Chapter

ACL Tear and Cartilage Lesions

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Abstract

Articular cartilage injuries are not uncommon finding in patients with anterior cruciate ligament (ACL) tear. There are several ways to address the cartilage injuries when encountered during ACL reconstruction. The favorable treatment of cartilage injuries during ACL reconstruction is controversial. Indeed, the treatment of cartilage injuries depends on multiple factors including patient variables and severity of lesion. It is unclear whether cartilage lesions affect the recovery after ACL reconstruction and vice versa. Whether ACL reconstruction has a preventive effect on further progression of cartilage lesions is also unclear. This chapter gives an overview of current literature related to cartilage injuries with ACL tear in terms of epidemiology, clinical presentation, and management.

Keywords: ACL, anterior cruciate ligament, cartilage, chondral, lesions, arthritis, knee, laxity, outcomes

1. Introduction

Articular cartilage injuries are a frequent finding in patients with anterior cruciate ligament (ACL) tear. The cartilage lesions may be pre-existing, especially in athletes, or may occur at the same traumatic episode of the ACL injury. The chondral injuries may be asymptomatic and difficult to identify on preoperative imaging; but discovered only at the time of ACL reconstruction (ACLR). The treatment options for cartilage lesions include nonoperative, chondroplasty, microfracture, mosaicplasty, osteochondral allograft, autologous chondrocyte implantation, and artificial joint replacement. When encountered with ACL tear, the influence of concomitant cartilage injuries on clinical outcomes, the return to sport, and long term progression to osteoarthritis is unclear [1]. The ideal treatment of cartilage injuries during ACLR is also controversial. In general, the treatment of cartilage injuries depend on multiple factors including patient demographics and activity level, severity and location of the lesion, and concomitant pathologies such as knee varus malalignment. The aim of this chapter is to highlight the current literature related to cartilage injuries with ACL tear in terms of epidemiology, clinical presentation, and management.

2. Epidemiology

The prevalence of cartilage injuries with ACL tear is not uncommon. Flanigan et al. in a systematic review of 11 studies involving 931 athletes reported the prevalence of full-thickness focal chondral defects of 36%, of whom, 14% were asymptomatic [2]. Brophy et al. in a systematic review of 5 studies reported that the incidence of severe articular injury identified during ACLR to be between 16% and 46% [3]. Wyatt et al. in a case series of 261 patients reported a prevalence of chondral injuries of 15% in primary and 32% in revision ACLR [4]. Rotterud et al. [5] studied the Norwegian and the Swedish National Knee Ligament Registry between 2005 and 2008 with a total of 8476 ACLRs. They found that 20% of the patients had a grade 1 or 2 International Cartilage Research Society (ICRS) cartilage lesion, and 7% had a grade 3 or 4 ICRS cartilage lesion and approximately half of the lesion had a surface area less than 2 cm^2. The most common location of chondral lesion was the medial femoral condyle (34–51%). Tandogan et al. [6] in their multicentric study of 764 patients who underwent arthroscopy for ACL tear found that at least one chondral injury was present in 19% of patients, of which 60% were observed in weight-bearing area of the medial condyle. One third of the chondral injuries were grades 3 and 4 ICRS. The mean surface was 219 ± 175 mm^2. Thus, current literature suggests that severe cartilage injuries are encountered in about one third of patients undergoing ACLR.

3. Effect of ACL injury on cartilage lesions

The cartilage injury accompanying ACL tears could occur at the time of the initial trauma that tore ACL or as a sequalae due to knee instability and altered tibiofemoral biomechanics. Notably, the literature indicates an increase in incidence of cartilage lesions in chronic ACL tear in comparison with acute cases. Sommerfeldt et al. [7] evaluated the 860 patients who underwent ACLR with a single surgeon and found that increased time duration between injury to surgery associated with higher odds of chondral damage of the medial femoral condyle, early degenerative changes of the medial tibiofemoral compartment, and medial meniscal tears, including irreparable medial meniscal tears. Shelbourne et al. [8] studied 2770 patients who underwent ACLR and found that the incidence of cartilage lesions was twice as common in patients with chronic ACL tear (54%) as compared to those with acute ACL tear (23%).

Several studies have evaluated the influence of duration between injury and ACLR on the incidence of chondral injury. Tandogan et al. in their multicentric study [6] found that the risk of grade 3 and 4 ICRS chondral injury increased with longer duration between ACL injury and arthroscopy and older age. The odds of grade 3 and 4 chondral injury at 2 to 5 years after ACL injury were 2.7 times which increased to 4.7 times after 5 years of ACL injury. Joseph et al. [9] studied the arthroscopic findings of 575 athletes and 800 non-athletes undergoing ACLR and found an increase in chondral injuries in both the groups who had a delay of 1 year for ACLR since injury. Yüksel et al. [10] evaluated the arthroscopic findings of patients with ACL tear who elected not to restrict their daily activities after the initial trauma and reported the characteristics of meniscal and chondral lesions. The prevalence of chondral injuries was significantly higher in patients who had a delay of 1 year (70%) from injury until treatment as compared to those with a delay of 6 weeks to 1 year (26%), and less than 6 weeks (9%). Michalitsis et al. [11] in their case series of 109 consecutive patients

with ACL tear reported increased incidence of high-grade cartilage lesion when reconstruction was performed more than 12 months after injury. Similarly, Anderson et al. [12] studying pediatric patients with ACL tear demonstrated that delayed ACLR increased the risk of secondary meniscal and chondral injuries. Taketomi et al. [13] in their retrospective study involving 226 patients concluded that ACLR should be performed within 6 months after the ACL injury to prevent cartilage and meniscus lesions. Bambrilla et al. [14] found that ACLR within 12 months of injury can significantly reduce the risk of meniscal tears and chondral lesions. In their study, older age and increased BMI were risk factors for the occurrence of at least one associated lesion. Prodromidis et al. [15] in their meta-analysis published in 2022 of 14 studies found that a delay in ACLR by 3 months after injury increased the odds of low-grade chondral injuries by 1.9 times and a delay of 1 year increased the odds of high-grade chondral injuries by 3 times. They recommended performing ACLR, when indicated, within 3 months of ACL injury. Wyatt et al. [4] reported in their case series of 261 patients that the prevalence of cartilage injuries increased from 14.9% at primary ACLR to 31.8% at revision ACLR. Thus, the current literature indicates that it may be critical to perform ACLR as early as 3 months or at least within 1 year of ACL injury and perhaps earlier in obese, older, and failed previous ACLR patients to prevent further damage to the knee cartilage and meniscus.

4. Does ACLR prevent from progression of chondral damage?

Whether ACLR prevents an increase in the identified chondral lesions and progression to osteoarthritis is controversial. MARS and MOON group [16] evaluated 134 patients undergoing revision ACLR for progression of chondral lesions as compared to primary ACLR. Significant progression of articular cartilage damage was defined in each compartment according to progression on the modified Outerbridge scale (increase ≥1 grade) or > 25% enlargement in any area of damage. Partial meniscectomy was found as a risk factor for progression of chondral lesions and older age, higher body mass index, and use of allograft in primary ACLR were associated with osteoarthritis progression. Sugiu et al. [17] in their study of 37 patients that underwent double bundle ACLR found an increase in the cartilage lesions from 11 sites at index ACLR surgery to 54 sites at the second look arthroscopy at a mean of 17 months follow up. The authors concluded that the knee articular cartilage lesions after ACL rupture cannot be completely suppressed, even with anatomical ACLR technique. Nakamae et al. [18] in a study of 174 patients who had second look arthroscopy after double bundle ACLR found that the chondral damage progression was strongly associated with partial meniscectomy. Huang et al. [19] studying the patellofemoral cartilage lesions detected during ACLR at a follow up of mean of 2 years found progression of lesions in 45 out of 129 patients. They identified medial or lateral partial meniscectomy and quadriceps muscle weakness to be the associated with progression of patellofemoral cartilage lesions. Hence, the role of ACLR to prevent progression of chondral lesions is controversial.

5. Effect of cartilage injuries on clinical outcomes after ACLR

Several studies have evaluated the influence of concomitant cartilage lesion on short-, mid-, and long-term clinical outcomes after ACLR. Everhart et al. [20] studied

508 patients undergoing ACLR and found that those with grade 2 or higher chondral damage had quadriceps weakness at 6 months follow up as compared to those without chondral damage. They also found that patients with chondral damage had lesser risk of ipsilateral and contralateral ACL injury, perhaps due to reduced activity level. Rotterud et al. [5] found worse functional patient-reported outcomes at short term follow up of 2 years after ACLR when concomitant cartilage lesion of grades 3 and 4 ICRS were present. Kowalchuk et al. [21] studied 402 patients of ACLR at a midterm follow up of mean 6.3 years and found lower International Knee Documentation Committee (IKDC) score in patients with concomitant chondral injuries. Similarly, Cox et al. [22] in another midterm (mean 6 years follow up) multicentric study in patients with ACLR found that grade 3 and 4 ICRS cartilage lesions and meniscal injury were the predictors of lower IKDC and KOOS scores. Another study by Webster et al. [23] of 180 patients undergoing revision ACLR evaluated at a mean of 4.6 years found that patients with ICRS 3 or 4 chondral pathology had significantly lower IKDC, KOOS-Quality of life, Marx activity, and Single Numerical Assessment scores as well as a lower rate of return to the same level of pre-injury sport. Brophy et al. [24] in a retrospective study of a cohort of 2575 patients who had ACLR found that the risk factors for worse IKDC and KOOS scores at 10 years follow up were chondral lesions in patellofemoral or medial compartments and previous meniscal surgery. In a prospective study of 100 patients undergoing ACLR, Janssen et al. [25] reported radiological signs of osteoarthritis in 53.5% of the cases at a long term follow of 10 years. They reported cartilage lesion and meniscectomy to be the risk factors for osteoarthritis after ACLR.

On the other hand, there are few studies [8, 26–28] that did not find any influence of concomitant cartilage lesions on outcomes of ACLR. Shelbourne et al. [8] evaluated 2770 ACLR patients and found no difference in IKDC scores at midterm follow up of mean 6.3 years between patients with or without concomitant grade 3 and 4 chondral lesions. Widuchowski et al. [28] in a long term of 10 and 15 years follow up study found that the patients with grade 3 and 4 Outerbridge chondral lesions identified during ACLR and left alone without treatment had similar Lysholm, Tegner, and IKDC scores as compared to those without chondral lesions.

Despite the discrepancy in literature on influence of chondral lesion on outcomes of ACLR, there is adequate evidence and rational favoring treatment of grade 3 and 4 chondral lesions when encountered during ACLR. In a systematic review of 37 studies, Filardo et al. [29] concluded that most of the studies in the literature showed a correlation between lesions of the articular surface and a poor outcomes after ACLR. Furthermore, it is well known that isolated grade 3 and 4 cartilage knee injuries can cause pain and effusion and affect the return to sport. Thus, it seems appropriate to treat high-grade focal chondral defects simultaneously with ACLR in order to give the best chance of return to function and sports and reduce chances of rapid progression to osteoarthritis.

6. Results of concomitant cartilage repair and ACLR

The preferred method of cartilage treatment during ACLR such as simple debridement, microfracture, mosaicplasty, osteochondral allograft, and biological cell based treatment like chondrocyte implantation or stem cell therapy is based on multiple factors and controversial. One cannot emphasize enough on the importance of preoperative assessment of imaging for the size and location of chondral lesion to

plan its treatment. Debridement, microfracture procedure, or mosaicplasty are simple techniques that will not require postoperative immobilization of the knee. On the other hand, more sophisticated and staged procedures, such as scaffolds and biological cell based treatment, usually requires a period of postoperative immobilization which could compromise the rehabilitation of the ACL based on early mobilization.

In a nationwide prospective cohort study from Norway and Sweden of 368 patients, comparing simple debridement, microfracture, and nonsurgical treatment of concomitant full-thickness cartilage lesions after ACLR, Ulstein et al. [30] showed no difference on KOOS scores at 5-year follow-up. Nakamura et al. [31] demonstrated that at second-look arthroscopy, after ACLR without any intervention to the articular cartilage, there was a significant recovery of chondral lesions by Outerbridge grading on both the medial and lateral femoral condyles. Differently for chondral lesions of patellofemoral joint or tibial plateau, there was no significant recovery of chondral lesions. They concluded that there was a location-specific difference in the natural healing response of chondral injury favoring those on femoral condyles. One of the reasons of spontaneous healing of chondral lesions with simple debridement in patients undergoing ACLR could be due to biological factors released during the surgery. ACLR involves drilling of bone tunnels, intra-articular enrichment in growth factors and progenitor cells from bone marrow might be involved in the repair processes of injured cartilage. Another study by Imade et al. [32] in a cohort of 40 patients undergoing ACLR with cartilage treatment either by microfracture or autologous osteochondral grafting at 1 year follow up found no differences in IKDC scores.

In our experience, only grade 3 and 4 ICRS lesions are treated at the same time as ACLR and grade 1 and 2 are left alone. For grade 3 and 4 lesions of size less than 3 cm^2 or less, microfractures or mosaicplasty are preferred. Among these, mosaicplasty is preferred over microfracture if the cartilage lesions involve substantial surface of weight bearing surface of the condyle as the literature shows better results of return to sports with mosaicplasty [33]. Above 3 cm^2, if available, osteochondral allograft is a good option because it allows starting an early mobilization after the combined surgery. More literature evidence is needed to ascertain the best method of cartilage treatment during ACLR.

7. Physiotherapy protocol after ACLR with concomitant chondral lesion

The presence of concomitant cartilage lesions, treated or not, in the setting of ACLR represents a peculiar and controversial challenge in terms of postoperative physiotherapy management. Most of the authors recommend caution in the rehabilitation in such cases. There is limited evidence in the literature to recommend a specific physiotherapy protocol. Thrush et al. [34] in their systematic review of 6 studies on physiotherapy after concomitant ACLR and chondral injury found very little uniformity, and no strong recommendations could be concluded regarding the most appropriate rehabilitation. Interestingly, use of aggressive rehabilitation, early weightbearing, no immobilization, and immediate range of motion did not compromise outcomes compared to more conservative protocols. The authors' preferred physiotherapy protocol for cases of microfracture in any area or auto- or allo-graft cartilage transplantation or autologous chondrocyte implantation in nonweight bearing area, is no restriction of range of motion and full weight bearing. In cases of auto- or allo-graft cartilage transplantation in the weight bearing area, we prefer partial weight bearing for 6 weeks without any restriction of range of motion.

As with any surgery, patient expectation is key to optimize satisfaction [35]. It is crucial for surgeons to inform patients undergoing ACLR about the additional treatment and modifications in physiotherapy in case full-thickness cartilage lesion is encountered. This is particularly important in athletic population who may be disappointed if the cartilage lesion leads to residual pain, swelling, and limitation to return to sport.

8. Conclusion

The presence of concomitant grade 3 and 4 cartilage injury leads to worse clinical outcomes after ACLR than those without cartilage lesion or even partial thickness cartilage lesion. Current evidence favors the treatment of the cartilage lesion at the time of ACLR to optimize the clinical outcomes and return to sports. The preferred treatment of cartilage lesion is controversial and depends on the size, location, and experience of the surgeon. Future studies should focus on refining the selection criteria for cartilage lesions that will benefit from treatment during ACLR and also the preferred method of treatment.

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