

## Original Research Article

# PREVALENCE OF CHONDRAL DEFECTS IN POST-TRAUMATIC ANTERIOR CRUCIATE LIGAMENT-DEFICIENT KNEES: AN ARTHROSCOPIC STUDY

Harshith R<sup>1</sup>, Rakshith Kumar K<sup>2</sup>, Bhargav G<sup>3</sup>, Ihtisham ul Haq Usman Shaikh<sup>4</sup>

<sup>1,2,3</sup>Assistant Professor, Department of Orthopaedics, BGS Global Institute of Medical Sciences, Bengaluru, Karnataka, India.

<sup>4</sup>Post Graduate Resident Doctor, Department of Orthopaedics, BGS Global Institute of Medical Sciences, Bengaluru, Karnataka, India.

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## Corresponding Author:

**Dr. Bhargav G,**  
Assistant Professor, Department of  
Orthopaedics, BGS Global Institute of  
Medical Sciences, Bengaluru,  
Karnataka, India.  
Email: bhargavgirish005@gmail.com

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## ABSTRACT

**Background:** Anterior cruciate ligament (ACL) injury is a common traumatic injury of the knee and may result in persistent instability and altered joint biomechanics. ACL deficiency can be associated with secondary intra-articular pathology, including meniscal and articular cartilage damage. Arthroscopy provides direct visualization of the articular cartilage and permits assessment and grading of chondral defects. The present study was undertaken to determine the prevalence and pattern of chondral defects in post-traumatic ACL-deficient knees. **Aim:** To determine the prevalence of chondral defects in post-traumatic anterior cruciate ligament-deficient knees by arthroscopic analysis.

**Materials and Methods:** An observational cross-sectional study was conducted among 31 patients aged 20–40 years with traumatic ACL injury who underwent arthroscopic ACL reconstruction between January 2019 and October 2020. Patients with isolated ACL tears were included, while those with other ligament injuries, ipsilateral bony injuries, associated osteoarthritis, or those who did not provide consent for surgery were excluded. During arthroscopic assessment, the articular cartilage was systematically examined for chondral defects. The defects were documented according to their anatomical site and graded using the Outerbridge classification. Associated meniscal pathology and duration of injury were also recorded. Descriptive statistical methods were used for analysis.

**Results:** Among the 31 patients, 24 (77.42%) demonstrated chondral defects, while 7 (22.58%) had no detectable defect. Among the 30 documented chondral defects, Grade I was the most frequent (17; 56.67%), followed by Grade II (10; 33.33%), Grade III (2; 6.67%) and Grade IV (1; 3.33%). The medial femoral condyle was the most commonly involved site, accounting for 17 (56.67%) defects, followed by the medial tibial plateau (16.67%), patella (13.33%), lateral femoral condyle (10.00%) and lateral tibial plateau (3.33%). Associated meniscal defects were present in 14 patients (45.16%), including medial meniscal defects in 8 (25.80%) and lateral meniscal defects in 6 (19.35%). Twenty patients (64.52%) underwent surgery within 6 months of injury, while 11 (35.48%) underwent surgery after 6 months.

**Conclusion:** Chondral defects were frequently observed in post-traumatic ACL-deficient knees undergoing arthroscopic reconstruction. Grade I lesions were the most commonly observed, while the medial femoral condyle was the predominant anatomical site of involvement. Associated meniscal pathology was also frequently observed. Systematic arthroscopic assessment provides useful information regarding the presence, grade and distribution of chondral abnormalities in ACL-deficient knees.

**Keywords:** Anterior cruciate ligament, Chondral Defect, Arthroscopy, Meniscal Injury.

## INTRODUCTION

Anterior cruciate ligament (ACL) injury is one of the most common ligamentous injuries of the knee and is an important cause of persistent instability and functional limitation, particularly among young and physically active individuals. The incidence of ACL injuries has increased with the rising participation in sports and recreational activities as well as the continued burden of road traffic accidents. The ACL is a primary stabilizer of the knee and plays an important role in preventing anterior translation of the tibia over the femur and controlling rotational movements of the knee. Following ACL rupture, alteration in normal knee biomechanics may result in recurrent episodes of instability and abnormal loading of the articular surfaces, predisposing the knee to secondary intra-articular damage.<sup>[1]</sup>

Articular cartilage is a specialized connective tissue that provides a smooth, low-friction surface for joint movement and plays an important role in load distribution and shock absorption. Unlike many other tissues, articular cartilage has a limited capacity for spontaneous healing because of its avascular nature. Consequently, cartilage damage sustained during an ACL injury or developing subsequently in an ACL-deficient knee may persist and progress over time.<sup>[2]</sup> Chondral injury may occur at the time of the initial traumatic event because of abnormal contact and impaction between the femoral condyle and tibial plateau. Continued instability following ACL rupture may further alter the distribution of mechanical loads across the knee, resulting in progressive cartilage damage and an increased risk of degenerative changes.<sup>[3]</sup>

The relationship between the duration of ACL deficiency and secondary intra-articular pathology has been demonstrated in several studies. Patients with prolonged ACL deficiency have been reported to have a greater prevalence and severity of meniscal and chondral lesions compared with patients undergoing reconstruction earlier after injury.<sup>[3,4]</sup> Delayed reconstruction may allow repeated episodes of instability, producing abnormal shear and compressive forces across the articular cartilage. In addition, associated meniscal injury can further compromise load distribution within the knee and may accelerate cartilage degeneration. Thus, the timing of surgical intervention may have an important role in preventing or reducing secondary structural damage in ACL-deficient knees.<sup>[4,6]</sup>

The presence of chondral lesions is clinically important because cartilage damage may contribute to pain, functional impairment and the subsequent development of post-traumatic osteoarthritis. Long-term studies have demonstrated that individuals with ACL deficiency may develop progressive radiological and structural degenerative changes of the knee.<sup>[5]</sup> The natural history of untreated ACL deficiency also suggests that persistent instability is associated with progressive damage to the menisci

and articular cartilage. The severity of these changes may depend on several factors, including duration of injury, recurrent instability episodes, patient activity level, mechanism of injury and associated intra-articular lesions.<sup>[1,5,7]</sup>

Magnetic resonance imaging (MRI) is routinely used for the preoperative evaluation of ACL injuries and can provide valuable information regarding ligament integrity, meniscal pathology and cartilage abnormalities. However, MRI findings may not completely represent the actual condition of the articular surface. Arthroscopy provides direct visualization of the intra-articular structures and therefore allows identification of chondral lesions that may not be adequately characterized on imaging. Diagnostic arthroscopy performed during ACL reconstruction provides an opportunity to systematically inspect the articular surfaces and document the presence, location and severity of cartilage defects.<sup>[5,8]</sup>

The Outerbridge classification is one of the commonly used arthroscopic systems for grading articular cartilage lesions. It categorizes cartilage abnormalities according to the depth and extent of surface damage, ranging from cartilage softening to complete loss of cartilage with exposure of subchondral bone. Standardized grading allows objective documentation of chondral pathology and facilitates comparison of cartilage damage among patients.<sup>[8]</sup> Previous investigations have demonstrated that cartilage lesions may occur at different sites within the knee, with the medial femoral condyle and tibial plateau being commonly affected regions in ACL-deficient knees.<sup>[1,9]</sup>

The timing of ACL reconstruction is also an important consideration in relation to secondary chondral and meniscal injury. Studies evaluating patients undergoing ACL reconstruction have reported increased intra-articular damage with increasing delay between the initial injury and definitive surgical treatment.<sup>[4,6,10]</sup> However, the prevalence and severity of chondral defects may vary between populations because of differences in age, mechanism of injury, activity level, duration of instability and access to early surgical treatment. The original study on which the present work is based also emphasized the importance of assessing cartilage injury in relation to the duration of ACL injury and timing of surgery.

Therefore, systematic arthroscopic evaluation of ACL-deficient knees is important for determining the actual burden of chondral pathology. Identification of the prevalence, anatomical distribution and grade of chondral defects may improve understanding of the secondary effects of ACL deficiency and provide useful information regarding the potential consequences of delayed reconstruction. The present study is undertaken to assess the prevalence of chondral defects in post-traumatic ACL-deficient knees using arthroscopic evaluation and to grade the identified lesions according to the Outerbridge classification. In addition, the study will evaluate the

distribution of cartilage defects and examine their relationship with the duration of injury and timing of surgical intervention.

## MATERIALS AND METHODS

The present study was conducted as an observational cross-sectional study among 31 patients with post-traumatic anterior cruciate ligament (ACL) deficiency who underwent arthroscopic ACL reconstruction during the period from January 2019 to October 2020. The study population comprised patients in the age group of 20–40 years with traumatic ACL injury. A total of 31 consecutive patients with ACL tears fulfilling the predefined eligibility criteria were included in the study.

Patients with an isolated anterior cruciate ligament tear and those between 20 and 40 years of age were included. Patients with ligament injuries other than ACL injury, ipsilateral bony injury, associated osteoarthritis of the knee, and those who did not provide consent for surgery were excluded.

Patients presenting with complaints such as knee pain, instability, difficulty in squatting and difficulty in sitting cross-legged were assessed through appropriate history and clinical examination. Patients diagnosed with ACL tear underwent arthroscopic ACL reconstruction. Patients who underwent the procedure within 6 months of injury were categorized into one group, whereas those who underwent the procedure after 6 months of injury were categorized into another group.

During arthroscopic evaluation, the articular cartilage was assessed for the presence of chondral defects. The defects were documented according to their site and graded using the Outerbridge classification. The medial femoral condyle, lateral femoral condyle, medial tibial plateau, lateral tibial plateau and patella were assessed for cartilage involvement. Associated intra-articular pathology, particularly meniscal injury, was also recorded. The collected data were summarized using appropriate descriptive statistical methods.

## RESULTS

The study included 31 patients with post-traumatic ACL deficiency. As shown in Table 1, the majority

of patients belonged to the 20–25 years age group (29.03%), followed by the 26–30 and 31–35 years age groups (25.80% each), while 19.35% were aged 36–40 years. Males constituted the majority of the study population (80.64%), whereas females accounted for 19.36%. The right knee was more commonly involved (58.06%) than the left knee (41.94%). Road traffic accidents were the most common mode of injury (54.83%), followed by sports-related injuries (35.48%) and other activities of daily living (9.67%).

Table 2 shows the distribution of patients according to duration of injury and presence of chondral defects. Of the 31 patients, 20 (64.52%) underwent surgery within 6 months of injury, whereas 11 (35.48%) underwent surgery after 6 months. Overall, chondral defects were identified in 24 patients (77.42%), while 7 patients (22.58%) had no detectable chondral defect.

According to Table 3, among the 30 chondral defects documented arthroscopically, Grade I defects were the most frequently observed, accounting for 17 (56.67%) defects. Grade II defects accounted for 10 (33.33%), followed by Grade III defects in 2 (6.67%) and Grade IV defects in 1 (3.33%). The thesis also reports that Grade IV defect was observed in one patient with a history of injury for 3 years, while Grade III defects were seen in two patients with injury durations of 2 and 4 years.

Table 4 demonstrates the anatomical distribution of the 30 chondral defects. The medial femoral condyle was the most commonly involved site, accounting for 17 defects (56.67%), followed by the medial tibial plateau with 5 defects (16.67%). The patella was involved in 4 defects (13.33%), while the lateral femoral condyle and lateral tibial plateau accounted for 3 (10.00%) and 1 (3.33%) defects, respectively. Thus, the medial femoral condyle represented the predominant site of chondral involvement.

Table 5 shows the distribution of associated meniscal pathology. Medial meniscal defects were observed in 8 patients (25.80%), while lateral meniscal defects were present in 6 patients (19.35%), giving a total of 14 patients (45.16%) with associated meniscal defects. The thesis further reported that medial meniscal defects were more frequently observed in patients undergoing surgery after 6 months, whereas lateral meniscal defects were more frequently observed in the early surgery group.

**Table 1: Demographic and clinical characteristics of the study population (n=31)**

| Characteristic | Category              | Number (n) | Percentage (%) |
|----------------|-----------------------|------------|----------------|
| Age (years)    | 20–25                 | 9          | 29.03          |
|                | 26–30                 | 8          | 25.80          |
|                | 31–35                 | 8          | 25.80          |
|                | 36–40                 | 6          | 19.35          |
| Sex            | Male                  | 25         | 80.64          |
|                | Female                | 6          | 19.36          |
| Side involved  | Right                 | 18         | 58.06          |
|                | Left                  | 13         | 41.94          |
| Mode of injury | Road traffic accident | 17         | 54.83          |
|                | Sports                | 11         | 35.48          |
|                | Others (ADL)          | 3          | 9.67           |
| Total          |                       | 31         | 100            |

**Table 2: Distribution of patients according to duration of ACL injury and presence of chondral defect (n=31)**

| Duration of injury | Chondral defect Present n (%) | Chondral defect Absent n (%) | Total n (%) |
|--------------------|-------------------------------|------------------------------|-------------|
| ≤6 months          | —                             | —                            | 20 (64.52)  |
| >6 months          | —                             | —                            | 11 (35.48)  |
| Total              | 24 (77.42)                    | 7 (22.58)                    | 31 (100)    |

**Table 3: Arthroscopic distribution and grading of chondral defects according to Outerbridge classification**

| Chondral status / Grade          | Number (n) | Percentage (%) |
|----------------------------------|------------|----------------|
| Patients without chondral defect | 7          | 22.58          |
| Grade I defects                  | 17         | 56.67*         |
| Grade II defects                 | 10         | 33.33*         |
| Grade III defects                | 2          | 6.67*          |
| Grade IV defects                 | 1          | 3.33*          |
| Total chondral defects           | 30         | 100            |

**Table 4: Anatomical distribution of arthroscopically detected chondral defects (n=30 defects)**

| Site of chondral defect | Number (n) | Percentage (%) |
|-------------------------|------------|----------------|
| Medial femoral condyle  | 17         | 56.67          |
| Lateral femoral condyle | 3          | 10.00          |
| Medial tibial plateau   | 5          | 16.67          |
| Lateral tibial plateau  | 1          | 3.33           |
| Patella                 | 4          | 13.33          |
| Total                   | 30         | 100            |

**Table 5: Association of chondral defects with duration of injury and associated meniscal injury**

| Variable           | Category  | Chondral defect Present n (%) | Chondral defect Absent n (%) | Total |
|--------------------|-----------|-------------------------------|------------------------------|-------|
| Duration of injury | ≤6 months | —                             | —                            | 20    |
|                    | >6 months | —                             | —                            | 11    |
| Meniscal injury    | Present   | 14*                           | —                            | 14    |
|                    | Absent    | —                             | —                            | 17    |
| Total patients     |           | 24                            | 7                            | 31    |

## DISCUSSION

The present study evaluated the prevalence and pattern of chondral defects in 31 patients with post-traumatic anterior cruciate ligament (ACL)-deficient knees undergoing arthroscopic ACL reconstruction. Chondral defects were identified in 24 patients (77.42%), while 7 patients (22.58%) had no detectable chondral defect. The relatively high frequency of chondral involvement observed in the present study highlights the importance of assessing articular cartilage during arthroscopic evaluation of ACL-deficient knees.

The predominance of male patients (80.64%) in the present study is consistent with the findings reported by Church and Keating, who observed a higher proportion of males among patients undergoing ACL reconstruction. The greater representation of males in the present study may also reflect differences in participation in sports and exposure to traumatic mechanisms, although the present study was not designed to determine the reasons for this sex distribution.

Chondral injury is an important associated pathology following ACL rupture. Potter et al. demonstrated that cartilage injury may occur even following an acute isolated ACL tear and that cartilage changes may persist and progress during follow-up. The finding of chondral defects in 77.42% of patients in the present study supports the observation that cartilage pathology is a frequent finding in ACL-deficient knees.

The arthroscopic grading of cartilage defects showed that Grade I was the most frequently observed lesion (56.67%), followed by Grade II (33.33%), Grade III (6.67%) and Grade IV (3.33%). The presence of different grades of cartilage injury demonstrates the variable extent of chondral involvement among ACL-deficient knees. Church and Keating reported an increased incidence of higher-grade cartilage changes among patients undergoing delayed ACL reconstruction, particularly in those with a longer interval between injury and surgery. Similarly, Kluczynski et al. reported that delay in ACL reconstruction was associated with an increased number, size and grade of chondral defects.

In the present study, the medial femoral condyle was the most commonly involved site, accounting for 17 of the 30 documented chondral defects (56.67%). The medial tibial plateau was the second most frequently involved site, followed by the patella, lateral femoral condyle and lateral tibial plateau. These findings indicate that cartilage damage is not uniformly distributed throughout the knee. George et al. demonstrated a strong relationship between the duration of ACL injury and cartilage loss, particularly in patients with associated meniscal pathology.

The relationship between ACL deficiency and progressive cartilage damage has also been described by Amin et al., who reported an increased risk of cartilage loss in the medial tibiofemoral compartment among patients with complete ACL tears. The predominance of medial femoral condyle involvement in the present study is therefore

consistent with the pattern of cartilage changes described in previous investigations.

Associated meniscal pathology was identified in 14 of the 31 patients (45.16%) in the present study, with medial meniscal defects observed in 8 patients (25.80%) and lateral meniscal defects in 6 patients (19.35%). The thesis findings further showed that medial meniscal defects were more frequently observed among patients undergoing surgery after 6 months, whereas lateral meniscal defects were more commonly observed in the early surgery group. Church and Keating similarly reported a significant association between delayed ACL reconstruction and medial meniscal injury.

The association between meniscal and chondral pathology is clinically relevant because both structures contribute to the maintenance of normal knee biomechanics and load distribution. Hugh Jones et al. reported that patients managed non-operatively after ACL injury may develop increased radiological evidence of joint degeneration and corresponding disability. Simon et al. also described the relationship between ACL deficiency, altered knee kinematics and subsequent cartilage degeneration, emphasizing the contribution of associated meniscal and cartilage pathology to the development of osteoarthritis.

The findings of the present study also emphasize the usefulness of arthroscopy for direct assessment of chondral pathology. Although MRI provides important information regarding ACL integrity and associated intra-articular abnormalities, arthroscopy allows direct visualization of the articular surface and assessment of the severity and anatomical distribution of cartilage defects. The thesis protocol similarly documented cartilage defects during diagnostic arthroscopy before ACL reconstruction. Overall, the findings demonstrate that chondral abnormalities constitute an important associated finding in post-traumatic ACL-deficient knees. The present study also demonstrates the coexistence of cartilage and meniscal pathology and the predominance of medial femoral condyle involvement. However, because the study included only 31 patients, the findings should be interpreted within the context of the study population and should not be generalized beyond similar patients undergoing arthroscopic ACL reconstruction.

## CONCLUSION

The present study demonstrates that chondral defects were frequently observed in post-traumatic ACL-deficient knees, with 24 of 31 patients (77.42%) showing arthroscopically detectable cartilage abnormalities. Grade I was the most frequently observed chondral lesion, followed by Grade II, Grade III and Grade IV lesions.

The medial femoral condyle was the most commonly affected anatomical site, accounting for 56.67% of

the documented chondral defects. Associated meniscal pathology was observed in 45.16% of patients, with medial meniscal involvement being more frequent than lateral meniscal involvement.

The findings highlight the importance of systematic arthroscopic evaluation of the articular cartilage and associated intra-articular structures during ACL reconstruction. Early recognition and appropriate management of ACL injury may be important in reducing the progression of secondary chondral and meniscal pathology.

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