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MRI Evaluation of Postoperative Complications Following ACL Reconstruction Using Hamstring or Peroneus Longus Tendon Autografts: A Cross-Sectional Study from Pakistan

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ABSTRACT

Background: The anterior cruciate ligament (ACL) is a commonly injured knee ligament. It is often reconstructed surgically. MRI is a non-invasive modality for evaluating graft integrity and post-surgical complications. **Objective:** To determine the frequency of complications on MRI in postoperative patients undergoing ACL reconstruction using hamstring or peroneus longus tendon autografts. **Study Design:** Descriptive cross-sectional study. **Settings:** The study was conducted in the Department of Radiology, Faisalabad Medical University & Allied Hospitals, Faisalabad Pakistan. **Duration:** 30th March to 29th September 2023. **Methods:** A total of 205 patients who had undergone ACL reconstruction (hamstring autograft, n=128; peroneus longus autograft, n=77) were included by consecutive sampling. MRI was performed on a 1.5T scanner using standardized SE T1W, FS T2W, and STIR sequences. Tunnel widening, tibial cystic degeneration, arthrofibrosis/Cyclops lesion, and partial and complete graft tears were assessed against established MRI diagnostic criteria by a consultant radiologist blinded to clinical findings. The data were analyzed with SPSS v25.0. The chi-square test was used to stratify by age, gender, time since reconstruction, and affected side ($p \leq 0.05$). **Results:** The mean age was 36.5 ± 9.1 years. Of the total 205 patients, 64.4% were males. Mean duration since reconstruction was 3.9 ± 1.3 months. Complications noted were tunnel widening in 15.1%, tibial cystic degeneration in 6.3%, arthrofibrosis/Cyclops lesion in 3.4%, partial graft tear in 9.6%, and complete graft tear in 21.0%. Complications were significantly associated with gender ($p<0.05$), duration since reconstruction ($p<0.05$), and side affected ($p<0.05$). **Conclusion:** MRI is a valuable modality for detecting complications after ACL reconstruction. Rather than routine surveillance of all patients, targeted MRI is recommended for those with persistent symptoms or clinical suspicion of graft failure, enabling early identification and management and improving long-term functional outcomes in Pakistani patients.

Keywords: *Anterior cruciate ligament (ACL), MRI, Hamstring graft, Peroneus graft, Tunnel widening, Graft tear.*

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INTRODUCTION

The anterior cruciate ligament (ACL) is a key stabilizer of the knee, which is commonly damaged during sports and road accidents. ACL tears are the most prevalent ligamentous injuries globally, with an estimated 95,000 ruptures occurring in the US alone each year. In young and physically active individuals, ACL injury is particularly problematic since it affects knee stability, leads to meniscal and chondral damage, and significantly increases the long-term risk of osteoarthritis if not addressed.[1,2] The gold standard for restoring knee stability to prevent subsequent osteoarthritis is surgical restoration with autografts, especially hamstring or peroneus tendons.[3] Although both grafts have shown good biomechanical properties, graft failure, particularly in the early postoperative phase, has been reported and may manifest as tunnel malposition, tunnel widening, cystic degeneration, arthrofibrosis, or graft rupture. The reconstructed graft also undergoes a maturation process known as ligamentization, during which avascular tendon tissue is progressively revascularized and remodelled; incomplete or delayed

ligamentization is reflected by altered graft signal on MRI and may predispose to failure. To avoid functional deterioration and to inform decisions about rehabilitation or revision surgery, it is important to identify these issues as early as possible.[4]

A small percentage of patients have poor results despite improvements in surgical methods because of arthrofibrosis, cystic alterations, tunnel malposition, or graft failure. For non-invasive assessment of ACL graft integrity and postoperative problems, MRI is commonly considered the preferred approach.[5] MRI allows comprehensive visualization of graft fibers, bone tunnels, and periarticular soft tissues, giving insights that may prevent or enhance diagnostic arthroscopy.[6,7]

Most published data on postoperative outcomes following ACL surgery originates from Western populations, with less data from South Asian countries. In Pakistan, where high-energy trauma from contact sports and traffic accidents is widespread, there is a lack of locally generated information about MRI-detected problems after ACL surgery. Given potential differences in injury mechanisms, surgical practices, rehabilitation adherence, and healthcare access, extrapolation from Western cohorts may not fully reflect the regional clinical reality. This study aimed to evaluate the frequency of postoperative complications following ACL reconstruction using MRI in a tertiary care hospital in Faisalabad, Pakistan.

METHODS

This descriptive cross-sectional study was conducted in the Department of Radiology, Faisalabad Medical University & Allied Hospitals, Faisalabad, between March 30, 2023, and September 29, 2023. Approval was obtained from the Institutional ERC of Faisalabad Medical University, Faisalabad. After approval from the ERC vide letter NO.48.ERC/FMU/2024-25/82 dated 20 April 2025, informed consent was taken from all patients. A sample size of 205 patients was calculated using the WHO calculator (95% CI, 3.5% margin of error, anticipated frequency of arthrofibrosis/Cyclops lesion 7%). Patients were recruited by non-probability consecutive sampling.

The study included patients of both genders aged 15-65 years who had undergone ACL reconstruction using a peroneus longus or hamstring tendon autograft more than 1 month previously. Patients with pacemakers and those who were claustrophobic were excluded.

Of the 205 patients, 128 (62.4%) had undergone reconstruction with a hamstring tendon autograft and 77 (37.6%) with a peroneus longus tendon autograft. All patients underwent MRI of the affected knee using a 1.5 Tesla scanner (Siemens/GE) with a dedicated knee coil. The standardized protocol comprised sagittal, coronal, and axial spin-echo T1-weighted (SE T1W), fat-suppressed T2-weighted (FS T2W), and short tau inversion recovery (STIR) sequences (slice thickness 3-4 mm, interslice gap 0.3-0.5 mm, field of view 14-16 cm). The knee was imaged in 10-15 degrees of external rotation in extension. The following MRI diagnostic criteria were applied: tunnel widening was defined as a bone tunnel diameter greater than 10 mm or an increase exceeding 10% relative to the immediate postoperative dimension; tibial cystic degeneration as a well-defined fluid-signal collection within or adjacent to the tibial tunnel; arthrofibrosis/Cyclops lesion as a focal nodular low-to-intermediate signal mass in the anterior intercondylar notch; partial graft tear as focal fibre disruption with intrasubstance high T2 signal but preserved continuity; and complete graft tear as full-thickness fibre discontinuity with absent or wavy graft fibres. All scans were interpreted by a consultant radiologist with at least 5 years of experience who was blinded to the patients' clinical findings and graft type. Demographic and clinical data were recorded on a structured proforma. Data were analyzed in SPSS v25.0. Quantitative variables were presented as mean ± SD, and categorical variables as frequencies and percentages. Stratification was performed by age, gender, affected side, and duration since reconstruction. The chi-square test was applied, with significance set at $p \leq 0.05$.

RESULTS

The mean age was 36.5 ± 9.1 years (range 15–65 years). Most patients (79.0%) were aged 15–40 years. In total, there were 64.4% males and 35.6% females, with a male-to-female ratio of 1.8:1. Mean duration since reconstruction was 3.9 ± 1.3 months. The right knee was affected in 56.9% of patients.

Table 1: Baseline characteristics of study participants (n=205)

Variable	Category	n (%)
Age (years)	15–40	162 (79.0)
Age (years)	41–65	43 (21.0)
Gender	Male	132 (64.4)
Gender	Female	73 (35.6)
Side affected	Right	115 (56.9)
Side affected	Left	90 (43.1)
Duration since reconstruction	≤3 months	89 (43.4)
Duration since reconstruction	>3 months	116 (56.6)

Tunnel widening was observed in 15.1% of cases, tibial cystic degeneration in 6.3%, and arthrofibrosis consistent with a Cyclops lesion in 3.4% of patients, according to the overall frequency of postoperative MRI complications. Graft-related complications were partial graft tears in 9.6% and complete graft rupture in 21.0% of cases.

Table 2: MRI-detected complications after ACL reconstruction

Complication	Frequency	%
Tunnel widening	31	15.1
Tibial cystic degeneration	13	6.3
Arthrofibrosis/Cyclops	7	3.4
Partial graft tear	20	9.6
Complete graft tear	43	21.0

Tunnel widening and graft tears were more frequent in males, with significant associations observed for complete graft tear

(p=0.006) and arthrofibrosis (p=0.045). No significant age-related differences were found.

Table 3: Stratification of complications by gender

Complication	Male (n=132)	Female (n=73)	p-value
Tunnel widening	27 (20.5%)	4 (5.5%)	0.004
Tibial cystic degeneration	9 (6.8%)	4 (5.5%)	0.706
Arthrofibrosis/Cyclops	7 (5.3%)	0 (0.0%)	0.045
Partial graft tear	13 (9.9%)	7 (9.6%)	0.952
Complete graft tear	20 (15.1%)	23 (31.5%)	0.006

Complications were significantly more frequent in patients more than 3 months since reconstruction, and tibial cystic degeneration was exclusively associated with left-sided reconstructions.

Table 4: Stratification of complications by duration since reconstruction

Complication	≤3 months (n=89)	>3 months (n=116)	p-value
Tunnel widening	14 (15.7%)	17 (14.7%)	0.831
Tibial cystic degeneration	1 (1.1%)	12 (10.3%)	0.008
Arthrofibrosis/Cyclops	0 (0.0%)	7 (6.0%)	0.018
Partial graft tear	4 (4.5%)	16 (13.8%)	0.026
Complete graft tear	19 (21.3%)	24 (20.7%)	0.908

DISCUSSION

MRI is a non-invasive, reliable, and safe modality for postoperative evaluation of ACL reconstructions. It has distinct advantages over diagnostic arthroscopy, which is considered the gold standard but is invasive and carries risks and patient discomfort. MRI has high sensitivity and specificity for detecting injuries to menisci, cruciate ligaments, and articular cartilage when using contemporary rapid spin-echo and fat-suppression methods.

In this study, the frequency of complications on MRI following ACL reconstruction with peroneus longus or hamstring tendon autografts was: tunnel widening (15.1%), tibial cystic degeneration (6.3%), arthrofibrosis/Cyclops lesion (3.4%), partial graft tear (9.6%), and complete graft tear (21.0%). These findings are consistent with previous literature, which reported similar rates: tunnel widening 17%, tibial cystic degeneration 10%, arthrofibrosis/Cyclops 7%, partial graft tear 10%, and complete graft tear 23%.[8] These results are consistent with the international literature, which indicates tunnel expansion rates of 10–20% and total graft tears of 15–25%.[9-11] The higher rate of complete graft tears in our population may reflect differences in surgical expertise, fixation techniques, rehabilitation protocols, or delayed presentation. In addition, a gender-specific study reported a higher rate of complete graft tears in females, consistent with worldwide data indicating that women are at greater risk of ACL graft failure owing to anatomical and hormonal factors.[12]

Despite advances in ACL reconstruction, graft failure remains significant. Reinhardt et al. found failure rates ranging from 7.2% to 15.8%.[13] Similarly, Crawford et al., in a meta-analysis, reported a 6.2% graft rupture rate and 10.3% clinical failure at >10 years of follow-up.[14] Our rate of complete graft tear (21%) is higher than these pooled estimates, likely reflecting differences in surgical technique and fixation method, variability in rehabilitation adherence, the predominance of high-energy trauma in our population, and delayed presentation that allows minor graft injury to progress to complete failure. Selection bias is also relevant, since our cohort comprised symptomatic patients referred for MRI rather than a consecutive surgical series, which inflates the apparent failure rate compared with prospective postoperative surveillance cohorts. These findings should therefore be interpreted as the complication burden in patients clinically suspected of graft pathology rather than the true population failure rate. Several MRI interpretation pitfalls must also be acknowledged: the normal increase in graft signal intensity during ligamentization can mimic a partial tear in the first 6-12 months; striped or banded graft signal from interposed synovial tissue should not be over-called as fibre disruption; partial volume averaging and magic-angle artefact may produce false-positive intrasubstance signal; and metallic susceptibility artefact from fixation devices can obscure the tunnel aperture. Awareness of these pitfalls, together with correlation of imaging findings with the time since reconstruction and clinical examination, is essential to avoid over-diagnosis of graft failure.

Cyclops lesions were detected in 3.4% of our patients, which is lower than the 1–10% prevalence reported in earlier studies and less than the 25% reported by Facchetti et al. on MRI at six months after reconstruction.[15] However, several MRI-detected lesions were clinically silent, indicating the need for more research on lesions that actually limit extension.

Tunnel cysts, while less common (6.3% in our cohort), remain clinically important. They are more frequently tibial and present as swelling or pain. Etiologies include graft degeneration, poor osteointegration, and foreign body reaction to fixation material.[16] Small fluid collections, however, are often normal and resolve within 18 months.[17]

Two additional postoperative concepts merit emphasis when interpreting these scans. First, graft maturation through ligamentization produces a predictable evolution of signal intensity: an early hyperintense phase reflecting revascularization and synovialization, followed by a return toward low signal as the graft remodels. Failure to recognize this physiological process can lead to a normal maturing graft being misread as a partial tear. Second, roof (notch) impingement occurs when an anteriorly malpositioned tibial tunnel causes the graft to abut the intercondylar roof in extension; on MRI this is seen as increased signal in the distal anterior graft fibres with anterior tunnel placement, and if unrecognized it may progress to attenuation and eventual failure. Systematic assessment of tunnel position and graft signal in relation to the roof is therefore an integral part of postoperative MRI evaluation.

The use of a standardized MRI protocol and explicit diagnostic criteria, together with a relatively large sample size, are the main strengths of our study. Its cross-sectional design, the lack of arthroscopic correlation, the single-centre setting, and the absence of paired immediate-postoperative imaging are the principal limitations.

CONCLUSION

MRI is a highly effective modality for detecting postoperative complications of ACL reconstruction, including graft tears, tunnel widening, and cystic degeneration. Rather than routine surveillance of all postoperative patients, MRI is best reserved for those with persistent symptoms, clinical suspicion of graft failure, or restricted range of motion, in whom it can guide decisions regarding rehabilitation or revision surgery. Targeted use of MRI in these higher-risk groups, including females and patients with a longer interval since reconstruction, is likely to optimize long-term joint stability and functional outcomes while avoiding unnecessary imaging.

LIMITATIONS

This single-center study with a limited sample size may restrict generalizability to other institutions. The cross-sectional design prevented tracking of long-term complications and correlation with functional outcome scores, such as the Lysholm IKDC scales.

SUGGESTIONS / RECOMMENDATIONS

Longitudinal follow-up studies with validated functional outcome assessment tools and multicenter prospective studies are recommended to improve generalizability and establish baseline complication profiles. Integration of advanced MRI sequences and standardized surgical protocols with clinical examination, strength testing, and stability assessments would enhance future research outcomes.

CONFLICT OF INTEREST / DISCLOSURE

The authors declare no competing interests.

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