29
Age Distribution			
< 30y, n (%)	123 (50.8)	51 (51.5)	174 (51)
$\geq 30y$, n (%)	119 (49.2)	48 (48.5)	167 (49)
Side			
Right, n (%)	135 (53.7)	48 (48.5)	183 (53.7)

Table 3

Age based differences in acl injury presentation.

Outcome	< 30y (n = 174)	$\geq 30y$ (n = 220)	P-Value
Continued playing, % (n)	25.8 (45)	26.3 (44)	0.91
Fall, % (n)	91.9 (160)	83.8 (140)	0.02*
Walked off, % (n)	36.2 (63)	41.3 (69)	0.30
Knee swelling, % (n)	71.8 (125)	68.9 (115)	0.53
ED, % (n)	26.4 (46)	25.8 (43)	0.89
Crutches, % (n)	40.8 (71)	40.7 (68)	0.98
Return to sport, % (n)	20.7 (36)	22.1 (37)	0.73

differences were found with regards to continuation of play.

The characteristic features of ACL injury have been well established in the literature. Approximately 70–80% of ACL injuries occurs as non-contact injuries, defined by Myklebust et al²¹ as an injury that occurs without any body-to-body contact. Other characteristic symptoms of ACL injuries include a shifting sensation, which has been shown to occur in 60% of patients,⁶ and a classical popping sound, which has been shown to occur in 30–60% of cases^{6,8}. Different studies report a range of 12–17% of patients are able to return to the field immediately after the injury,^{6,8} whilst we report 27% of males and 23% of females were able to return immediately. Larger studies have shown that swelling was experienced in 92% of patients,⁸ whilst we report it occurred in only 70% of patients immediately after injury.

There were no statistical differences in presentation based on age, apart from the fact that patients less than thirty years of age were more likely to fall compared with older patients at the time of injury. Very few studies have assessed the impact of age on ACL injury clinical presentation. There is a consensus, however, that ACL injury prevalence peaks in late adolescence and early adulthood and declines thereafter.

This study is limited because of its retrospective design. First, only 44% of the initial cohort of ACL injuries within the database responded to the survey and formed part of the subsequent analysis, creating a risk of sampling bias. However, this loss of follow up is partly mitigated by the fact that patient demographics between test groups are statistically identical. In addition, due to the retrospective nature of the study, there is a risk of recall bias from patients answering the questionnaire.

5. Conclusions

There are very few differential features with regards to patterns of behaviour immediately following ACL injury based on age or sex. Younger patients fall over at a higher rate compared to older patients and men are less likely to require crutches to ambulate when recovering and more likely to return to sports once the injury has occurred. Overall, our results do not support the use of a differential diagnostic framework based on age and gender alone in behavioural patterns following ACL injury.

Disclosure statement

The authors declare no conflict of interest in the development of this research article.

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