



**HAL**  
open science

# Knee Ligament Sprains: Diagnosing Anterior Cruciate Ligament Injuries by Patient Interview. Development and Evaluation of the Anterior Cruciate Ligament Injury Score (ACLIS).

Simon Lukas, Sophie Putman, Cyril Delay, Alexandre Blairon, Emmanuel Chazard, Romain Letartre

## ► To cite this version:

Simon Lukas, Sophie Putman, Cyril Delay, Alexandre Blairon, Emmanuel Chazard, et al.. Knee Ligament Sprains: Diagnosing Anterior Cruciate Ligament Injuries by Patient Interview. Development and Evaluation of the Anterior Cruciate Ligament Injury Score (ACLIS).. Orthopaedics & Traumatology: Surgery & Research, 2022, Orthopaedics & Traumatology: Surgery & Research, pp.103257. 10.1016/j.otsr.2022.103257 . hal-04537012

**HAL Id: hal-04537012**

**<https://hal.univ-lille.fr/hal-04537012v1>**

Submitted on 22 Jul 2024

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution - NonCommercial 4.0 International License

**Knee Ligament Sprains: Diagnosing Anterior Cruciate Ligament Injuries by Patient Interview. Development and Evaluation of the Anterior Cruciate Ligament Injury Score (ACLIS)**

Simon **Lukas**<sup>a,b</sup>, Sophie **Putman**<sup>a,b,c</sup>, Cyril **Delay**<sup>d</sup>, Alexandre **Blairon**<sup>e</sup>, Emmanuel **Chazard**<sup>c</sup>, Romain **Letartre**<sup>f</sup>

a Univ. Lille, CHU Lille, ULR 4490 - PMOI, F-59000 Lille, France

b Service d'Orthopédie, Hôpital Salengro, Avenue du Professeur Emile Laine, F-59037 Lille, France

c Univ. Lille, CHU Lille, ULR 2694 - METRICS, CERIM, Public Health Dept, F-59000 Lille, France

d Service d'Orthopédie Traumatologie, Centre Hospitalier de Cambrai, Avenue de Paris, F-59400 Cambrai, France

e Service d'Orthopédie Traumatologie, Centre Hospitalier Jean Bernard, Avenue Desandrouin, F-59322 Valenciennes, France

f Hôpital Privé de la Louvière, 69 Rue de la Louvière, groupe Ramsay, F-59800 Lille, France

**\*Corresponding author:** Simon Lukas, Service d'orthopédie, hôpital Roger Salengro, Avenue Emile Laine 59000 Lille, France

E-mail: [sp.lukas21@gmail.com](mailto:sp.lukas21@gmail.com)

Tel.: +33 667 903 872

## **ABSTRACT**

**Background:** Knee ligament sprains are a common reason for emergency-room visits.

Initially, the often difficult physical examination provides limited information, creating a risk of missing cruciate-ligament injuries, which can result in substantial functional impairments. No simple tool is available to emergency and primary-care physicians for decisions regarding specialist referral of patients with knee ligament sprains. An easy to use clinical score for the emergency setting would help identify patients at high risk of anterior cruciate ligament (ACL) tears after knee ligament sprains. The primary objective of this study, in two separate cohorts with acute knee injuries, was to develop, then validate a score for assessing the probability of ACL tear and, therefore, the need for specialist referral.

**Hypothesis:** A score based on patient-interview information with a cut-off associated to good sensitivity and positive predictive value (PPV) for ACL tears can be developed.

**Material and Methods:** A literature review identified seven items to be used in the score: pivoting and contact activity at the time of injury, perceived cracking sound, sensation of dislocation, joint effusion, suggestive mechanism, inability to resume the activity, and immediate sensation of instability upon walking. To select the most relevant items, we recruited a development cohort of 228 patients (127 males and 101 females) with a mean age of  $32\pm 9$  years who were seen for knee injuries between November 2017 and November 2018 at three healthcare institutions; 183 (80%) had ACL tears. The score was then tested in a validation cohort of 121 patients (79 males and 42 females) with a mean age of  $28\pm 2.5$  years seen at two healthcare institutions between November 2019 and November 2020; 81 (67%) had ACL tears. In all patients, the diagnosis of ACL tear was confirmed by a specialist examination and magnetic resonance imaging.

**Results:** Four items proved both sensitive and specific for ACL injury and were combined into the score: an immediate sensation of knee instability, an inability to resume the sports

activity, a sensation of dislocation, and injury during a pivoting-contact activity. Patient report of two or more of these four criteria had 96% sensitivity and 66% specificity for ACL tear, with a PPV of 91% and an NPV of 83%. Results were similar in the validation cohort, confirming that a cut-off of at least two of the four items strongly suggested an ACL tear, with 94% sensitivity, 56% specificity, a PPV of 82% and an NPV of 82%.

**Conclusion:** The ACLIS score performs well for the emergency-room diagnosis of ACL tear, with 95% sensitivity, 62% specificity, an 88% PPV, and an 82% NPV. Patients with ACLIS scores of 2 or more probably require specialist referral with or without magnetic resonance imaging. The ACLIS score could be used routinely in emergency departments to decrease the proportion of patients with undiagnosed ACL tears.

**Level of evidence:** III, prospective case-control study of a diagnostic score

**Key words:** Knee. Sprain. Anterior cruciate ligament. Score.

## **1. Introduction**

Nearly 60,000 knee ligament surgeries are performed annually in France [1]. Trauma due to any cause accounts for nearly half of all emergency-room visits [2]. Among knee injuries, half are ligament sprains, contributing to 15% to 50% of sports-related injuries [3-5]. At the knee, sprains are injuries to at least one peripheral ligament and are classified as severe when the anterior cruciate ligament (ACL) and/or posterior cruciate ligament (PCL) are injured [6]. The diagnosis of severe knee ligament sprains relies on a well-conducted physical examination and on investigations including radiographs and magnetic resonance imaging (MRI). The clinical presentation varies widely, however, and greater symptom intensity does not correlate with greater lesion severity [7,8]. Consequently, difficulties may arise in determining the appropriate level of investigation and care, resulting in diagnostic delays [9,10]. A 2008 study by Guillodo et al. [11] showed that 75% of cruciate ligament injuries were missed in the emergency room. Decision rules have been developed to help determine when radiographs are needed to look for fractures in patients with acute ankle [12] or knee [13] injuries. We reasoned that a similar tool could be developed to identify ACL injuries.

The primary objective of this study in two separate cohorts with acute knee injuries was to develop then validate a score for assessing the probability of ACL tear and, thus, the need for specialist referral [14,15,16]. The secondary objective was to determine whether a score cut-off had greater than 80% positive predictive value (PPV) and an information-utility index greater than 0.35 [17].

## **2. Material and methods**

The first step of our study consisted in building a score in a development cohort. The score was then tested in a validation cohort. A calibration procedure done on both populations established the optimal score cut-off.

## ***2.1 Development cohort for building the score***

### *2.1.1 Population*

The development cohort was composed of 228 consecutive patients included prospectively and seen on an emergency or post-emergency basis for an acute knee injury, at any of three community hospitals located in Cambrai (n=16), Louvières (n=184), and Valenciennes, (n=28), in France, between November 2017 and November 2018. (Figure 1). Patients included were older than 16 years and seen for a recent knee ligament sprain during the study period. Patients with a history of knee surgery and those with contra-indications to MRI were excluded. For each patient, an observer who was blinded to the findings provided by the initial physical examination and MRI were entered into a standardised form. Mean age in the development cohort was 32 years (range, 15–68 years).

### *2.1.2 Items selected to build the score*

Based on a review of the current literature [6, 9,18-24] and on advice from experts in the field, we identified seven items. Among them, three were subjective patient perceptions: a heard or felt cracking sensation as described by Bonnet [18]; perceived dislocation followed by spontaneous reduction; and perceived sensation of instability upon resumption of walking, potentially indicating loss of rotational knee control. The four other items were objective facts reported by the patients: occurrence of the knee injury while participating in a pivoting contact sport [19-21] (Supplemental Table S1), mechanism consistent with injury to the cruciate ligaments (valgus, flexion, and external rotation or varus, flexion, and internal

rotation or hyperextension) [22-24], an inability to resume the previous activity, and presence of a knee effusion [9].

### *2.1.3 Diagnostic reference standard*

The goal of the score was to identify patients with ACL tears. The reference standard was MRI confirming the presence of structural ACL damage combined with a specialist physical examination. At all three participating hospitals, MRI was performed routinely to evaluate patients with knee ligament sprains.

## *2.2 Validation cohort for testing the score*

The objective was to validate the findings in the development cohort and to identify the optimal cut-off score for suggesting an ACL tear. The ACLIS was used to classify patients as having severe or mild ligament sprains. We then determined whether the classification of each patient matched that established by MRI and specialist examination.

### *2.2.1 Population*

Patients for the validation cohort were recruited prospectively at two centres: the emergency-department of the Lille university hospital (France) included 70 patients between November 2019 and October 2020 and the Louvières community hospital (France) 51 patients between May 2020 and October 2020. The inclusion and exclusion criteria were the same as for the development cohort. (Figure 2). Of the 121 patients, 81 (67%) were males. Mean age was 28 years (range, 17–68 years). The diagnoses in these 121 patients were as follows: ACL tear, n=81 (67%); patellar dislocation followed by spontaneous reduction, n= 3 (2%); isolated meniscal lesions, n=12 (10%); and intact menisci and ligaments, n=25 (21%).

### *2.2.2 Study variables*

In each validation-cohort patient, we tested the score built using the seven above-described items.

### *2.2.3 Identification of the optimal score cut-off*

Using the two cohorts, we determined the cut-off score above which patients should be prescribed an MRI scan. This cut-off was then tested on the overall population (development and validation cohorts pooled).

## **2.3 Statistical methods**

### *2.3.1 Descriptive statistics*

Qualitative, binary, and discrete variables with very few modalities were described as n (%) and quantitative variables as mean $\pm$ SD (range for age) when shown by the histogram to be normally distributed and as median [interquartile range] otherwise.

### *2.3.2 Bivariate analyses*

Independence of two qualitative variables was assessed using the chi-square test or logistic regression with the results reported as odds ratios (ORs) and associated 95% confidence intervals (95% CIs).

### *2.3.3 Score validation*

To evaluate scores producing quantitative or ordinal qualitative responses, we plotted the receiver operating characteristics (ROC) curves and computed the areas under these curves (AUROCs) with their 95% CIs. We classified AUROC values as follows:  $>0.9$ , exceptional;  $\geq 0.8$ , excellent;  $\geq 0.7$ , acceptable; and  $\leq 0.7$ , non-discriminating. To assess scores with a binary response or with an ordinal response and set cut-off, we computed sensitivity, specificity, the positive predictive value (PPV) and negative predictive value (NPV), and the distance to the upper left corner ( $d = \sqrt{(1 - \text{sensitivity})^2 + (1 - \text{specificity})^2}$ ).

### *2.3.4 Multivariate analyses*



We used a decision tree to model and test associations linking candidate co-variables to a binary variable. All available co-variables were included in this analysis and were selected automatically during decision-tree construction. We describe only the final model.

### *2.3.5 Statistical significance*

All statistical tests were two-sided. Values of  $p$  below 0.05 were taken to indicate statistically significant differences. Confidence intervals were computed for a 95% level of confidence.

## **3. Results**

### *3.1 Description and comparison of the development and validation cohorts*

**Table 1** reports the main baseline features of the development and validation cohorts.

### *3.2 Construction of the Anterior Cruciate Ligament Injury Score (ACLIS)*

**Table 2** compares the clinical variables in the groups with mild sprains vs. severe sprains involving cruciate ligament injury. The between-group differences were statistically significant for all variables.

Based on the results of the multivariate logistic regression analysis, classification trees, and correlation analyses, we selected the following four items: injury during a pivoting-contact event, sensation of dislocation at the time of injury, inability to resume the prior activity, and sensation of instability at the first attempt to walk.

**Table 3** reports the diagnostic performances according to the number of items present and **Figure 3** shows the corresponding ROC curve, with an AUROC of 0.850 (95%CI, 0.755–0.946). The ACLIS is considered positive in patients with at least two of the four items (**Supplemental Table S2**).

### *3.2 Testing in the validation cohort*

### *3.2.1 Validation of the optimal cut-off*

With the four-item score, we computed the different cut-offs using the questionnaire data from the 121 patients in the validation cohort (Table 4). The AUROC was similar to that in the development cohort (0.871; 95%CI, 0.775–0.967).

### *3.2.2 Confirmation of the cut-off*

The statistical analysis on the overall population obtained by pooling the two cohorts (n=349) showed similar diagnostic performance. With the two-item cut-off, sensitivity was 95%, specificity 62%, PPV 88%, and NPV 82%. In the pooled population, patients with at least two items had a 2.5-fold higher risk of ACL tear compared to patients with less than two items (positive likelihood ratio, 2.5). The information-utility index was 0.54.

## **4. Discussion**

No simple tools are currently available to reliably identify ACL tears without referral to an orthopaedic surgeon or slice imaging. The ACLIS exhibited excellent performance for diagnosing ACL tears, with an AUROC in the 0.8–0.9 range.

We applied the method used to develop the Ottawa ankle rules in 1994 [12]. These rules rely on five items to help determine when radiographs are required in patients with acute ankle injuries. The rules were validated using 259 records of adults and 37 records of patients younger than 16 years. Sensitivity was 97%, specificity 30%, PPV 17%, and NPV 97%. Applying the rules would have decreased the number of patients who underwent radiography by 26.3%. A single fracture was missed [12,13]. These findings are comparable to those obtained in our study with the ACLIS.

The test on the validation cohort allowed us to select four items and to validate a cut-off of two of four items. This cut-off allows room for discussion. In the pooled population of 349

patients, 264 patients had ACL tears and, among these, 12 (4.5%) had ACLIS values of 0 or 1. In all our study centres, patients with acute knee injuries routinely underwent specialist referral and MRI. However, this policy is not applied in all centres. In the pooled population, using the ACLIS with the cut-off of two items would have avoided 67 MRIs in patients with intact cruciate ligaments. The resulting logistical and cost-saving benefits would be substantial. A positive ACLIS allows more expeditious specialist referral.

Our study has several limitations. The presence of a majority of patients with ACL tears in the development cohort spuriously increased the PPV, thereby introducing bias. Nonetheless, the results were similar in the validation cohort, which had a lower prevalence of ACL tears. Moreover, the frequency of ACL tears in patients with acute knee injuries may be underestimated by current management strategies [11]. Also, in a standard population with a lower prevalence of ACL tears compared to our development cohort, the false-negative rate would be expected to be lower than in our study. The development of the ACLIS followed the steps described by L. Herzig et al., except for the impact analysis, which is only very rarely completed [25]. The utility of the ACLIS lies in its ability to identify those patients who require further evaluation such as specialist referral and/or MRI in order to optimise the management and avoid inappropriate treatments that may result in functional loss.

The strongest feature of the ACLIS is its simplicity. The four items are easy to understand and require only yes/no answers. A brief interview is sufficient to collect the items, and no paper or digital questionnaire is needed.

Recent studies indicate a marked tendency towards score simplification. Decreasing the number of items avoids redundancies, thereby improving adherence while providing similar performance [26]. The Parker score often used in elderly trauma patients also has a small number of items with limited response options and is thus easy to use in everyday practice [27,28].

## **5. Conclusion**

The four-item ACLIS is a simple tool for detecting ACL tears in patients with acute knee injuries. Score values of at least 2/4 have 95% sensitivity and 85% PPV for ACL tears. This tool seems particularly relevant for guiding decisions made by primary-care and emergency physicians performing initial evaluations of patients with acute knee injuries. We believe the routine use of this score in emergency departments can be recommended.

**Conflicts of interest**

None of the authors has any conflicts of interest to disclose.

**Funding**

None

**Contributions of each author**

S. Lukas conceived the study, collected data, drafted the manuscript, and revised the manuscript for important intellectual content.

S. Putman: drafted the manuscript and revised the manuscript for important intellectual content.

C. Delay et A. Blairon collected data.

E. Chazard performed the statistical analysis and drafted the manuscript.

R. Letartre conceived the study, collected data, drafted the manuscript, and revised the manuscript for important intellectual content.

## References

- [1] Erivan R, Tardieu A, Villatte G, Ollivier M, Jacquet C, Descamps S, et al. Knee surgery trends and projections in France from 2008 to 2070. *Orthop Traumatol Surg Res* 2020;106:893-902.
- [2] Potel G, Nantes S. L'organisation de l'aval des urgences : état des lieux et propositions. mai 2005.  
  
[www.sfmusport.org/upload/referentielsSFMU/Aval\\_SU\\_SFMU\\_mai\\_2005.pdf](http://www.sfmusport.org/upload/referentielsSFMU/Aval_SU_SFMU_mai_2005.pdf)
- [3] Gage BE, McIlvain NM, Collins CL, Fields SK, Comstock RD. Epidemiology of 6.6 million knee injuries presenting to United States emergency departments from 1999 through 2008. *Acad Emerg Med* 2012;19:378-85.
- [4] De Loës M, Dahlstedt LJ, Thomée R. A 7-year study on risks and costs of knee injuries in male and female youth participants in 12 sports. *Scand J Med Sci Sports* 2000;10:90-7.
- [5] Aaron M. Gray, BA and William L. Buford, PhDJ. Incidence of Patients With Knee Strain and Sprain Occurring at Sports or Recreation Venues and Presenting to United States Emergency Departments. *J Athl Train* 2015;50:1190–1198.
- [6] Lustig S, Servien E, Parratte S, Demey G, Neyret P. Lésions ligamentaires récentes du genou de l'adulte. *EMC - Appareil locomoteur* 2013;8:1-17.
- [7] Nacey NC, Geeslin MG, Miller GW, Pierce JL. Magnetic resonance imaging of the knee: An overview and update of conventional and state of the art imaging. *Journal of Magnetic Resonance Imaging* 2017;45:1257-75.
- [8] Griffin JW, Miller MD. MRI of the knee with arthroscopic correlation. *Clin Sports Med* 2013;32:507-23.
- [9] Noyes FR, Paulos L, Mooar LA, Signer B. Knee sprains and acute knee hemarthrosis: misdiagnosis of anterior cruciate ligament tears. *Phys Ther* 1980;60:1596-601.
- [10] Curado J, Hulet C, Hardy P, Jenny JY, Rousseau R, Lucet A, Steltzlen C, Morin V, Grimaud

O, Bouguennec N, Pujol N, Sonnery-Cottet B, Gravelleau N; French Society for Orthopaedic, Trauma Surgery (Société française de chirurgie orthopédique et traumatologique, SoFCOT).

Very long-term osteoarthritis rate after anterior cruciate ligament reconstruction: 182 cases with 22-year' follow-up. *Orthop Traumatol Surg Res* 2020;106:459-463.

- [11] Guillolo Y, Rannou N, Dubrana F, Lefèvre C, Saraux A. Diagnosis of anterior cruciate ligament rupture in an emergency department. *J Trauma* 2008;65:1078-82.
- [12] McBride KL. Validation of the Ottawa ankle rules. Experience at a community hospital. *Can Fam Physician* 1997;43:459-65.
- [13] Stiell IG, Greenberg GH, Wells GA, McDowell I, Cwinn AA, Smith NA, et al. Prospective validation of a decision rule for the use of radiography in acute knee injuries. *JAMA* 1996;275:611-5.
- [14] Rubin DA, Kettering JM, Towers JD, Britton CA. MR imaging of knees having isolated and combined ligament injuries. *Am J Roentgenol* 1998;170:1207-13.
- [15] Tavernier T, Dejour D. Knee imaging: what is the best modality. *J Radiol* 2001;82:387-405.
- [16] Sigonney G, Klouche S, Chevance V, Bauer T, Rousselin B, Judet O, Hardy P. Risk factors for passive anterior tibial subluxation on MRI in complete ACL tear. *Orthop Traumatol Surg Res* 2020;106:465-468.
- [17] Lavelle SM, Kanagaratnam B. The information value of clinical data. *Int J Biomed Comput* 1990;26:203-9.
- [18] Bonnet A. *Traité des maladies articulaires*. 2ème édition. Baillière; 1853.
- [19] Kimura Y, Ishibashi Y, Tsuda E, Yamamoto Y, Tsukada H, Toh S. Mechanisms for anterior cruciate ligament injuries in badminton. *Br J Sports Med* 2010;44:1124-7.
- [20] Levine JW, Kiapour AM, Quatman CE, Wordeman SC, Goel VK, Hewett TE, et al. Clinically relevant injury patterns after an anterior cruciate ligament injury provide insight into injury mechanisms. *Am J Sports Med* 2013;41:385-95.

- [21] Ruedl G, Webhofer M, Linortner I, Schranz A, Fink C, Patterson C, et al. ACL injury mechanisms and related factors in male and female carving skiers: a retrospective study. *Int J Sports Med* 2011;32:801-6.
- [22] Hewett TE, Myer GD, Ford KR, Paterno MV, Quatman CE. Mechanisms, prediction, and prevention of ACL injuries: Cut risk with three sharpened and validated tools. *J Orthop Res* 2016;34:1843-55.
- [23] Waldén M, Krosshaug T, Bjørneboe J, Andersen TE, Faul O, Häggglund M. Three distinct mechanisms predominate in non-contact anterior cruciate ligament injuries in male professional football players: a systematic video analysis of 39 cases. *Br J Sports Med* 2015;49:1452-60.
- [24] Colombet P, Jenny JY, Menetrey J, Plaweski S, Zaffagnini S, the French Arthroscopy Society. Current concept in rotational laxity control and evaluation in ACL reconstruction. *Orthop Traumatol Surg Res* 2012;98S,S201-S210
- [25] Lilli Herzig, Paul Vaucher, Nicole Mühlemann, Thomas Bischoff, Bernard Favrat, Baris Gencer. Développement, implémentation et utilisation pratique d'un score diagnostique. *Rev Med Suisse* 2011;7:1078-1083.
- [26] Sophie Putman, Henri Migaud, Gilles Pasquier, Julien Girard, Cristian Preda, Alain Duhamel. Does change in language change the properties of a shortened score previously validated in its complete version? Validation of the French versions of the HOOS-12 and KOOS-12 scores in primary knee and hip arthroplasties. *Orthop Traumatol Surg Res* 2021;107(3):102824.
- [27] M J Parker, C R Palmer. A new mobility score for predicting mortality after hip fracture. *J Bone Joint Surg Br* 1993 Sep;75(5):797-8.
- [28] Adrien Van Haecke, Anthony Viste, Romain Desmarchelier, Pascal Roy, Marcelle Mercier, Michel-Henri Fessy. Incidence and risk factors for bilateral proximal femoral fractures. *Orthop Traumatol Surg Res* 2021;9:102887.



**Table 1: Main features of the development and validation cohorts**

	<b>Development cohort</b>	<b>Validation cohort</b>	<b>Total</b>
<b>Features</b>			
Males, n (%)	128 (56%)	79 (65%)	207 (59%)
Age, years, median [IQR]	32.6 [15–68]	28.3 [17–68]	31.1 [15–68]
<b>Diagnostic MRI, n (%)</b>			
<b>Torn ACL</b>	183 (80%)	81 (67%)	264 (76%)
<b>Meniscal injury</b>	6 (3%)	12 (10%)	18 (5%)
<b>Patellar dislocation</b>	4 (2%)	3 (2%)	7 (2%)
<b>No lesions</b>	35 (15%)	25 (21%)	60 (17%)

MRI: magnetic resonance imaging; ACL: anterior cruciate ligament

**Table 2:** Description of the clinical variables in patients with and without MRI evidence of cruciate ligament injury

	<b>No cruciate- ligament injury  N=44</b>	<b>Cruciate- ligament injury  N=184</b>	<b>TOTAL  N=228</b>	<b>Odds ratio</b>	<b>p value</b>
<b>Pivoting-contact sport</b>	27 (61.4%)	167 (90.8%)	194 (85.1%)	6.18 [2.82–13.57]	<10 <sup>-4</sup>
<b>Sensation of dislocation</b>	8 (18.2%)	120 (65.2%)	128 (56.1%)	8.437 [3.70–19.23]	<10 <sup>-4</sup>
<b>Cracking sound or feeling</b>	20 (45.5%)	136 (73.9%)	156 (68.4%)	3.4 [1.72–6.70]	<10 <sup>-4</sup>
<b>Suggestive mechanism</b>	31 (70.5%)	158 (85.9%)	189 (82.9%)	2.548 [1.18–5.50]	0.017
<b>Effusion</b>	21 (47.7%)	158 (85.9%)	179 (78.5%)	6.656 [3.23–13.70]	<10 <sup>-4</sup>
<b>Sensation of instability</b>	8 (18.2%)	157 (85.3%)	165 (72.4%)	26.167 [10.98–62.94]	<10 <sup>-4</sup>
<b>Inability to resume activity</b>	13 (29.5%)	162 (88%)	175 (76.8%)	17.759 [8.00–38.53]	<10 <sup>-4</sup>

**Table 3:** Diagnostic performance of various ACLIS cut-offs in the development cohort

<b>Number of items</b>	<b>Sensitivity</b>	<b>Specificity</b>	<b>PPV</b>	<b>NPV</b>
≥0	1.00	0.00	0.78	(not computable)
≥1	0.99	0.18	0.81	0.90
≥2	0.96	0.66	0.91	0.82
≥3	0.84	0.78	0.93	0.57
4	0.47	0.88	0.93	0.32

PPV: positive predictive value; NPV: negative predictive value

**Table 4:** Diagnostic performance of the ACLIS in the validation cohort

<b>Number of items</b>	<b>Sensitivity</b>	<b>Specificity</b>	<b>PPV</b>	<b>NPV</b>
≥0	1.00	0.00	0.68	(not computable)
≥1	0.99	0.15	0.71	0.86
≥2	0.94	0.56	0.82	0.81
≥3	0.85	0.82	0.91	0.73
4	0.55	0.92	0.94	0.49

PPV: positive predictive value; NPV: negative predictive value

## **FIGURE LEGEND**

**Figure 1:** Flow chart for the development cohort

**Figure 2:** Flow chart for the validation cohort

**Figure 3:** ROC curve for the ACLIS score in the development cohort (AUROC, 0.850; 95% confidence interval, 0.755–0.946)





