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INCIDENCE OF MENISCAL ROOT TEARS IN ACL-INSUFFICIENT KNEES: A PROSPECTIVE STUDY AT A TERTIARY CARE CENTRE

Orthopaedics

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ABSTRACT

Background: Meniscal root tears disrupt hoop-stress transmission and leave the meniscus functionally equivalent to a total meniscectomy. They frequently accompany anterior cruciate ligament (ACL) injury but are easily missed on MRI and at arthroscopy. Data on their incidence in Indian patients with ACL insufficiency are limited.**Aim:** To determine the incidence of meniscal root tears in ACL-insufficient knees and to compare root tear involvement between the medial and lateral menisci.**Methods:** A prospective observational study was conducted over two years in the Department of Orthopaedics of a tertiary care centre. Forty adults (16–88 years) with clinically and radiologically confirmed ACL insufficiency underwent clinical examination, radiography, MRI and diagnostic arthroscopy. Tears were classified by meniscus, location and morphology; root tears were graded by the LaPrade classification. Proportions were compared with Fisher's exact test.**Results:** Mean age was 33.12 years; 24 patients (60%) were male. Twisting injury was the commonest mechanism (45%). Seventeen patients (42.5%) had isolated ACL tears and 23 (57.5%) had associated meniscal tears. Root tears were present in 12 patients, an incidence of 30% in the whole cohort and 52.2% among knees with meniscal injury. Five of seven lateral meniscal tears (71.4%) were root tears, against 7 of 18 medial meniscal tears (38.9%) ($p = 0.20$). Lateral root tears clustered in acute injuries, whereas medial meniscal tears predominated in chronic ACL insufficiency. LaPrade types 2, 4 and 5 were most frequent. ACL reconstruction with root repair was the commonest procedure among patients with meniscal tears.**Conclusion:** Nearly one in three ACL-insufficient knees harbours a meniscal root tear. A lateral meniscal tear after acute trauma should raise strong suspicion of a root variant. Systematic arthroscopic inspection of both posterior roots during ACL reconstruction is recommended.

KEYWORDS

Anterior Cruciate Ligament; Meniscal Root Tear; Lateral Meniscus; Medial Meniscus; Arthroscopy; Acl Reconstruction

INTRODUCTION

The menisci are fibrocartilaginous wedges that transmit 50–70% of the load across the tibiofemoral joint. They also absorb shock, add secondary stability, aid lubrication and contribute to proprioception [1,2]. These functions depend on circumferential collagen fibres converting axial load into hoop stress, which can be generated only when both anterior and posterior roots remain firmly anchored to the tibial plateau [3].

A meniscal root tear is a radial tear or bony avulsion within 1 cm of the root attachment [4]. A complete posterior root tear raises peak tibiofemoral contact pressure to a level comparable with total meniscectomy [5,6]. Left untreated, it leads to meniscal extrusion, subchondral insufficiency and accelerated osteoarthritis [3,7]. Root tears are reported to account for roughly 10–21% of all meniscal tears [3].

ACL injury is the commonest setting for traumatic meniscal pathology, with associated meniscal tears reported in about half to two-thirds of ACL-injured knees [8,9]. The pattern differs by meniscus and by chronicity. Lateral meniscal tears, including posterior root tears, are typical of the acute pivot-shift event [10,11]. Medial meniscal tears accumulate with chronic anterior instability, because the posterior horn of the medial meniscus becomes the main secondary restraint to anterior tibial translation [9,12].

Root tears are easily missed. MRI sensitivity for lateral root tears is modest, and the posterior root is difficult to visualise at arthroscopy without deliberate inspection [10,11]. A missed root tear at ACL reconstruction also increases load on the graft and may compromise its outcome [6]. Data on the incidence of root tears in ACL-insufficient knees in the Indian population remain scarce.

This study therefore aimed:

1. To determine the incidence of meniscal root tears associated with ACL insufficiency in adults at a tertiary care centre.
2. To identify which meniscus, medial or lateral, shows a higher incidence of root tear in ACL-insufficient knees.

Materials and Methods

Study design and setting

This prospective observational study was conducted in the Department of Orthopaedics, Smt. Kashibai Navale Medical College and General Hospital, Narhe, Pune, a tertiary care centre in Maharashtra, India, over two years ([month year] to [month year]). Approval was obtained from the Institutional Ethics Committee (Ref. No. [ ]). Written informed consent was obtained from every patient. The study was conducted in accordance with the Declaration of Helsinki.

Participants

Consecutive adults presenting with knee injury and a diagnosis of ACL insufficiency were enrolled. Forty patients aged 16–88 years were included.

Inclusion criteria: age 16 years or older; complete or functionally incompetent ACL tear confirmed on clinical examination and MRI; consent to arthroscopy.

Exclusion criteria: multiligament knee injury requiring reconstruction of the posterior cruciate or collateral ligaments; tibial plateau or distal femoral fracture; previous surgery on the index knee; advanced osteoarthritis (Kellgren–Lawrence grade 3–4); inflammatory arthritis.

Clinical evaluation

A detailed history recorded age, sex, side, mechanism of injury and time from injury to presentation. Injuries were grouped as acute (≤ 6 weeks) or chronic (> 6 weeks). Examination included the Lachman, anterior drawer and pivot-shift tests for ACL competence, and joint-line tenderness, McMurray and Thessaly tests for meniscal injury.

Imaging

Standard anteroposterior and lateral radiographs were obtained to exclude bony injury. MRI of the knee was used to assess the ACL and menisci. A root tear was suspected on the ghost sign, the truncation sign, a vertical linear defect on coronal images, or meniscal extrusion greater than 3 mm.

Arthroscopic assessment

All patients underwent diagnostic arthroscopy through standard anterolateral and anteromedial portals. Both menisci were probed systematically, with deliberate inspection of the posterior root attachments. Each tear was recorded by meniscus (medial or lateral), zone (root, horn or body) and morphology (root, vertical longitudinal or bucket-handle). Root tears were classified by the LaPrade system into types 1–5 [4]. Arthroscopy served as the reference standard for diagnosis.

Surgical management

ACL reconstruction was performed with [graft type, e.g. hamstring autograft]. Root tears were repaired with [technique, e.g. transtibial pull-out suture repair] [13–15]. Other meniscal tears were repaired or partially resected according to tear pattern, location and tissue quality.

Outcome measures

The primary outcome was the incidence of meniscal root tears in ACL-insufficient knees. Secondary outcomes were the proportion of root tears in each meniscus, LaPrade tear type, and the association of tear pattern with injury chronicity.

Statistical analysis

Data were entered in Microsoft Excel and analysed with [software and version]. Continuous variables are reported as mean and range, and categorical variables as frequency and percentage. The proportion of root tears in the medial and lateral menisci was compared with Fisher's exact test. A p-value below 0.05 was considered statistically significant.

RESULTS

Meniscal root tears were found in 12 of 40 ACL-insufficient knees (30%) and accounted for more than half of all knees with meniscal injury.

Demographic and injury profile

The mean age was 33.12 years (range 16–88), and the 31–40-year group was the largest (Figure 1). Males outnumbered females 3:2. Twisting was the commonest mechanism of injury, and the right knee was involved slightly more often (Table 1).

Table 1. Demographic and injury characteristics (n = 40)

Parameter	Category	n	%
Sex	Male	24	60.0
	Female	16	40.0
Mechanism of injury	Twisting	18	45.0
	Sports	11	27.5
	Road traffic accident	11	27.5
Side	Right	21	52.5
	Left	19	47.5

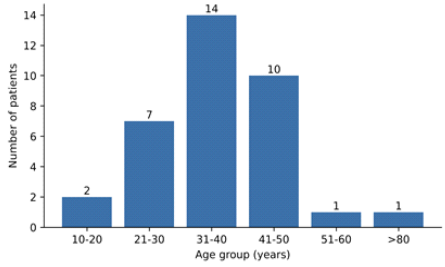


Figure 1. Age distribution of patients with ACL insufficiency.

Arthroscopic diagnosis

Seventeen patients (42.5%) had an isolated ACL tear. The remaining 23 (57.5%) had at least one meniscal tear; two of these had tears of both menisci, giving 25 torn menisci in all (Table 2).

Table 2. Arthroscopic diagnosis by side (n = 40)

Diagnosis	Right	Left	Total	%
Isolated ACL tear	9	8	17	42.5
ACL + MM root tear	4	2	6	15.0
ACL + MM horn tear	2	3	5	12.5
ACL + MM vertical tear	2	2	4	10.0
ACL + LM root tear	2	2	4	10.0
ACL + MM bucket-handle tear	1	0	1	2.5
ACL + LM vertical tear	0	1	1	2.5
ACL + MM root + LM vertical tear	0	1	1	2.5
ACL + LM root + MM vertical tear	1	0	1	2.5
Total	21	19	40	100

MM, medial meniscus; LM, lateral meniscus.

Incidence of root tears

Twelve patients had a root tear: seven medial and five lateral. No patient had root tears of both menisci (Table 3).

Table 3. Incidence of meniscal root tears

Denominator	Root tears	n	Incidence (%)
All ACL-insufficient knees	12	40	30.0
Knees with any meniscal tear	12	23	52.2
All torn menisci	12	25	48.0

Medial versus lateral meniscus

Root tears made up 71.4% of lateral meniscal tears, against 38.9% of medial meniscal tears (Table 4; Figure 2). The difference did not reach statistical significance in this sample (Fisher's exact test, p = 0.20; odds ratio 3.93). Medial root tears were the larger group in absolute number (7 of 12), but a torn lateral meniscus was almost twice as likely to be a root tear.

Table 4. Tear morphology by meniscus

Tear type	Medial meniscus, n (%)	Lateral meniscus, n (%)
Root tear	7 (38.9)	5 (71.4)
Posterior horn tear	5 (27.8)	0
Vertical longitudinal tear	5 (27.8)	2 (28.6)
Bucket-handle tear	1 (5.6)	0
Total torn menisci	18 (100)	7 (100)

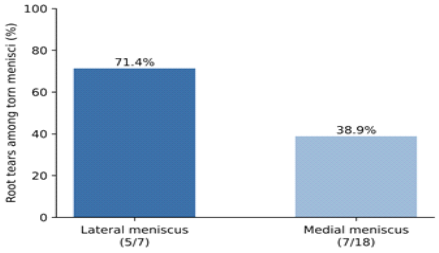


Figure 2. Proportion of root tears among torn lateral and medial menisci.

Root tear type and chronicity

LaPrade types 2 (complete radial tear within 9 mm of the root), 4 (complex oblique tear extending into the root) and 5 (bony avulsion) were the most common. Lateral root tears were seen predominantly in patients presenting after acute trauma, whereas medial meniscal tears were more frequent in chronic ACL insufficiency. [Authors to insert acute/chronic and LaPrade type counts.]

Procedures

Arthroscopic ACL reconstruction with meniscal root repair was the most frequent procedure among patients with meniscal tears. [Authors to insert procedure-wise counts.]

DISCUSSION

This study found a meniscal root tear in 30% of ACL-insufficient knees and in 52.2% of those with any meniscal injury, making root tears the single largest category of meniscal pathology in the cohort. A torn lateral meniscus was a root tear in 71.4% of cases, compared with 38.9% for the medial meniscus.

Incidence in context

In the general meniscal tear population, root tears are reported in roughly 10–21% of cases [3]. Our figure of 48% of torn menisci is considerably higher, reflecting the selected population. ACL rupture produces the combined compressive, rotational and translational loads that avulse the posterior roots, and series focused on ACL-injured knees report posterior lateral root tears in a substantial minority of patients, rising further when the root is inspected deliberately [10,11]. The high figure here probably also reflects systematic arthroscopic inspection of both roots in every knee.

The overall rate of associated meniscal injury (57.5%) lies within the range reported in other ACL series [8,9,16]. The demographic profile, a mean age of 33 years and a 3:2 male-to-female ratio, matches the young, active population typically affected by ACL injury. Twisting and sports injuries together accounted for nearly three-quarters of cases, consistent with a non-contact pivoting mechanism.

Lateral meniscal root tears and acute trauma

The lateral meniscus is more mobile than the medial and is trapped between the femur and tibia during the pivot-shift subluxation of acute ACL rupture. This explains why lateral meniscal tears, and lateral root

tears in particular, dominate in acute injury [10,11,16]. In our series nearly three of every four lateral meniscal tears involved the root, and these were seen mainly after acute trauma. In practice, a lateral meniscal tear in an acute ACL injury should be considered a root tear until proven otherwise.

This matters because the lateral posterior root lies close to the meniscofemoral ligaments and is easily overlooked on MRI and through the standard anterolateral portal [10]. Lateral root tears increase tibiofemoral contact pressure and rotational laxity and add strain to the reconstructed ACL, while repair restores contact mechanics close to the intact state [6].

Medial meniscal tears and chronic insufficiency

Medial meniscal tears were the larger group overall and predominated in chronic ACL insufficiency. In the ACL-deficient knee, the posterior horn of the medial meniscus acts as a secondary restraint to anterior tibial translation, and repeated episodes of instability progressively load and tear it [9,12]. Church and Keating showed that delaying ACL reconstruction beyond 12 months significantly increases the incidence of medial meniscal tears [12]. Our finding that all horn and bucket-handle tears were medial supports this progressive, attritional pattern, in which a longitudinal tear may extend into a displaced bucket-handle fragment.

Root tear morphology

LaPrade types 2, 4 and 5 were the commonest root tear types. Type 2, a complete radial tear close to the root, is the most frequent type in published series [4]. Bony avulsions (type 5) and complex oblique tears (type 4) are typical of higher-energy trauma, consistent with the acute injury profile of our lateral root tears.

Surgical implications

ACL reconstruction combined with root repair was the commonest procedure in patients with meniscal tears, reflecting the shift from resection to meniscal preservation. Partial meniscectomy or non-operative management of a root tear gives poor long-term results and does not halt the progression of osteoarthritis [7,17]. Repair by transtibial pull-out or suture-anchor techniques restores hoop function and is preferred where tissue quality allows [13–15,18]. Long-term outcome data favouring repair over meniscectomy for traumatic tears further support meniscal preservation [19,20].

Medial versus lateral root tears

Although the proportion of root tears was almost twice as high in the lateral meniscus, the difference was not statistically significant ($p = 0.20$). With only seven torn lateral menisci, the study was underpowered for this comparison. Krych et al. similarly reported distinct presentations, with lateral root tears linked to ligamentous injury and medial root tears to older age and degeneration [21]. A larger sample is needed to confirm the difference.

Limitations

- The sample was small (n = 40) and drawn from a single centre, limiting statistical power and generalisability.
- The medial-versus-lateral comparison did not reach significance and should be interpreted as a trend.
- Functional outcomes, MRI–arthroscopy agreement and repair healing were not assessed.
- Patients with advanced osteoarthritis were excluded, which may under-represent degenerative medial root tears.

CONCLUSION

Meniscal root tears are common in ACL-insufficient knees, present in 30% of all patients and in more than half of those with meniscal injury. Lateral meniscal tears were root tears in 71.4% of cases and were associated with acute trauma, whereas medial meniscal tears were more frequent in chronic ACL insufficiency, consistent with progressive degeneration.

Both posterior roots should be inspected deliberately during every ACL reconstruction, with particular suspicion of a lateral root tear after acute injury. Early reconstruction with root repair, rather than resection, is advised to restore hoop function and protect the joint from early osteoarthritis. Larger multicentre studies with functional follow-up are needed to confirm these patterns.

Declarations

Ethical approval: Institutional Ethics Committee, Smt. Kashibai Navale Medical College and General Hospital, Pune, Ref. No. [ ], dated [ ].

Informed consent: Written informed consent was obtained from all participants.

Author contributions: NPD: conception, data collection, analysis and manuscript drafting. RN: data collection, literature review and manuscript revision. PB: study supervision, surgical procedures and critical revision. All authors read and approved the final manuscript.

Authorship and approval: All authors confirm the order of authorship as listed: Dr Nikhil Pramod Duthade (first and corresponding author), Dr Raj Nawkhare (second author) and Dr Prashant Bhandari (third author). All authors have read and approved the final manuscript and its title, and agree to be accountable for all aspects of the work.

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Data availability: Data are available from the corresponding author on reasonable request.

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