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The incidence of secondary pathology after anterior cruciate ligament rupture in 5086 patients requiring ligament reconstruction

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We reviewed 5086 patients with a mean age of 30 years (9 to 69) undergoing primary reconstruction of the anterior cruciate ligament (ACL) in order to determine the incidence of secondary pathology with respect to the time between injury and reconstruction. There was an increasing incidence of medial meniscal tears and chondral damage, but not lateral meniscal tears, with increasing intervals before surgery. The chances of requiring medial meniscal surgery was increased by a factor of two if ACL reconstruction was delayed more than five months, and increased by a factor of six if surgery was delayed by > 12 months. The effect of delaying surgery on medial meniscal injury was also pronounced in the patients aged < 17 years, where a delay of five to 12 months doubled the odds of medial meniscal surgery (odds ratio (OR) 2.0, $p = 0.001$) and a delay of > 12 months quadrupled the odds (OR 4.3, $p = 0.001$). Increasing age was associated with a greater odds of chondral damage (OR 4.6, $p = 0.001$) and medial meniscal injury (OR 2.9, $p = 0.001$), but not lateral meniscal injury. The gender split (3251 men, 1835 women) revealed that males had a greater incidence of both lateral (34% ($n = 1114$) vs 20% ($n = 364$), $p = 0.001$) and medial meniscal tears (28% ($n = 924$) vs 25% ($n = 457$), $p = 0.006$), but not chondral damage (35% ($n = 1152$) vs 36% ($n = 665$), $p = 0.565$). We conclude that ideally, and particularly in younger patients, ACL reconstruction should not be delayed more than five months from injury.

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Injuries to the anterior cruciate ligament (ACL) are common, with an estimated incidence of one in 3000 in the general population,¹ and one in 1750 in people aged between 16 and 45 years.²

Additional injuries to the menisci and articular cartilage are often found at the time of ACL reconstructive surgery. These could represent pre-existing pathology, or injuries that occur either at the time of the index injury or develop later because of repeated injury or abnormal loading.³ The medial meniscus contributes more to stability of the knee in the absence of a functioning ACL, and most medial meniscal tears usually require meniscectomy or repair.⁴ Large tears of the lateral meniscus require repair, but small tears are seen in the posterior aspect of the lateral meniscus, and these can usually be left untreated.⁴

It is accepted that the incidence of secondary pathology after ACL rupture increases with time,^{3,5} and in order to reduce this risk it may be better to perform a reconstruction as soon as possible after injury. However, the exact timing of reconstruction of the ACL remains controversial, in particular regarding how long one can safely wait while avoiding further

damage. Previous studies have established an association between time to surgery and the risk of meniscal and cartilage injury.^{6,7} A delay of > 12 months to ACL reconstruction is associated with more secondary pathology and long-term degenerative change.^{6,7} A more precise estimation of the length of time that is appropriate to delay before surgery without increasing the risk of damage to the articular cartilage and menisci is desirable.

The aim of this study was to determine the incidence of secondary pathology in ACL deficient knees with respect to the time between injury and reconstruction in a large group of patients, and establish a 'safe' waiting time.

Patients and Methods

We reviewed 5086 consecutive patients who underwent primary ACL reconstruction between January 2000 and August 2010 at the North Sydney Orthopaedics and Sports Medicine Centre. Patients treated conservatively were excluded. There were 3251 men (64%) and 1835 women (36%) with a mean age of 30 years (9 to 69). The median time to surgery was three months (mean of 17 months (0.25 to 480)). We considered the patients in four age

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Table I. Distribution of patients by age and time interval to surgery

Time interval	Age group				Total
	< 17 years	17 to 30 years	31 to 50 years	> 50 years	
< 5 months	318	1514	1320	122	3274
5 to 12 months	80	374	375	56	885
> 12 months	33	279	565	50	927
Total	431	2167	2260	228	5086

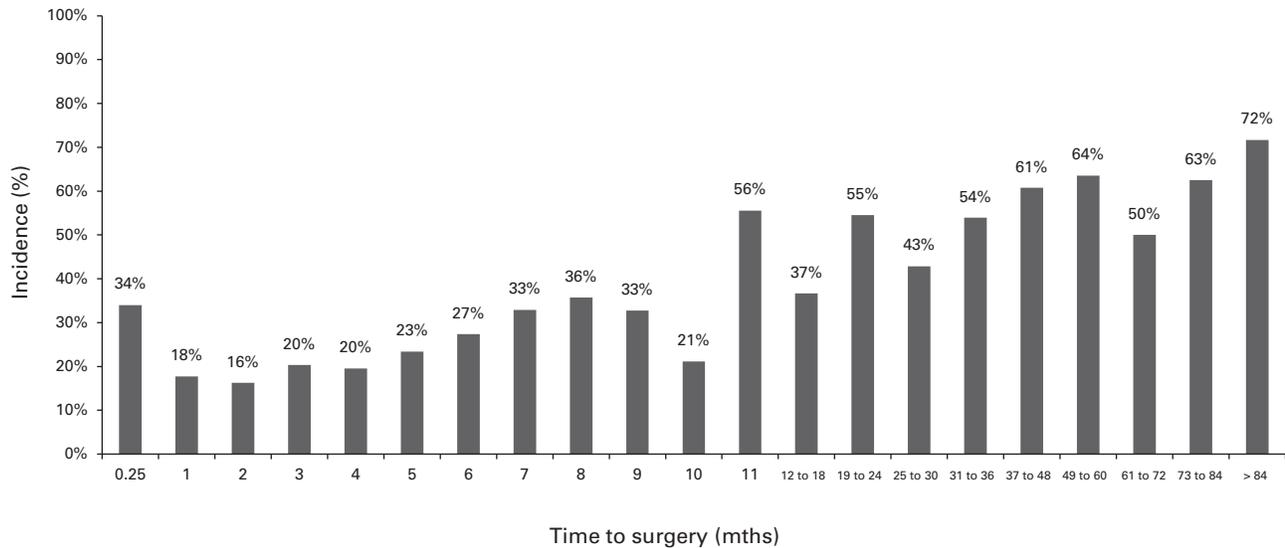


Fig. 1

Bar chart showing the incidence of medial meniscal tears in relation to increasing time from injury to surgery.

groups: < 17 years, 17 to 30 years, 31 to 50 years and > 50 years. Based on the initial data, we analysed the findings at three intervals that had elapsed from injury to treatment: < five months, five to 12 months and > 12 months. The number in each group is shown in Table I.

Diagnosis of an ACL tear was made clinically; not all patients undergoing ACL reconstruction had an MR scan. The decision to proceed to elective ACL reconstruction was based on laxity, age and expected level of activity.

The senior authors (JPR and LAP) undertook all the ACL reconstructions and assessment of secondary pathology. Repair was undertaken using a four-strand hamstring tendon autograft following a standard technique that has been previously described.⁸ All surgical data were collected in a prospective manner and entered into a large longitudinal database that has been operating since 1993. Meniscal tears were recorded according to type and location (medial or lateral). Only those requiring meniscectomy or repair were considered to have significant secondary pathology. Articular cartilage abnormalities were graded according to the International Cartilage Repair Society (ICRS) system as follows: grade 0, (normal) healthy cartilage; grade 1, superficial lesions (soft indentation and/or superficial fissures and cracks); grade 2, lesions extending down to < 50% of

cartilage depth; grade 3, cartilage defects extending down > 50% of cartilage depth as well as down to calcified layer, and down to but not through the subchondral bone; grade 4, the cartilage tear exposes the underlying (subchondral) bone.⁹ From the prospective database information was retrieved regarding patient characteristics, the interval (months) from injury to surgery and the incidence of secondary pathology observed at the time of surgery.

Statistical analysis. Binary logistic regression was used to assess the relationship between chondral and meniscal damage and time to surgery, gender and age at surgery. Odds ratios (OR) are reported with 95% confidence intervals (CI) and significance values. Incidence of concurrent injuries was compared between categorical groups (gender) with chi-squared tests. Statistical significance was set at a p-value of < 0.05.

Results

The overall incidence of any meniscal tear requiring treatment was 48% (n = 2428). The incidence of medial meniscal tear was 27.1% (n = 1381), and lateral was 29.1% (n = 1478). The overall incidence of articular cartilage damage as defined by the ICRS was 35.7% (n = 1817); the incidence of grades I and II was 32.6% (n = 1659) and grades III and IV was 3.1% (n = 158).

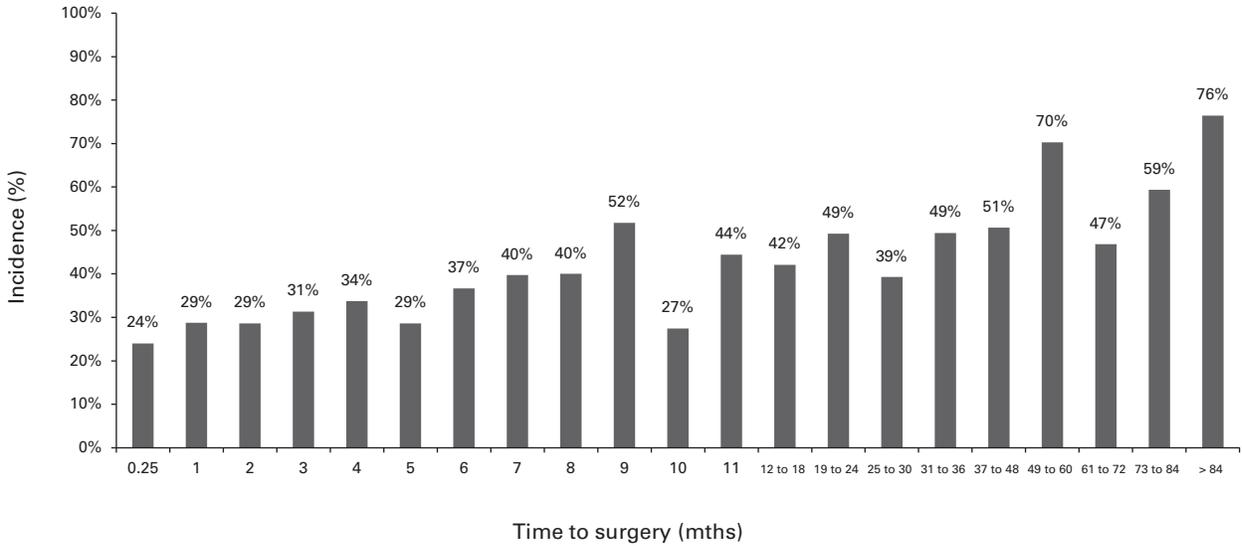


Fig. 2

Bar chart showing the incidence of chondral damage in relation to increasing time from injury to surgery.

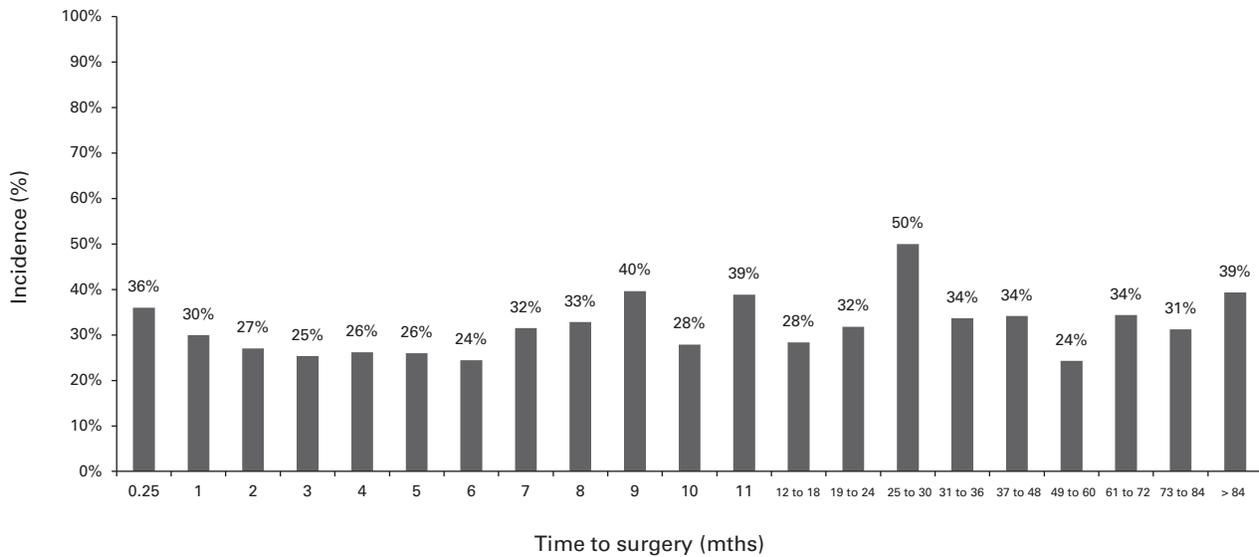


Fig. 3

Bar chart showing the incidence of lateral meniscal tears damage in relation to increasing time from injury to surgery.

Overall, an increasing incidence of medial meniscal injury and chondral damage occurred as the duration from injury increased (Figs 1 and 2). The incidence of lateral meniscal tears did not increase markedly until after 12 months from injury (Fig. 3). There was a high incidence of medial meniscal tears seen in those reconstructed within one month from injury in all age groups (17 of 50, 34%) (Fig. 1). This represents those with bucket-handle tears of the medial meniscus, which resulted in earlier presentation to the surgeon and early reconstruction. The odds of secondary pathology with increasing time to surgery are shown in Table II.

When compared with those aged < 17 years, the odds of secondary pathology increased progressively with advancing age from 17 to 30 years (OR 1.4 (95% CI 1.1 to 1.7); $p = 0.002$) to 31 to 50 years (OR 3.6 (95% CI 6.9 to 18.1); $p = 0.001$) and to > 50 years (OR 11.1 (95% CI 6.9 to 18.1); $p = 0.001$). An age > 30 years was associated with a greater odds of chondral damage (OR 4.6 (95% CI 4.0 to 5.6); $p = 0.001$) and medial meniscal injury (OR 2.9 (95% CI 2.6 to 3.3); $p = 0.001$), but not lateral meniscal injury (OR 0.86 (95% CI 0.8 to 1.0); $p = 0.11$) (Fig. 4).

The effect of delaying surgery on medial meniscal status was pronounced in the group aged < 17 years, where a

Table II. The odds of secondary pathology with increasing time to surgery

	Odds ratio (95% CI)	p-value
Any meniscal surgery or chondral injury		
< 5 months	Reference	-
5 to 12 months	1.3 (1.1 to 1.5)	0.002
> 12 months	3.4 (2.9 to 4.0)	< 0.001
Medial meniscal surgery		
< 5 months	Reference	-
5 to 12 months	1.8 (1.5 to 2.1)	< 0.001
> 12 months	6.4 (5.5 to 7.5)	< 0.001
Lateral meniscal surgery		
< 5 months	Reference	-
5 to 12 months	1.0 (0.9 to 1.2)	0.841
> 12 months	1.3 (1.2 to 1.6)	< 0.001
Chondral damage		
< 5 months	Reference	-
5 to 12 months	1.4 (1.2 to 1.6)	< 0.001
> 12 months	4.0 (3.4 to 4.9)	< 0.001

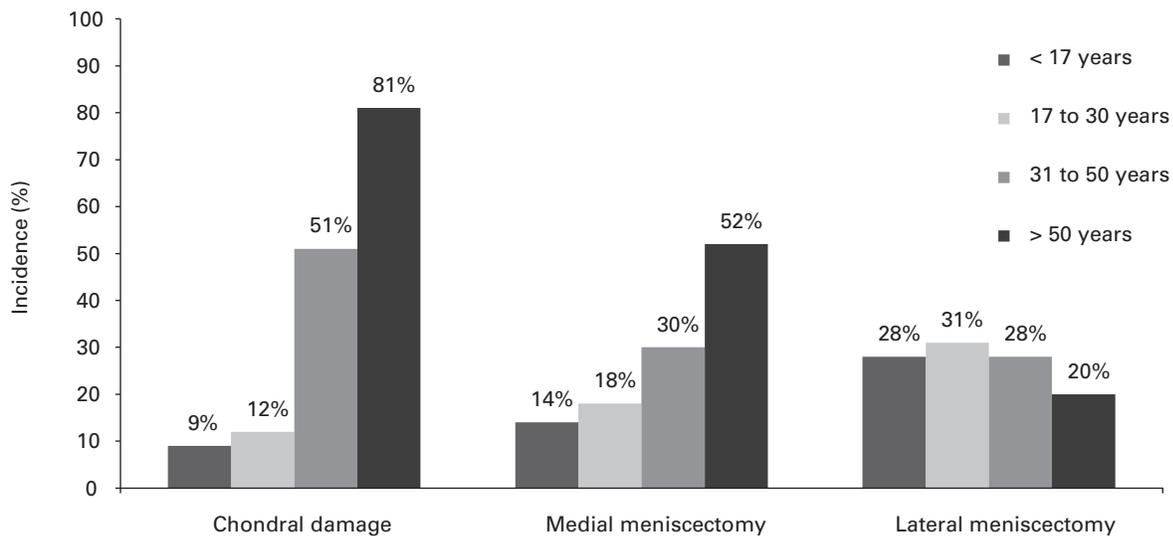


Fig. 4

Bar chart showing the relationship between age and incidence of secondary pathology.

delay of five to 12 months doubled the odds of medial meniscal surgery (OR 2.0 (95% CI 1.2 to 3.8); $p = 0.001$) and a delay of > 12 months quadrupled the odds of medial meniscal surgery (OR 4.3 (95% CI 1.9 to 9.6); $p = 0.001$) (Fig. 5).

Male patients had a significantly greater incidence of lateral (34% ($n = 1114$ of 3251) *vs* 20% ($n = 364$ of 1835); $p = 0.001$, chi-squared) and medial (28% ($n = 924$) *vs* 25% ($n = 457$); $p = 0.006$, chi-squared) meniscal tears, but not chondral damage (35% ($n = 1152$) *vs* 36% ($n = 665$); $p = 0.565$, chi-squared).

Males had greater odds of having any secondary pathology than females, but of a small magnitude (OR 1.4 (95% CI 1.2 to 1.6); $p = 0.001$).

Discussion

Anterior cruciate ligament injuries are common. The goals of ACL reconstruction are to abolish the symptoms of instability in the knee and to reduce the risk of secondary meniscal tears and chondral damage. Our findings suggest that the latter goal is more likely to be achieved if surgery is conducted without delay.

After four months from injury there is a steady increase in the incidence of medial meniscal and chondral pathology. It has been previously documented that delaying surgery by > 12 months is associated with increasing secondary damage^{6,10} and degenerative change over the long term.⁷ We have further refined this period by showing that the ideal time to surgery, to minimise the odds of

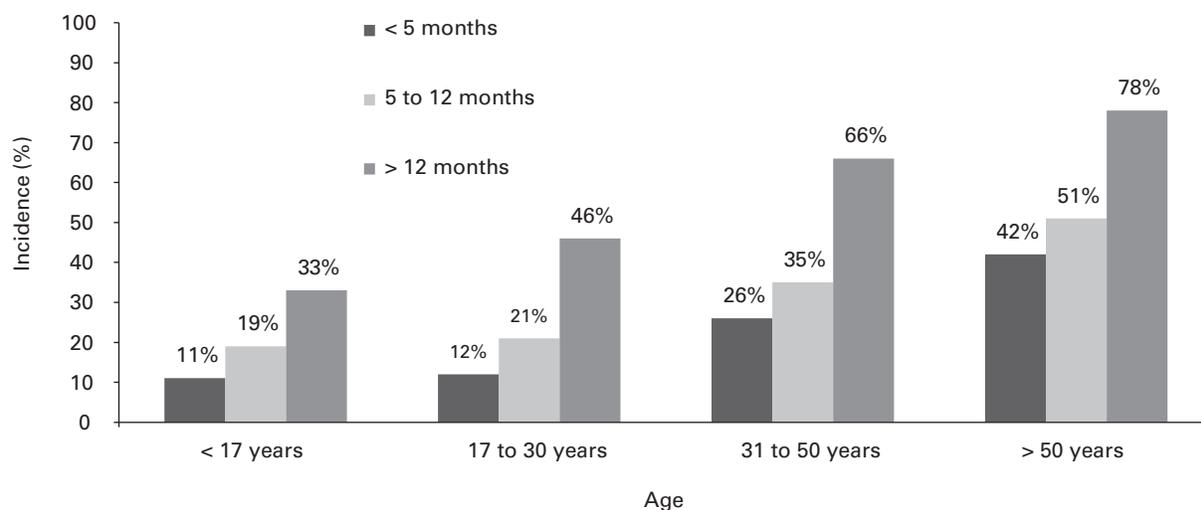


Fig. 5

Bar chart showing the incidence of lateral meniscal tears in relation to increasing time from injury to surgery.

secondary pathology, is reconstruction within five months of injury. If surgery is delayed for more than 12 months the odds of requiring medial meniscal surgery is increased by a factor of six and the odds of having a chondral lesion is increased by a factor of four.

This study shows the incidence of lateral meniscal tears does not change greatly with time, and this leads us to speculate that these tears occur at the time of the index injury. Similar findings have recently been reported.^{6,10} The incidence of medial meniscal tears and articular damage show a very clear temporal relationship. This supports the belief that secondary pathology occurs either acutely following repeated episodes of subluxation or chronically following overloading of the medial meniscus, leading to attrition and tears.

Similar findings have been reported previously.^{5,10,11-16} Most of these studies had a smaller number of patients than this series and therefore had to group the patients into more prolonged time intervals. This study is unique in that it has shown a gradual increase in secondary pathology on a monthly basis following the time from injury. The large number of patients included has also permitted a closer examination on the effect of age and gender. We have shown that the incidence of chondral damage and medial meniscal tears increase with increasing age and males have an increased incidence of meniscal tears but not chondral damage. These findings have been supported in some studies¹¹ but not in others.¹⁰ On the other hand it might be argued that the increasing incidence in older patients could represent the presence of pre-existing chondral or meniscal pathology and although we cannot refute this, in our series there remains a demonstrable temporal relationship with respect to secondary pathology.

This study has also allowed investigation into the juvenile population. There were 431 patients below the age of

17 years, and 113 had an interval between injury and surgery of greater than five months, in which circumstance the odds of medial meniscal surgery was doubled and if surgery was delayed more than 12 months the odds were quadrupled. It has previously been reported that secondary meniscal tears occur in conservatively managed juvenile ACL ruptures¹⁷ and when there is delayed ACL reconstruction.¹⁸ Although many surgeons have concerns about ACL reconstruction in juvenile patients, we are in agreement with other authors,^{19,20} in that we would encourage early reconstruction in this group with the aims of restoring stability in the knee and the prevention of secondary damage. Our experience in this young age group of using a transphyseal hamstring graft secured with extraphyseal fixation has resulted in good outcomes and no growth arrest.²¹

In considering the safe time to wait before ACL reconstruction, it is clear that sooner is better. If a patient wishes to defer treatment we can offer advice that the risk of meniscal injury will increase, particularly beyond five months. The situation can be made worse if there is unnecessary delay in establishing the diagnosis.^{22,23} In this setting, it may be more appropriate to consider ACL surgery in a similar manner to fractures or tendon ruptures, rather than as an elective procedure. Alternatively, the introduction of rapid assessment clinics may help reduce delays.²⁴

Our study does not address whether or not reconstruction of the ACL reduces the risk of developing osteoarthritis (OA). However, it has been shown clearly that there is an increased risk of OA in knees with previous meniscectomy.^{25,26} Furthermore, there is an increased risk of OA in knees with ACL reconstruction and meniscectomy, compared with ACL reconstruction alone.^{7,27,28} Therefore, one might speculate that late ACL reconstruction where significant delay increases the risks of secondary damage will increase the risk of developing OA.

A strength of this study is the large sample size of over 5000 patients with prospectively collected information. As there are only two surgeons involved in this series, a degree of selection bias is inevitable.

Conclusions. In patients with ACL rupture warranting reconstruction for instability, the incidence of chondral damage and medial meniscal tears increases with increasing time after injury. The incidence of lateral meniscal tears does not increase. The timing of surgery is important and ideally, and particularly in younger patients, ACL reconstruction should be performed early and not be delayed beyond five months from injury.

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