Received: 23 October 2023 | Accepted: 26 March 2024

DOI: 10.1002/ksa.12194



# Risk factors and prevalence of ramp lesions in ACL ruptures: An analysis from the registry of the Francophone Arthroscopic Society

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## Abstract

**Purpose:** The study aimed to estimate the prevalence of ramp lesions among patients undergoing anterior cruciate ligament (ACL) reconstruction and identify risk factors associated with these lesions.

**Methods:** A retrospective, multicentre cohort study was conducted using data from the Francophone Arthroscopic Society's registry, including 5359 patients who underwent ACL reconstruction (ACLR) from June 2020 to June 2023. Potential risk factors for ramp lesion such as patient demographics, revision surgery, pivot shift, side-to-side anteroposterior laxity, medial collateral ligament (MCL) injury, lateral meniscal tear and the volume of ligament remnant were evaluated using multivariate regression analyses. BMI and delay to surgery were also assessed.

**Results:** Ramp lesions were identified in 822 patients (15.3%). Univariate analysis identified male sex, younger age, revision surgery, lateral meniscal injury, percentage of ACL remnant (all $p < 0.0001$) and pivot shift ($p = 0.0103$) as significant risk factors. MCL injury was associated with a lower risk ($p < 0.0001$). In multivariate analysis, male sex, younger age, revision surgery, lateral meniscal injury and percentage of ACL remnants remained significant risk factors, while MCL injury remained a protective factor. The anteroposterior laxity wasn't a significant predictor in either analysis. In subgroup analysis, there were differences concerning body mass index (n.s) and the delay to surgery (n.s).

**Conclusion:** The study identified male sex, younger age, revision surgery, lateral meniscal injury and pourcentage of ACL remnant as significant risk factors for ramp lesions, with MCL injury acting as a protective factor. This will help regarding the suspicion and identification of ramp lesions.

**Level of Evidence:** Level III.

**KEYWORDS**

ACL, ACLR, medial meniscus, ramp, remnant

**Abbreviations:** ACL, anterior cruciate ligament; ACLR, anterior cruciate ligament reconstruction; BMI, body mass index; CI, confidence intervals; MCL, medial collateral ligament; MRI, magnetic resonance imaging.

## INTRODUCTION

Ramp lesions, defined as disruptions or tears in the peripheral meniscocapsular attachments of the medial meniscus's posterior horn [1, 14], are often concomitant with anterior cruciate ligament (ACL) injuries. They have obtained attention due to their significant clinical implications and controversial management approaches [6]. Identification of ramp lesions is particularly important because they may contribute to persistent knee instability following ACL reconstruction (ACLR) if left untreated [13]. The biomechanical and clinical studies available to date show an increase in rotatory and anteroposterior laxity in the event of an ACL injury associated with a ramp lesion [21, 26, 35]. Moreover, ramp lesions may compromise the results of surgery in the event of residual laxity as medial meniscus is responsible for a part of knee laxity during ACLR [8, 10]. Nevertheless, although concomitant injuries associated with ACL tears may affect patients outcomes after ACLR [16], the systematic repair of ramp lesions during ACLR is still subject to debate, particularly in cases of stable lesions [2, 5, 9, 12, 18, 23].

However, despite growing recognition, the epidemiology of ramp lesions and the associated risk factors remain relatively unsolved. While advanced age, male sex and higher body mass index (BMI) have traditionally been linked with a higher prevalence of meniscal and ligamentous injuries [25], their role in the specific context of ramp lesions remains unclear. Similarly, the contact of factors such as time to surgery, contralateral meniscal lesions and the presence of medial collateral ligament (MCL) injuries has not yet been studied in detail. In addition, the role of knee laxity and jerk test results is of particular interest as they may reveal underlying rotational instability, which could indicate the presence of an occult ramp lesion.

Using data from the Francophone Arthroscopic Society's registry, as registries have become essential in the analysis of ACL [15, 29], this study aims to assess the prevalence of ramp lesions among a large cohort of patients who underwent posteromedial compartment evaluation during ACLR and identify risk factors for the presence of ramp lesions to categorise patients who are most at risk of developing a ramp lesion and who should undergo careful arthroscopic assessment and more rapid treatment. These factors include age, sex, contralateral meniscal tear, anteroposterior laxity, jerk test for pivot shift, MCL injury and the volume of remaining ACL remnant.

## MATERIALS AND METHODS

This study was conducted with the approval of our local Institutional review board (Scientific Committee of the GCS Ramsay Santé) with the approval number: COS-RGDS-2023-10-004-THAUNAT-M and complied with the Declaration of Helsinki as a statement of ethical principles for medical research. Data were deidentified for retrospective analysis.

### Study design and participants

This is a retrospective, multicenter, cohort study conducted using data extracted from the ACL Francophone Arthroscopic Society's registry. The registry includes data from patients who underwent ACLR surgeries, captured longitudinally. The patients included all had an ACL lesion diagnosed preoperatively by clinical examination and magnetic resonance imaging (MRI), and all had ACLR surgery between June 2020 and June 2023. A total of 43 surgeons specialised in arthroscopic knee surgery and affiliated to the Francophone Arthroscopic Society participated in this registry (Figure 1).

### Data collection

From the registry, we obtained information regarding patient demographics as age and sex; clinical features as BMI, primary ACLR or revision and delay before surgery; surgical examination as anteroposterior laxity (side-to-side laxity measured in millimetre), jerk test for pivot shift (three grades) [3] and MCL injury (evaluated preoperatively by MRI and physical examination and just before surgery) all assessed under anaesthesia; arthroscopic diagnosis as ACL remnant percentage and associated lateral meniscal tear. Ramp lesion was diagnosed through a posteromedial compartment evaluation and stability with an arthroscopic probe. The assessment of anterior laxity, pivot shift and MCL injury had to be completed by the surgeon along with the intraoperative data after examination under general anaesthetic. The data were requested as follows:

- Anterior laxity under anaesthesia: <3, 3–5, 5–10, >10 mm. These values were compiled into 0–5 and >5 mm to limit the risk of inter-individual variability.
- Pivot shift: absent, glide (+), clunk (++), gross (+++)
- MCL injury: laxity was evaluated at 20° flexion and full extension, any lesion greater than or equal to grade 1 was considered to be an MCL lesion.
- The surgeon had to estimate the ACL remnant according to the following criteria: absent (0%), <10%, 10%–30%, 30%–50%, 50%–70%, 70%–90% and >90%. Values > 70% were gathered in the analysis to obtain a sufficient number of patients.

### Statistical analysis

Descriptive data analysis was conducted depending on the nature of the considered criteria. Qualitative data

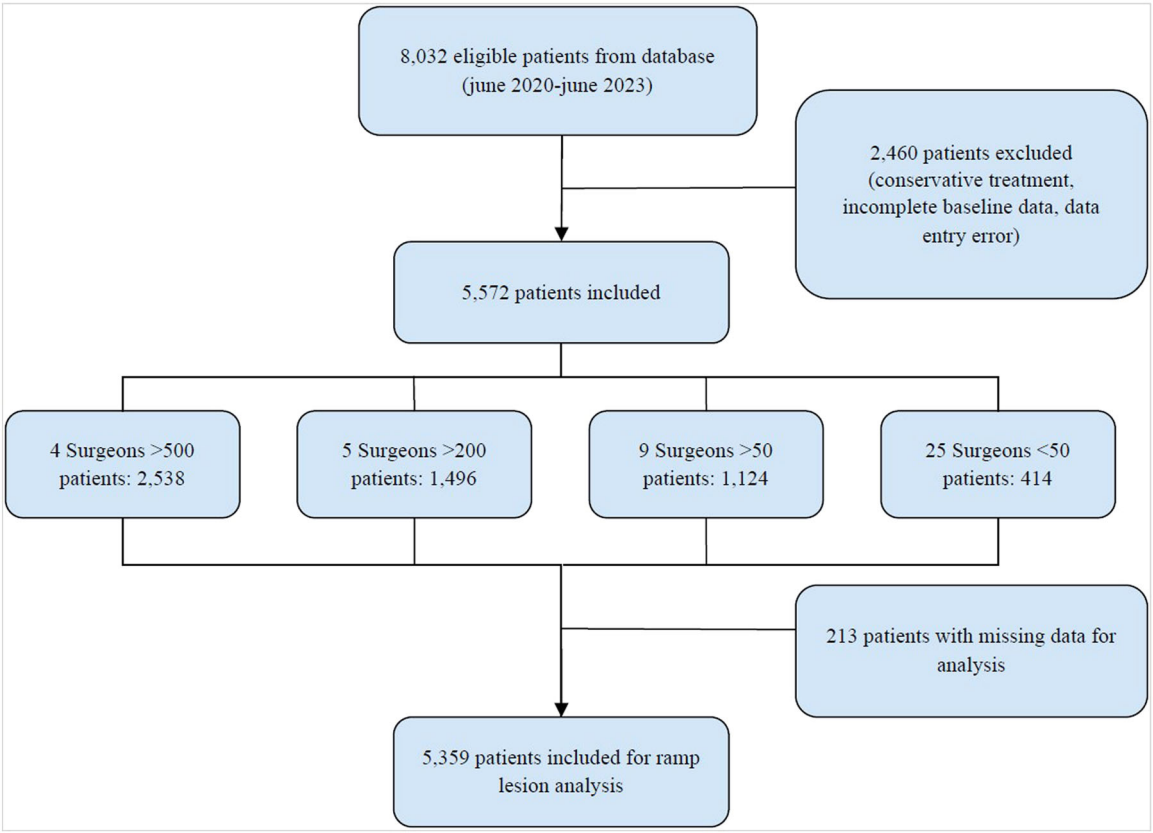


**FIGURE 1** Consort flowchart of the study.

were represented in terms of frequency and percentage. The number of completed and missing data items for each modality was also reported. Proportions were estimated with their exact 95% confidence intervals (CIs) when appropriate. Comparisons of data were made using the $\chi^2$ test or Fisher exact test, according to the expected values under the assumption of independence. For quantitative data, this included number of filled and missing data, arithmetic mean, standard deviation, median, first and third quartiles an minimum and maximum. Comparisons of data were made using a Student test or Mann–Whitney–Wilcoxon test (nonparametric test comparing ranks) depending on the distribution of the variable of interest. Risk factors associated with different types of lesions were analysed using a logistic regression model. The probability of having a lesion was modelised with the following factors: class of age, sex, revision, lateral meniscal tear, MCL injury, ACL remnant, side-to-side anteroposterior laxity and pivot shift on jerk test. Subgroup analysis was performed to assess differences considering BMI and delay to surgery. All comparisons were performed at the level of statistical significance set at $p < 0.05$. The multicollinearity between variables was tested before multivariate analysis (VIF criterion). All calculations were made with SAS for Windows (v 9.4; SAS Institute Inc.).

## RESULTS

The sample included a total of 5359 patients who underwent ACLR. Out of these, 822 (15.3%) patients were found to have a ramp lesion. The mean age was 29.4 ± 10.3 years [11; 77] (Table 1). There were no statistical differences between the BMI of patients without ramp lesion and those with a ramp lesion (24.2 ± 4.0 kg/m$^2$ [16.0; 40.3] vs. 24.2 ± 3.5 kg/m$^2$ [15.6; 39.6]; n.s) and considering delay to surgery (8.45 ± 23.5 weeks [0.2; 347.2] vs. 7.53 ± 16.8 weeks [0.3; 228.0]; n.s).

### Univariate analysis (Table 2)

In the univariate logistic regression analysis, male sex ($p < 0.001$), younger age (≥40 vs. <20 years, $p < 0.0001$), revision surgery ($p < 0.0001$), lateral meniscal injury ($p < 0.001$), ACL remnant (0% vs. > 70%, <10% vs. > 70%, 10%–30% vs. > 70%, 30%–50% vs. >70%, 50%–70% vs. >70%; $p < 0.001$) and pivot shift on jerk test (glide vs. absent, clunk vs. absent, gross vs. absent; $p = 0.009$) were associated with a significantly higher risk of ramp lesion, while MCL injury ($p < 0.001$) was associated with a significantly lower risk of ramp lesion. The side-to-side anteroposterior laxity was not significantly associated with the risk of ramp lesion.

**TABLE 1** Descriptive analysis of factors associated with ramp lesions—Population analysis.

| Characteristics | No ramp lesion (*N* = 4537) | Ramp lesion (*N* = 822) | Total (*N* = 5359) |
|---|---|---|---|
| Sex | | | |
| Woman | 1769 (88.6%) | 228 (11.4%) | 1997 (100%) |
| Man | 2768 (82.3%) | 594 (17.7%) | 3362 (100%) |
| Missing | 0 | 0 | 0 |
| Age (years) | | | |
| <20 | 734 (83.2%) | 148 (16.8%) | 882 (100%) |
| 20–30 | 1913 (82.6%) | 403 (17.4%) | 2316 (100%) |
| 30–40 | 1058 (85.4%) | 181 (14.6%) | 1239 (100%) |
| ≥40 | 832 (90.2%) | 90 (9.8%) | 922 (100%) |
| Missing | 0 | 0 | 0 |
| BMI (kg/m²) | | | |
| <25 | 1409 (65.0) | 225 (62.5) | 1634 (64.7) |
| ≥25 | 758 (35.0) | 135 (37.5) | 893 (35.3) |
| Missing | 2563 | 482 | 3045 |
| Delay before surgery (months) | | | |
| <3 | 328 (83.5%) | 65 (16.5%) | 393 (100%) |
| 3; 6 | 212 (83.5%) | 42 (16.5%) | 254 (100%) |
| 6; 12 | 75 (76.5%) | 23 (23.5%) | 98 (100%) |
| 12; 24 | 45 (80.4%) | 11 (19.6%) | 56 (100%) |
| ≥24 | 27 (84.4%) | 5 (15.6%) | 32 (100%) |
| Missing | 3561 | 286 | 3847 |
| Revision surgery | | | |
| No | 4240 (85.8%) | 704 (14.2%) | 4944 (100%) |
| Yes | 297 (71.6%) | 118 (28.4%) | 415 (100%) |
| Missing | 0 | 0 | 0 |
| Lateral meniscal tear | | | |
| No | 3265 (87.0%) | 490 (13.0%) | 3755 (100%) |
| Yes | 1272 (79.3%) | 332 (20.7%) | 1604 (100%) |
| Missing | 0 | 0 | 0 |
| Medial collateral ligament injury | | | |
| No | 4108 (84.0%) | 782 (16.0%) | 4890 (100%) |
| Yes | 429 (91.5%) | 40 (8.5%) | 469 (100%) |
| Missing | 0 | 0 | 0 |
| ACL remnant (%) | | | |
| 0 | 571 (81.8%) | 127 (18.2%) | 698 (100%) |
| <10 | 575 (81.3%) | 132 (18.7%) | 707 (100%) |
| 10–30 | 1350 (84.1%) | 255 (15.9%) | 1605 (100%) |

**TABLE 1** (Continued)

| Characteristics | No ramp lesion (*N* = 4537) | Ramp lesion (*N* = 822) | Total (*N* = 5359) |
|---|---|---|---|
| 30–50 | 1078 (85.8%) | 178 (14.2%) | 1256 (100%) |
| 50–70 | 610 (86.4%) | 96 (13.6%) | 706 (100%) |
| >70 | 353 (91.2%) | 34 (8.8%) | 387 (100%) |
| Missing | 0 | 0 | 0 |
| Side-to-side anteroposterior laxity (mm) | | | |
| 0–5 | 683 (85.6%) | 115 (14.4%) | 798 (100%) |
| >5 | 3854 (84.5%) | 707 (15.5%) | 4561 (100%) |
| Missing | 0 | 0 | 0 |
| Pivot shift | | | |
| 0 (absent) | 130 (92.9%) | 10 (7.1%) | 140 (100%) |
| 1 (+/Glide) | 871 (85.8%) | 144 (14.2%) | 1015 (100%) |
| 2 (++/Clunk) | 2982 (84.5%) | 546 (15.5%) | 3528 (100%) |
| 3 (+++/Gross) | 554 (82.0%) | 122 (18.0%) | 676 (100%) |
| Missing | 0 | 0 | 0 |

**TABLE 2** Univariate analysis of factors associated with ramp lesions—Population analysis (*N* = 5359).

| Variables | | Univariate analysis | |
|---|---|---|---|
| Factor | Comparison | Odds Ratio [95% CI] | Global *p* Value |
| Sex | Man vs. woman | 1.66 [1.41–1.96] | <0.001 |
| Age | <20 vs. ≥40 years | 1.86 [1.41–2.47] | <0.001 |
| | 20–30 vs. ≥40 years | 1.95 [1.53–2.48] | <0.001 |
| | 30–40 vs. ≥40 years | 1.58 [1.21–2.07] | <0.001 |
| Revision surgery | Yes vs. no | 2.39 [1.91–3.00] | <0.001 |
| Lateral meniscal tear | Yes vs. no | 1.74 [1.49–2.03] | <0.001 |
| Medial collateral ligament injury | Yes vs. no | 0.49 [0.35–0.68] | <0.001 |
| ACL remnant | 0% vs. >70% | 2.31 [1.55–3.45] | <0.001 |
| | 10%–30% vs. >70% | 1.96 [1.35–2.86] | <0.001 |
| | 30%–50% vs. >70% | 1.71 [1.17–2.52] | <0.001 |
| | 50%–70% vs. >70% | 1.63 [1.08–2.47] | <0.001 |
| | <10% vs. >70% | 2.38 [1.60–3.55] | <0.001 |
| Side-to-side anteroposterior laxity | >5 vs. 0–5 mm | 1.09 [0.88–1.35] | n.s |
| Pivot shift | 1 (+/Glide) vs. 0 (absent) | 2.06 [1.12–4.20] | 0.010 |
| | 2 (++/Clunk) vs. 0 (absent) | 2.28 [1.27–4.57] | 0.010 |
| | 3 (+++/Gross) vs. 0 (absent) | 2.75 [1.49–5.62] | 0.010 |

Abbreviations: ACL, anterior cruciate ligament; CI, confidence interval.

## Multivariate analysis (Table 3, Figure 2)

After adjustment for potential confounders in the multivariate logistic regression analysis, male sex ($p < 0.001$), younger age (≥40 vs. <20 years, $p < 0.001$), revision surgery ($p < 0.001$), lateral meniscal injury ($p < 0.001$) and ACL remnant (0% vs. >70%, <10% vs. >70%, 10%–30% vs. >70%, 30%–50% vs. > 70%, 50%–70% vs. >70%; $p = 0.040$) remained significant risk factors for ramp lesion in contrast to pivot shift. MCL injury ($p < 0.001$) remained a significant protective factor for ramp lesion. As in the univariate analysis, the side-to-side anteroposterior laxity was not found to be a significant predictor in the multivariate model.

# DISCUSSION

The most important finding of this study of 5359 ACLR patients from a multicentre cohort was the prevalence of ramp lesions, which was 15.3%. This prevalence falls within the wide range reported in the literature from 9% to 41.7% [4, 7, 20, 28, 33], reinforcing the need for systematic posteromedial compartment examination in ACLR cases.

The multivariate analysis identified several independent risk factors for ramp lesions.

Sex was a significant factor. This finding aligns with previous studies, possibly reflecting higher rates of sports participation and different biomechanical characteristics in the male population [22, 34].

Age, particularly being 20 years or younger versus more than 40 years old, significantly increased the risk of ramp lesions. Comparable results had already been found by Sonnery-Cottet et al. and Liu et al. [22, 34], both of whom found a higher risk of ramp lesions in patients under 30. In a previous study, Malatray reported the same prevalence in children and adolescents as in adults. However, this was a low-volume study. Our series, with a very large number of patients, helps to clarify this point. We did not find significant associated risk inside the young active population <40 years old. Over that age, we can assume that the lower intensity of the sports involved and the lower kinetics required for an ACL rupture are at the origin of the lower risk of ramp lesions observed.

Revision surgery emerged as a significant risk factor, confirming results found by Sonnery-Cottet et al. [34]; this suggested that patients with previous ACLRs might present a higher likelihood of concomitant injuries due to meniscal weakness or unaddressed injuries from the initial surgery and thus residual instability which is known to contribute to the failure of ACLR [11].

**TABLE 3** Multivariate analysis of factors associated with ramp lesions—Population analysis ($N = 5359$).

| Variables | | Univariate analysis | | |
|---|---|---|---|---|
| **Factor** | **Comparison** | **Odds ratio** | **[95% CI]** | **Global *p* value** |
| Sex | Man vs. woman | 1.531 | [1.293–1.812] | <0.001 |
| Age | <20 vs. ≥40 years | 1.752 | [1.317–2.332] | <0.001 |
| | 20–30 vs. ≥40 years | 1.776 | [1.388–2.273] | |
| | 30–40 vs. ≥40 years | 1.419 | [1.079–1.865] | |
| Revision surgery | Yes vs. no | 2.131 | [1.677–2.707] | <0.001 |
| Lateral meniscal tear | Yes vs. no | 1.601 | [1.366–1.877] | <0.001 |
| Medial collateral ligament injury | Yes vs. no | 0.445 | [0.317–0.624] | <0.001 |
| ACL remnant | 0% vs. >70% | 1.782 | [1.176–2.702] | 0.040 |
| | 10%–30% vs. >70% | 1.780 | [1.215–2.608] | |
| | 30%–50% vs. >70% | 1.638 | [1.108–2.422] | |
| | 50%–70% vs. >70% | 1.646 | [1.084–2.500] | |
| | <10% vs. >70% | 1.988 | [1.321–2.991] | |
| Side-to-side anteroposterior laxity | >5 vs. 0–5 mm | 0.754 | [0.527–1.080] | n.s |
| Pivot shift | 1 (+/Glide) vs. 0 (absent) | 1.664 | [0.839–3.299] | n.s |
| | 2 (++/Clunk) vs. 0 (absent) | 2.114 | [1.080–4.136] | |
| | 3 (+++/Gross) vs. 0 (absent) | 2.221 | [1.104–4.468] | |

Abbreviations: ACL, anterior cruciate ligament; CI, confidence interval.

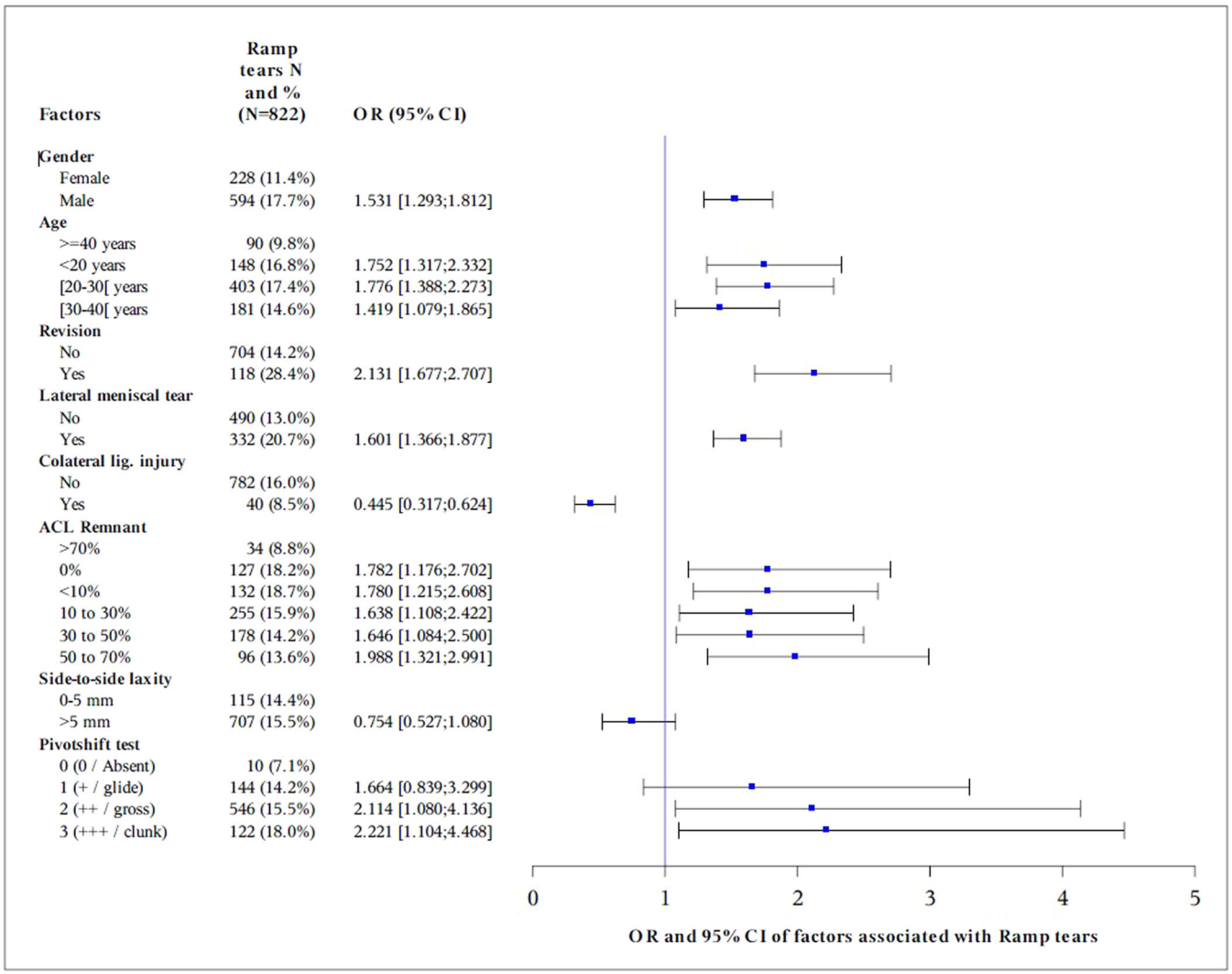


**FIGURE 2** Forest plot of factors associated with ramp lesions—population analysis ($N = 5359$).

The association between lateral meniscal tear and ramp lesions highlights the frequent association of these lesions, particularly ramp lesions with lesions of the posterior root of the lateral meniscus, following the same injury. This underlines the importance of accurate assessment of both compartments during ACLR [4, 34].

Another significant risk factor for ramp lesions was the low percentage of ACL remnant. This was found to be independent of the presence or absence of anterior laxity or pivot shift. This is the first study to report this data based on direct arthroscopic assessment of the remnant. Seil et al. as well as Magosch et al. [24, 30] have found an increased risk of meniscal injury in the presence of a complete ACL lesion. This finding may imply that there is a relationship between the intensity of the initial trauma, the degree of ACL damage, delay to surgery, as it has been found to be a risk factor for smaller remnant volume, and the ramp lesion. Recently, Tan et al. [36] found an association between the type of ACL injury and the prevalence of medial meniscus tear.

Interestingly, MCL injury emerged as a protective factor against ramp lesions in our study. This observation, which may seem contradictory at first sight, could be due to several reasons. In the literature, while Willinger et al. [37] found a strong association between medial MCL injuries and ramp lesion, Park et al. and Cristiani et al. did not [7, 28]. One possible explanation would be that the concomitant rupture of the MCL would relieve the pressure applied to the meniscus; the presence of an MCL injury might be indicative of a force vector that is more aligned to stress the MCL, thereby reducing the probability of the specific shear forces and rotations that are implicated in ramp lesions during ACL tears. However, there is no biomechanical evidence for this, and this needs further investigation.

Pivot shift on the jerk test initially significant in univariate analysis did not remain significant in multivariate analyses, suggesting its impact might be mediated through other variables. Mouton et al. [26] found in 58 patients with ramp lesion and ACL injury a higher grade of dynamic rotatory laxity compared to patients with isolated ACL injury. If a ramp lesion biomechanically increases rotational laxity, the pivot shift cannot be considered as an independent risk factor for a higher prevalence of these lesions.

This study failed to identify the delay between accident and surgery as a risk factor for associated ramp lesions. Although often reported in the literature [19, 20]. This is due to the low number of patients studied for this factor. Still, this number is higher than many studies, and we did not find significant differences between ramp lesions and no ramp lesion groups. However, early repair after rupture appears to be important in preventing the later development of new medial meniscus tears [31]. Similarly, BMI was not statistically different between the two groups. Thus, this has been reported as a risk factor in other studies [7, 28].

Laxity was not found to be significant in our analysis. Park et al. [28], in their machine learning analysis of 362 knees, and Sonnery-Cottet et al. [34], in their analysis of 3214 knees, found side-to-side laxity to be a significant risk factor for ramp lesions. One explanation may be the existence of a confounding factor in our study. The presence of an ACL remnant, assessed specifically in our study, has been correlated with the preoperative laxity by Muneta et al. [27], which could explain why we did not find laxity to be a significant risk factor.

Other risks factors not studied here have been analysed in the literature as the medial meniscal slope [32], medial tibial slope, lateral femoral condyle ratio [28], Segond fracture, posteromedial bone bruising [7] and could also be connected with a higher prevalence of ramp lesion.

This study has some limitations. First, the study population is extracted from a registry that covers multiple centres and surgeons. This could introduce variability related to differing surgical techniques, patient selection and surgeon's ability to diagnose and treat ramp lesions. This could potentially lead to underdiagnosis or overdiagnosis. Nevertheless, this may reflect an honest day-to-day practice [17]. Moreover, considering that, as affiliate members of the Francophone Arthroscopic Society, they were specialised surgeons, well trained in arthroscopic knee surgery. Similarly, the evaluation of certain measures (anterior laxity, pivot shift, frontal laxity, ACL remnant rate) was carried out by each surgeon according to a precise clinical examination, but it is impossible to rule out a certain interindividual variability which could be the source of a possible bias. However, most patients were assessed by hyperspecialised surgeons, and the ordinal variable discretisation was intended to limit this risk. Another potential limitation in interpreting the results of this study is the number of missing responses for certain variables as delay before surgery and BMI. For this reason, these values are only part of secondary analyses. While these limitations may affect the interpretation of the results, these findings can guide further prospective studies and help improve patient management strategies.

Knowledge of these factors will help in preoperative and intraoperative assessment regarding the suspicion and identification of ramp lesions, thereby improving patient outcomes and reducing complications.

## CONCLUSION

In conclusion, this study identified several risk factors for ramp lesions in ACLR as male sex, younger age <20, lateral meniscal tear, revision surgery and low percentage of remnant ACL, while the presence of an MCL lesion was associated with a lower occurrence of ramp lesions.

Presence of these factors should be a warning to surgeons of the possibility of a ramp lesion.

### THE FRANCOPHONE ARTHROSCOPIC SOCIETY - ACL Registry Study Group

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### AUTHOR CONTRIBUTIONS

All authors have given final approval of the submitted manuscript and their agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All authors have made substantial contributions to the design of the work and manuscript writing. Conceptualisation of the work was by Pierre-Jean Lambrey, Mathieu Thaunat and Jean-Marie Fayard. The acquisition, analysis and interpretation of data were performed by Pierre-Jean Lambrey, Mathieu Thaunat, Jean-Marie Fayard, Etienne Cavaignac, Nicolas Graveleau, Cécile Toanen, Thibaut Noailles, Romain Letartre and Johannes Barth. All authors were involved in drafting the work or revising it critically for important intellectual content.

### ACKNOWLEDGEMENTS

The authors have no funding to report.

### CONFLICT OF INTEREST STATEMENT

Dr Mathieu Thaunat, Dr Johannes Barth, Dr Etienne Cavaignac, Dr Jean-Marie Fayard, Dr Nicolas Graveleau, Dr Romain Letartre and Dr Cécile Toanen have potential conflict of interest. Dr Thaunat is consultant for Arthrex. Dr

Johannes Barth is employee for Arthrex, is paid consultant for Move up and is unpaid consultant for SBM. Dr Etienne Cavaignac is consultant for Arthrex, Amplitude and Orthonov. Dr Jean-Marie Fayard is consultant for Arthrex and New Clip Technics. Dr Nicolas Graveleau has royalties for Newclip, is Speaker for Arthrex, SBM, Stryker and FH Ortho-Olympus, is consultant for SBM, has support receveived from Arthrex, SBM, Stryker and Adler and is Board of Directors member for Sport Clinic Merignac, Vivalto group. Dr Romain Letrartre is consultant for Arthrex and Amplitude. Dr Cécile Toanen is occasionnal consultant for FH Orthopedics and Smith&Nephew.

## ETHICS STATEMENT

IRB: Référence Direction Recherche et Enseignement Ramsay Santé: COS-RGDS-2023-10-004-THAUNAT-M, N° IRB: RB00010835. All patients gave valid consent to participate.

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**How to cite this article:** Lambrey, P.-J., Fayard, J.-M., Graveleau, N., Toanen, C., Noailles, T., Letartre, R. et al. (2024) Risk factors and prevalence of ramp lesions in ACL ruptures: an analysis from the registry of the Francophone Arthroscopic Society. *Knee Surgery, Sports Traumatology, Arthroscopy*, 1–10. https://doi.org/10.1002/ksa.12194