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Intra-articular calcifications following arthroscopic ACL reconstruction: prevalence and possible significance

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Abstract

Purpose The goal of our study was to determine the frequency of intra-articular calcifications on initial postoperative radiographs following arthroscopic ACL reconstruction, describe their appearance, hypothesize their etiology, and determine their significance.

Materials and methods Review of records and post-operative radiographs for individuals undergoing arthroscopic ACL reconstruction at our institution identified 758 knees between November 2002 and April 2010. All patients underwent femoral and tibial tunnel drilling regardless of graft source. All but 23 underwent notchplasty.

Results Intra-articular calcifications on initial postoperative radiographs were observed in 252 knees. The majority of calcifications were curvilinear, paralleling the posterior femoral condyles. Nineteen of the patients with calcifications on initial studies had repeat radiographs within 6 years. The calcifications resolved in every case.

Conclusions This study shows that intra-articular calcifications are a common finding on initial post-operative radiographs following ACL reconstruction. We feel they are of doubtful clinical significance, and in our limited experience, they eventually resolve. They should not be confused with chondrocalcinosis or vascular calcification.

Keywords Anterior cruciate ligament reconstruction · Calcification of joints and arteries · Chondrocalcinosis

Introduction

Arthroscopically assisted anterior cruciate ligament (ACL) reconstruction is a common orthopedic surgical procedure [1]. Reconstruction techniques have varied over the years, and have included advancements in equipment, tunnel placement, graft fixation devices, and types of grafts [2, 3]. Controversy continues to exist with respect to graft choices, the number of tunnels drilled (single versus double bundle), and biologic augmentation. Currently accepted ACL reconstruction techniques rely on intra-articular reconstruction using biologic tissue. These tissues can be autograft or allograft. Autograft used include bone-patellar tendon-bone, quadriceps tendon, and hamstring tendon. Allografts used include bone-patellar tendon-bone, Achilles tendon, or tibialis anterior/posterior tendon.

Regardless of the source, intra-articular graft is placed within tunnels in the distal femur and proximal tibia, and secured either directly or indirectly. Multiple types of fixation devices exist and range from metal interference screw fixation to buttons and posts. Their use depends on the type of graft, bone quality, reconstructive technique, and surgeon preference. Notchplasty is commonly undertaken to facilitate visualization and graft placement during surgery as well as to prevent graft impingement.

It is common practice to obtain anteroposterior (AP) and lateral radiographs of the knee either immediately following surgery or at the time of the first post-operative visit to evaluate tunnel and screw position. We have noted that on many of these routine post-operative images, intra-articular densities were often seen in the posterior knee joint. These were usually thin curvilinear bands, closely paralleling the

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Fig. 1 Lateral radiograph showing the typical appearance of post-arthroscopic ACL reconstruction calcification; a radiodense thin line closely paralleling the posterior femoral condyle (*arrows*)

posterior femoral condyles (Fig. 1). Far less often, calcifications would be seen more posterior to the condyles, and often thicker and/or linear (Fig. 2).

The purpose of our study was to determine the frequency of intra-articular calcifications on initial postoperative radiographs following arthroscopic ACL reconstruction, describe their appearance, hypothesize their etiology, and speculate as to their significance.

Materials and methods

After IRB exemption was obtained, operative reports and post-operative radiographs of all patients undergoing arthroscopically assisted ACL reconstruction at our institution between November 2002 and April 2010 were reviewed. Electronic notes were reviewed by a single individual (ES), noting the patient's age and sex, side of surgery, date of surgery, graft source, description of notchplasty, date of first post-operative radiographs and date of any follow-up imaging.

Exclusion criteria included revision ACL reconstruction, a lack of post-operative radiographs within 5 weeks of surgery and non-diagnostic post-operative radiographs.



Fig. 2 Linear calcifications may mimic vascular calcification (*arrows*)

Table 1 Patient characteristics with intra-articular calcifications (total=252)

| Graft type | | |
|--|----------|--------------|
| Allograft | (40.8 %) | |
| Bone-patellar tendon - bone | | 84 (33.3 %) |
| Achilles tendon | | 17 (6.7 %) |
| Tibialis anterior tendon | | 2 (0.8 %) |
| Autograft | (59.2 %) | |
| Bone-patellar tendon - bone | | 139 (55.2 %) |
| Hamstring tendon | | 10 (4.0 %) |
| Notchplasty type | | |
| “Notchplasty” | | 86 (34.1 %) |
| “Minor, slight, or conservative notchplasty” | | 143 (56.8 %) |
| No notchplasty performed | | 22 (8.7 %) |
| Unknown | | 1 (0.4 %) |

Post-operative radiographic studies were reviewed on a PACS workstation by a single individual (LLS). The presence or absence of intra-articular calcifications was noted, as well as the type of calcification; curvilinear following the contour of the posterior femoral condyles, or more linear and/or thicker in the posterior joint space.

Results

A total of 876 patients were identified. Of these, 117 were eliminated (ten revision surgeries, two nondiagnostic radiographs, and 105 without radiographs within 5 weeks of surgery), leaving 758 knees available for evaluation. Of the 758 knees, 259 patients were female, and 499 patients were male. Fifty percent of the knees were left knees (379) and 50 % (379) were right knees. The average age of the patient undergoing ACL reconstruction was 29.0 years (range, 12–65 years).

Table 2 Total study patient characteristics (total = 758)

| Graft type | | |
|---|----------|--------------|
| Allograft | (38.5 %) | |
| Bone-patellar tendon - bone | | 241 (31.8 %) |
| Achilles tendon | | 48 (6.3 %) |
| Tibialis anterior tendon | | 3 (0.4 %) |
| Autograft | (61.5 %) | |
| Bone-patellar tendon - bone | | 443 (58.5 %) |
| Hamstring tendon | | 23 (3.0 %) |
| Notchplasty type | | |
| “Notchplasty” | | 363 (47.9 %) |
| “Minor, slight or conservative notchplasty” | | 328 (43.3 %) |
| No notchplasty performed | | 64 (8.4 %) |
| Unknown | | 3 (0.4 %) |

Table 3 Patient characteristics without intra-articular calcifications (total = 506)

| Graft type | | |
|---|--------------|--|
| Allograft (37.3 %) | | |
| Bone-patellar tendon - bone | 157 (31.0) | |
| Achilles tendon | 31 (6.1 %) | |
| Tibialis anterior tendon | 1 (0.2 %) | |
| Autograft (62.7 %) | | |
| Bone-patellar tendon - bone | 304 (60.1 %) | |
| Hamstring tendon | 13 (2.6 %) | |
| Notchplasty type | | |
| “Notchplasty” | 277 (54.7 %) | |
| “Minor, slight or conservative notchplasty” | 185 (36.6 %) | |
| No notchplasty performed | 42 (8.3 %) | |
| Unknown | 2 (0.4 %) | |

Of these 758 knees in the study population, 252 showed intra-articular calcifications on initial lateral postoperative radiographs obtained within 5 weeks of surgery. Patient characteristics are outlined in Table 1. A total of 139 patients (55.2 %) had undergone bone-patellar tendon-bone autograft, 84 (33.3 %) bone-patellar tendon-bone allograft, 17 (6.7 %) Achilles tendon allograft, ten (4.0 %) hamstring autograft, and two (0.8 %) tibialis anterior allograft (Fig. 1). All patients underwent femoral and tibial tunnel drilling regardless of the graft source. As described in the operative report, 86 patients (34.1 %) underwent “notchplasty”, 143 (56.8 %) “minor” or “conservative” notchplasty, one (0.4 %) unknown (notchplasty not mentioned) and 22 (8.7 %) had no notchplasty.

Patient characteristics for those with intra-articular calcifications (Table 1) were compared to the total population (Table 2), and those without intra-articular calcifications (Table 3). When comparing these three groups, there was minimal difference in graft type (allograft=40.8, 35.5, and

37.3 %; autograft=59.2, 61.5, and 62.7 %) or presence of notchplasty (90.9, 91.2, and 91.3 %).

Of the 252 knees with calcifications, 243 (96.4 %) showed a thin (<1 mm) curvilinear density closely paralleling the posterior femoral condyles (Fig. 1). These had an appearance similar, if not identical to, chondrocalcinosis. The remaining nine were further posterior paralleling the joint capsule, and either thicker than 1 mm and/or linear (Fig. 2). These often mimicked vascular calcification.

Of the total study population of 758, 654 (86 %) had pre-operative radiographs available for review. Intra-articular calcifications were present on none.

Fifty-one (7 %) of the total study population had repeat radiographs within 6 years. None showed calcifications. This included 19 patients with calcifications on initial post-operative studies (Fig. 3a,b).

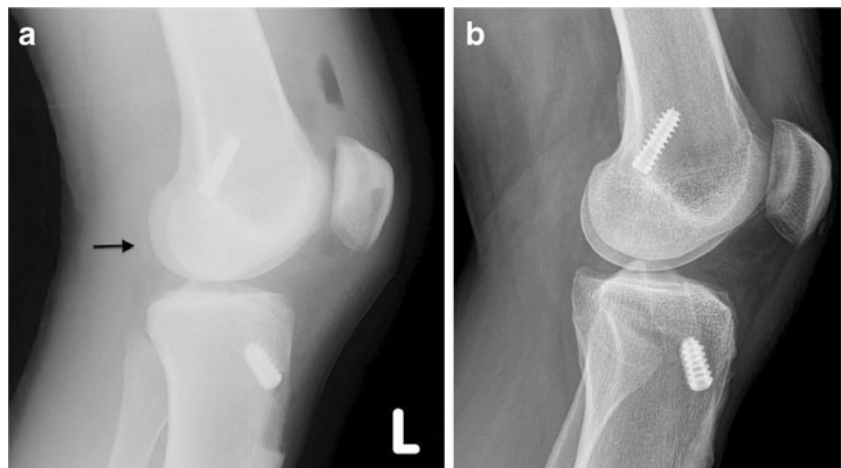
Discussion

Post-operative radiographs following ACL reconstruction are common and are used to evaluate graft and fixation placement. These radiographs are also important for assessing fixation migration or changes related to post-operative trauma if this occurs. In our experience, intra-articular calcifications are commonly seen on these radiographs.

We hypothesize that these likely originate from shavings related to tunnel creation and/or the notchplasty, although notchplasty was not required for their presence. We feel that it is unlikely that these densities are clinically relevant. They seem to resolve or are absorbed over time, as they were not apparent on radiographs more remote from surgery.

An alternative consideration for the source of these calcifications is so-called secondary (post-traumatic) chondrocalcinosis. In 1998, Minezaki et al. [4] published a case report describing a woman who underwent ACL reconstruction with a Leeds-Keio artificial ligament. Four years later, she was found to have

Fig. 3 **a** Immediate post-operative lateral radiograph showing faint calcifications posterior to the femoral condyles (arrow). **b** Lateral radiograph taken 3 years, 7 months after surgery. The calcifications are not seen



synovial and meniscal crystal deposition. They hypothesize that this may be secondary chondrocalcinosis or possibly related to the foreign body (synthetic graft). The author also states that "... no calcification as apparent in any other joints", but makes no mention of which other joints were evaluated.

Chondrocalcinosis has been associated with osteochondritis dissecans of the femoral condyles, particularly following surgery [5]. Although the specific location of the calcifications was not detailed, one can infer that this was generalized throughout the joint. All of our patients showed calcification confined to the posterior joint, only evident on the lateral radiograph. None could be seen on frontal projections.

Localized chondrocalcinosis has been reported following meniscectomy [6]. Review of this 1982 article points out that the authors are using the post-meniscectomy osteoarthritic knee as a model for "isolated joint damage" and therefore, secondary or post-traumatic chondrocalcinosis. The mean interval between meniscectomy and radiographic follow-up was 24.8 years, and the mean patient age at the time of evaluation was 57.3 years. They propose that the initial injury and/or previous surgery predispose the knee to both osteoarthritis and chondrocalcinosis. This would not be the case in our patient population. None of our patients showed radiographic changes of degenerative joint disease.

Localized chondrocalcinosis has also been described in chronically unstable joints [7]. These authors surmise that this is a secondary form of the disease, related to previously damaged joints. Of the four patients reported, two were described as having osteoarthritis (one knee, one thumb carpometacarpal joint). The radiographic presence or absence of degenerative disease was not mentioned for the other two (one knee, one ankle).

One could also speculate that the calcifications in this report represented some sort of "transient" chondrocalcinosis. We deem this to be unlikely, as this phenomenon has, to our knowledge, never been described in the literature.

An additional possible source for intra-articular calcifications following ACL reconstruction is calcification of the graft [8]. This was not shown in any of our patients.

Our study has several weaknesses. There were a limited number of patients with delayed post-operative imaging, and we cannot document that the calcifications resolved in every case. Also, we have no way to determine the timeframe for their disappearance. We have not followed those patients who showed initial calcifications to determine if their long-term prognosis is the same as those individuals without. Finally, this is a single institution study with a small group of operating surgeons. Results may vary at other locations where the surgeons might use different techniques or instrumentation.

Conflict of interest The authors declare that they have no conflict of interest.

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