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Excessively Anterior Tunnel Placement during Anterior Cruciate Ligament Reconstruction Causes Subsequent Tearing

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The goal of anterior cruciate ligament (ACL) reconstruction is to help patients regain the ability to participate in sports with minimal loss of preoperative levels of daily activity. However, the outcome of ACL reconstruction is not always positive, with knee contracture being a common postoperative complication. Here, we described a 22-year-old female who sustained graft impingement following ACL reconstruction induced by excessively anterior placement of the tibial and femoral tunnels. Arthroscopic decompression was performed and all suspected structures that may have led to impingement and flexion limitation were shaved. The preoperative symptoms were resolved and full range of motion of the affected joint returned 4 weeks after operation. We also reviewed the complications of ACL reconstruction, including the causes and possible preventive procedures.

Key word: anterior cruciate ligament, reconstruction, contracture, postoperative complication

INTRODUCTION

The anterior cruciate ligament (ACL) is the main stabilizing ligament in the knee, contributing to both anterior-posterior and rotational stability.[1,2] However, ACL injuries often occur during sports or other activities where the knee is twisted, bent backward, or bent side to side. An ACL injury leads to knee instability and, if left untreated, to long-term complications, such as meniscus tear and osteoarthritis.[3]

In ACL reconstruction, the injured ACL is surgically rebuilt using new tissue graft. The most valuable predictor of clinical prognosis among those with an ACL injury is tunnel placement during ACL reconstruction. Indeed, inappropriate choice of tunnel placement may cause limited range of motion (ROM), persistent knee pain, the sensation of giving way, and intraoperative fracture of the posterior femoral cortex. Herein, we report a case of early failure of ACL reconstruction caused by excessively anterior tibial and femoral tunnel placement. Even after undergoing 2 years of rehabilitation, the patient experienced arthralgia and knee contracture after previous ACL reconstruction.

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CASE REPORT

A 22-year-old Taiwanese female with ACL deficiency in her left knee following an injury due to a fall 4 years ago. One year following the initial injury, the patient underwent arthroscopic ACL reconstruction with a hamstring tendon graft. The patient presented at our institution with continuous knee pain and stiffness and an inability to stretch the leg to the full extent since the initial operation. Physical examination revealed a positive Lachman test, negative anterior drawer test, and obvious extension lag with ROM 15 to 90 degrees. As illustrated in X-ray images presented in Figure 1, mild joint space narrowing of the medial compartment and excessively anterior tibial and femoral tunnel placement were observed. Magnetic resonance image (MRI) revealed an ill-defined lesion about 1.0 cm in size at Hoffa's fat pad (Figure 2). Accordingly, a cyclops lesion could not be ruled out.

We initially diagnosed the patient as having a graft-induced impingement or a cyclops lesion. Immediate arthroscopic decompression, via notchplasty or ablation was suggested. On arthroscopy, an almost complete tear of the harvested ACL graft and an obvious cyclops lesion were found. We also observed an intact femoral interference screw and medial meniscus central wearing (Figure 3). All suspected structure that may have led to impinge-

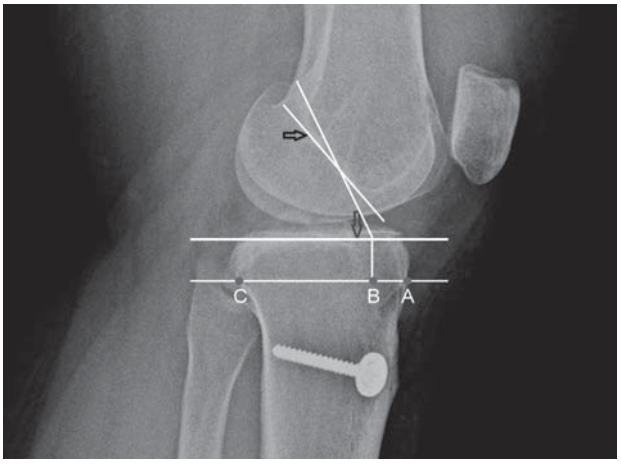

Fig. 1 Lateral roentgenogram view of the patient's knee joint before revision. Tunnel placement was too anterior, as clearly defined by the sclerotic line and extra-cortex cortical screw retention. Black arrow shows the correct femoral tunnel position and blue arrow shows the correct tibial tunnel position. Blumensaat's line should correct 15 degree clockwise because of knee extension lag. AB/AC = roof-plateau intersection ratio.

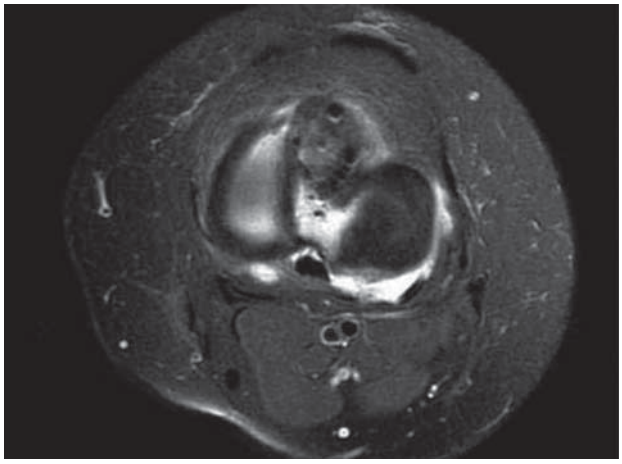

Fig. 2 Ill-defined lesion in front of tibial eminence, with low signal on T2 weighted imaging, cyclops lesion cannot be ruled out.

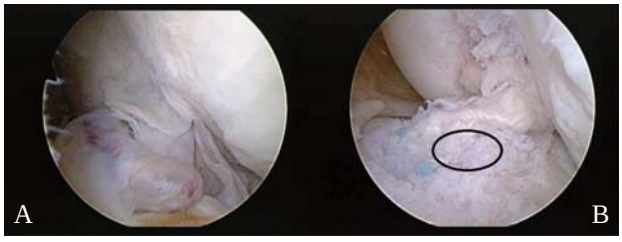

Fig. 3 (A) Classical cyclops lesion was noted, and induced severe impingement at intercondylar notch. (B) Following adequate debridement, surviving remanent graft within the posterior part of footprint was noted. Marked area is the suitable tibial footprint.

ment or flexion limitation, including synovial tissue and the remanent graft, were shaved. Preoperative symptoms dissipated and full ROM of the affected joint returned 4 weeks after operation. The final physical examination revealed positive result in the Lachman test and grade I laxity in the anterior drawer test.

DISCUSSION

It is our opinion that complications occurred in our patient due to poor arthroscopic techniques and disorientation in the tibial plateau anatomy during the original surgery. Since the previous surgeon used the trans-tibial technique for femoral tunnel drilling, the correct placement of the first guide wire influenced not only tibial but also femoral tunnel placement. Recognizing the footprint of ACL and the margin of the lateral meniscus anterior horn can help surgeons make the correct decision regarding placement of the tibial tunnel. Precise tibial guide placement has been traditionally performed using posterior cruciate ligament (PCL) and lateral meniscus as references.[4] However, junior orthopedic surgeons should check the guide wire and ensure that the tunnel lies within the correct point of the tibial plateau using intraoperative fluoroscopy.[5,6]

Blumensaat's line is defined by the roof of the intercondylar notch. Some former surgeons have used Blumensaat's line as the single checkpoint to prevent roof impingement. According to Buzzi *et al*.[6] the average roof-plateau intersection ratio in female patients is 32.2%±5.0%, meaning that the anterior margin of the tibial tunnel is posterior to 32.2% of the width of the tibia. However, our patient's roof-plateau intersection ratio[6] was nearly 20%, indicating that roof inclination was not steep enough, thus resulting in excessive transtibial drilling and wrong placement of the femoral tunnel almost 5 mm anterior to the real tibial footprint (Figure 1).

Intraoperative presentations of excessive anterior tibial and femoral tunnel placement include intercondylar impingement during knee extension and tension at the harvest graft site during knee flexion due to loss of knee flexion. The main clinical features include severe limitation throughout the motion arc, combined with arthralgia, effusion, contracture and slow rehabilitation progress.

Table 1 Common complications related to graft placement in ACL reconstruction[7]

- Tibial tunnel placed too anterior[5,9]
- Tibial tunnel placed too posterior[10,11]
- Femoral tunnel placed too anterior[13]
- Femoral tunnel placed too posterior[14]
- Femoral tunnel placed too vertical[12]
- Graft fixed in excessive knee flexion[17,18]
- Graft-screw divergence and broken screw[16,19]

In these cases, an adequate arc of motion might be more important than ACL function to provide stability during rotation or anterior-posterior translation. Additionally, immediate post-operative plain films can sometimes reveal a clear tunnel sclerotic line. If symptoms persist, radiography must be arranged within 2-4 weeks. If no tunnel position errors are found, MRI should be conducted to evaluate knee arthrofibrosis or further meniscal injury.

Graft selection, graft fixation, graft tensioning, graft placement, and the choice of allograft versus autograft material have received significant discussion in the literature. Complications related to graft placement are summarized in Table 1.[7] Accurate tunnel placement is associated with anterior tibial translation, rotational knee stability, adequate ROM and low graft failure rates. In a study comparing three different ACL reconstruction procedures, a Kirschner wire with a diameter of 2 mm was drilled through the sleeve into the tibia so that the wire passed through the center of the tibial footprint; this was considered the desired tunnel position.[8] On the other hand, excessively anterior placement of the tibial tunnel will produce a higher tensile load on the graft when in full extension, which is what occurred in the present case.[5,9] Conversely, an excessively posterior placement of the tibial tunnel may lead to poor rotational stability of the graft and PCL impingement.[10,11] Both types of incorrect tibial tunnel placement may cause early graft failure or severely limited knee motion.

Following the drilling of the tibia tunnel, a Kirschner wire was drilled into the lateral femoral condyle beyond the resident ridge[8] using the transtibial tunnel placement or independent drilling technique. This technique may help provide accurate femoral tunnel placement. Excessively vertical placement of femoral tunnel may lead to poor rotational stability,[12] while excessively anterior placement of femoral tunnel may lead to intercondylar impingement and loss of knee flexion.[13] Finally, excessively posterior placement of femoral tunnel is even more disastrous than the above conditions,[14] and is associated with potential for posterior cortex blowout or bone cracks as interference screwing.

Malpositioned tunnel placement continues to be one of the most common reasons for revision of ACL reconstruction.[15] In the present case, the revision of ACL reconstruction should use a bone-patellar-tendon bone (BPTB) graft that could circumvent the necessity of making a new tunnel. The goal of successful revision surgery may only be the return to activities of daily living or work. With proper planning and attention to details, revision of ACL reconstruction can provide a satisfying solution to difficult cases of knee instability.

CONCLUSION

Errors in tunnel placement are often committed by junior orthopedic surgeons. A clearer identification of the ACL footprint and accurate arthroscopic technique would decrease the incidence of such mistakes.[16] However, all surgeons should be aware that delayed progress of rehabilitation, knee pain and effusion, and limited knee motion may be caused by inadequate tunnel creation. Further MRI or plain radiographic examination must be arranged to determine the actual tunnel position. The goal of early revision is to offer the patient a joint that is functional, pain-free and with full ROM. Advanced ACL reconstruction is not necessary if the patient returns to daily activity and experiences a decrease in symptoms of previous knee contracture.

DISCLOSURE

All authors declare that they have no conflict of interest.

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