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Early Graft Failure (Graft Resorption) after Quadriceps Tendon Autograft Anterior Cruciate Ligament Reconstruction – A Series of 10 Cases

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Abstract

Background: Quadriceps tendon (QT) autografts have become increasingly popular for anterior cruciate ligament reconstruction (ACLR) due to their biomechanical properties and ease of harvest. At the same time, vancomycin soaking has emerged as a widely adopted method to reduce postoperative infections. However, while vancomycin's impact on hamstring tendon (HT) autografts has been studied, its effects on QT autografts remain unknown.

Methods: This case series presents ten patients who underwent revision ACLR with QT autograft. All grafts underwent vancomycin soaking, which resulted in early graft failure due to graft resorption within 12 months. Clinical and imaging evaluations were conducted, including MRI and arthroscopic assessments of graft integrity.

Results: All patients experienced recurrent knee instability without major trauma and MRI scans confirmed complete graft resorption in all cases. Arthroscopy revealed an empty notch with only tibial remnants remaining, necessitating revision surgery in eight patients.

Conclusion: This case series highlights a potential association between vancomycin-soaked QT autografts and early graft failure, a phenomenon not previously reported for HT autografts. Given the widespread use of both QT grafts and vancomycin soaking, further research is urgently needed to determine the safety, biological effects and long-term viability of this technique in ACLR.

Keywords: Anterior cruciate ligament reconstruction (ACLR); Quadriceps tendon autograft; Graft failure; Graft resorption; Early graft failure; Knee instability; Recurrent ACL injury

Introduction

Anterior Cruciate Ligament (ACL) injuries are frequent orthopaedic injuries leading to knee instability and impaired knee mechanics [1]. It is commonly accepted that knee instability after an ACL rupture subsequently leads to secondary damage of menisci and cartilage [2]. ACL Reconstruction (ACLR) therefore is the recommended treatment of choice in young and active patients to avoid such secondary damage to other knee structures [3]. To reconstruct the torn ACL, various surgical options are available: preservation of the torn ACL by refixation or reconstruction by using autologous tendon grafts or allografts [4]. If the native ACL is replaced by a tendon graft, most surgeons prefer autografts for primary repair whereas allografts are more used for revision cases [5]. If autografts are used, the preferred graft type depends on the surgeon's choice and is depending on preferences, learning curve and accompanying injuries as well as activity levels, type of preferred sports of a patient and considerations in terms of donor site morbidity [6]. Whereas still most surgeons prefer hamstring tendon (HT) autografts, Quadriceps Tendon (QT) autografts have become increasingly popular even for primary ACLR in recent years [7,8]. Rational considerations to use QT autografts for primary ACLR are the comparably easy harvest procedure, lower donor site morbidity and frequent accompanying injuries of the medial compartment including the medial collateral ligament [7]. Some studies suggested lower rates of revision surgery after QT autografts were used for ACLR. Others found similar outcomes when comparing QT autografts with other graft types [8-10]. Probably the most important paradigm shift in ACLR during the past decade was to use the antibiotic vancomycin to soak the tendon graft before implantation. Meanwhile, numerous studies have shown the beneficial aspects of vancomycin by drastically reducing or even eliminating the risk of postoperative septic arthritis after ACLR [11]. The effect of vancomycin on QT grafts in ACLR has not yet been fully investigated, highlighting the need for further research, which we aim to address in this case series. In the present case series, we present a series of ten patients after undergoing ACLR by using a QT autograft and developing early graft failure (within 12 months) after the index operation. We then discuss the current literature and possible factors associated with this phenomenon.

Operation Method

Patients were placed and draped in the supine position on the operating table. Eight patients received general anaesthesia, Two patients had spinal anaesthesia. A single-shot of cephazolin was administered in every patient pre-operatively. The middle third of the QT was harvested after an 8 cm longitudinal skin incision. The graft was prepared with a femoral suspensory button device (Tight Rope RT, Arthrex, United States) and armed with tibial non-resorbable sutures (Fiber Wire no. 2, Arthrex, United States). Then, the graft was pre-soaked in 1% Vancomycin for 15 minutes. Meanwhile, arthroscopic debridement was performed and the bone tunnels were created by using a 9 mm femoral and a 10 mm tibial reamer. The extended version of the surgical and postoperative protocol was recently described by Weninger et al. [12].

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All patients (3 female, 7 male) presented with recurrent knee instability after primary ACLR (7 HT

and 3 QT, mean 4.7 years ago (3.4-10.7)) and after typical rotation-valgus trauma during sports activities. Patients were examined clinically by the first author, scheduled for magnetic resonance imaging to verify the injury and then consented for ACLR by using an ipsilateral QT autograft. None of the patients had an injury of the anteriorlateral structures or relevant collateral ligament injuries that needed surgical repair. Six patients had a meniscus injury and three had cartilage degeneration or defects. After revision ACLR, patients were followed up for a minimum of twelve months and visited the office every two months for clinical examination. During the 12 months follow-up period, all ten patients reported discomfort and recurrent subjective instability during sports or everyday activities. None of the patients reported adequate trauma as possible cause for a graft re-rupture and recurrent instability. As a consequence, all ten patients underwent MRI examination to assess graft integrity **(Figure 1).** In all ten patients, the MRI scans confirmed complete graft resorption **(Figure 1).** Arthroscopic evaluation further verified this finding, showing an empty notch with only small tibial remnants in the affected patients **(Figure 2).** As a result, eight patients underwent revision ACLR by using allografts. Two patients refused to undergo further surgical procedures and chose conservative treatment.

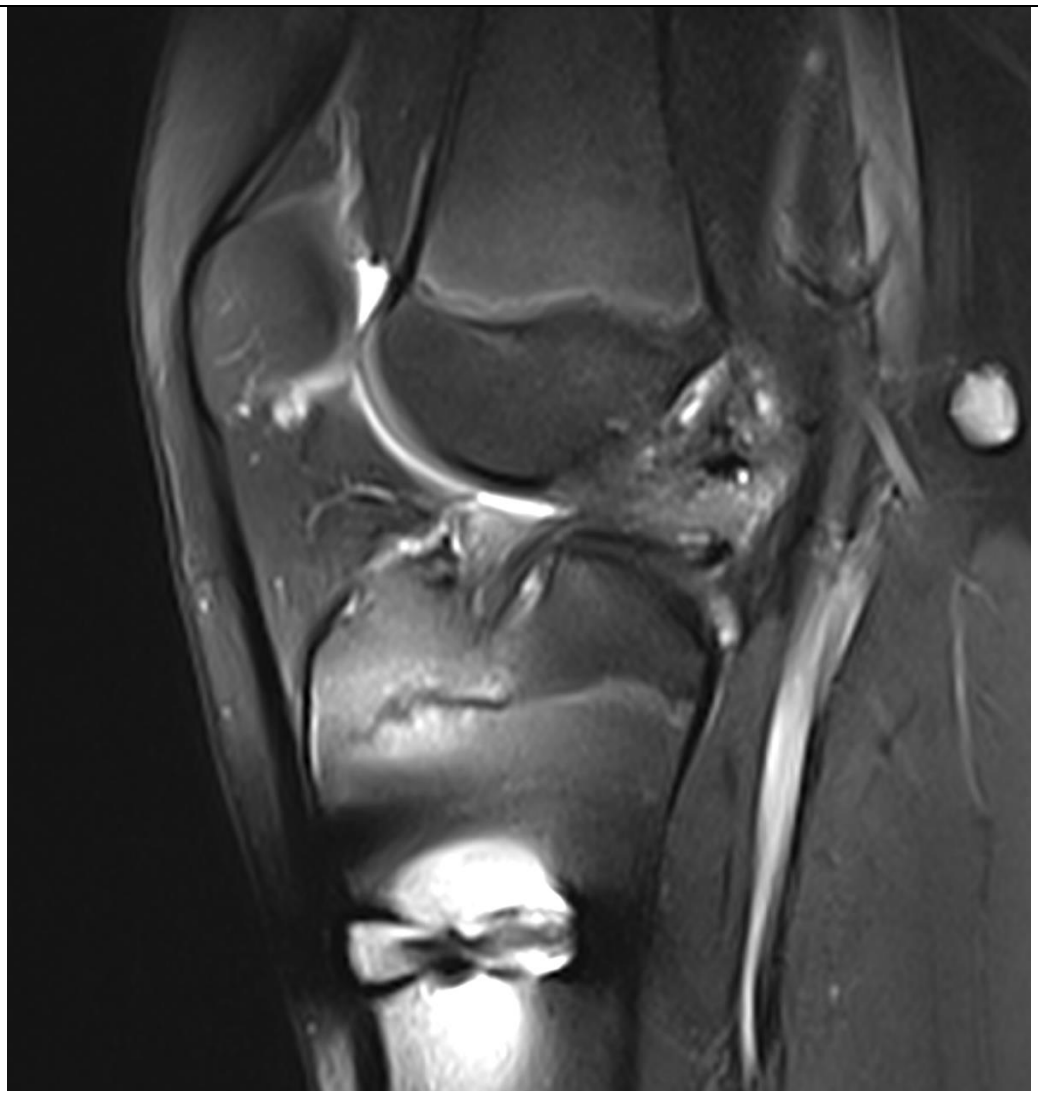

Figure 1: 16-year old male patient at follow-up MRI five months after QT autograft ACLR showing complete graft resorption and missing graft signal.

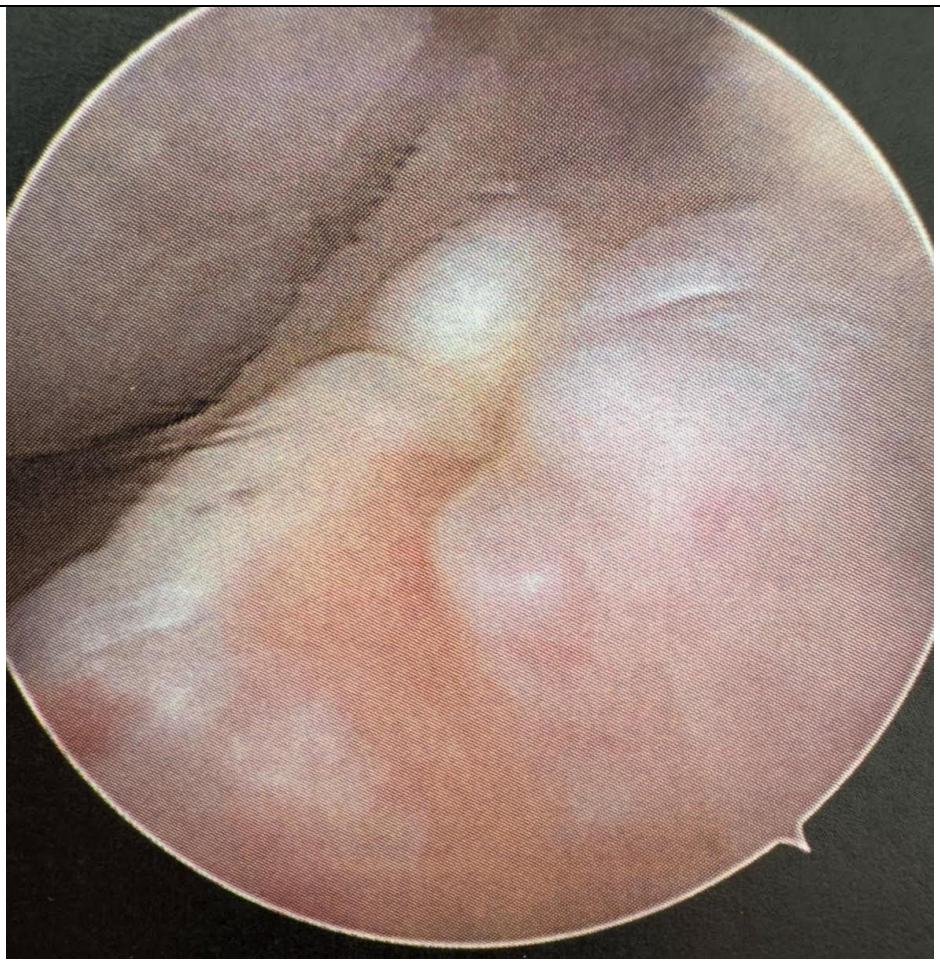

Figure 2: Arthroscopic view into the empty notch of the patient from Figure 1 showing the missing QT autograft with only a little tibial remnant visible. The graft is completely resorbed.

Discussion

The use of vancomycin soaking in ACL reconstruction has been widely adopted due to its proven efficacy in preventing postoperative infections without apparent negative effects on graft integrity **[11].** However, while Hamstring Tendon (HT) autografts have been extensively studied in this context, the impact of vancomycin soaking on Quadriceps Tendon (QT) autografts remains insufficiently explored. This case series presents an unusual finding of early graft failure and resorption in QT autografts following vancomycin soaking, raising concerns about potential biological or structural differences between QT and HT grafts that may predispose QT grafts to this complication. Potential Effects of Vancomycin on QT Autografts Despite initial concerns about cytotoxicity, in vitro and in vivo studies have shown that vancomycin at clinically used concentrations (5 mg/mL) does not impair tenocyte viability or tendon matrix integrity **[13].** In a large cohort of ACLR's, vancomycin pre-soaking led to a tenfold reduction in infection rates without increasing graft failure or compromising mechanical properties **[11].** Additionally, histological evaluations of human and animal tendons exposed to vancomycin found no evidence of necrosis,

apoptosis, or significant alterations in collagen organization [13,14]. These findings suggest that vancomycin alone is unlikely to cause direct cytotoxic effects on QT grafts. However, its interaction with QT-specific biological and mechanical properties remains unclear. Why Was Graft Resorption Observed in QT but Not in HT Autografts? One possible explanation for this observation lies in the structural and vascular differences between QT and HT tendons. HT autografts retain their paratenon, which may facilitate better revascularization and healing, whereas QT autografts are often harvested without their synovial sheath, potentially reducing their ability to revascularize efficiently [15]. This difference could render QT grafts more vulnerable to biological degradation if early revascularization is impaired [16]. Furthermore, a recent MRI-based study comparing QT and HT autografts found that QT grafts exhibited faster early revascularization but a sharper decline in vascularity at later stages, possibly making them more susceptible to degradation if early biological remodeling is disrupted [17].

Proposed Hypothesis: Biological Susceptibility of QT Grafts. Given the observed differences in vascular supply and structural composition, a plausible hypothesis is that QT autografts are inherently more susceptible to early biological degradation than HT autografts when subjected to additional stressors such as vancomycin exposure, mechanical loading, or altered synovial fluid composition. Although vancomycin alone is unlikely to be the sole cause, it is possible that its local antibacterial effects alter synovial fluid composition or early inflammatory responses, thereby affecting the QT graft's remodeling process. This could be further exacerbated by mechanical stress, as QT grafts—being thicker and stiffer than HT grafts—might experience different strain distributions that could contribute to structural failure if remodelling is delayed [16].

Limitations

This study has several limitations that must be considered. First, the small sample size (n=10) limits the generalizability of the findings and precludes robust statistical comparisons. Second, there is a potential selection bias, as all patients in this series had QT autografts with vancomycin soaking, but no direct control group with untreated QT autografts was available for comparison. Third, the study lacks histological confirmation of the exact mechanisms leading to graft resorption, leaving the possibility that other biological or mechanical factors contributed to the observed failures. Fourth, the relatively short follow-up period prevents an assessment of whether late-stage healing patterns differ between QT and HT grafts. Finally, due to the retrospective nature of this study, causal relationships between vancomycin exposure and QT graft failure cannot be definitively established. Future prospective studies with larger cohorts, controlled experimental models and longer follow-up durations are necessary to validate these findings and provide stronger clinical guidance.

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