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Original article

Construction and validation of a functional diagnostic score in anterior cruciate ligament ruptures of the knee in the immediate post-traumatic period. Preliminary results of a multicenter prospective study

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ABSTRACT

Introduction: Knee ligament injuries are frequent and their number is constantly increasing with the development of sports activities. Dynamic knee maneuvers usually make it possible to diagnose anterior cruciate ligament (ACL) injuries but they remain difficult to perform in the early post-traumatic phase. This leads to the almost systematic use of MRI scans, many of which turn out to be superfluous. The aim of this study was to construct a screening score based solely on history-taking, in order to help diagnose ACL injuries, and to define thresholds that could help inform recommendations for MRI usage. The hypothesis was that this score could distinguish a population of patients with a ruptured ACL from a population of patients with other knee injuries.

Material and methods: This prospective multicenter study included 166 patients. Patients were included if they were between 18 and 55 years of age, with knee trauma that had occurred in the last 10 days, and without a bone fracture on standard radiographs. They were excluded if the trauma required immediate surgical management and if they had a history of knee trauma. The screening score was completed by the physician. The score included the following items: assessment of pain, immediate post-traumatic functional impairment, notion of a "pop", feeling of instability and presence of a swelling. An MRI was systematically performed and the patient consulted a referring physician to compare the initial score with the diagnosis.

Results: Eighty-six patients had an injured ACL and 80 had a healthy ACL. Two thresholds could be identified. For a score lower than 4, the risk of an ACL injury was low with a sensitivity of 96% and a negative predictive value of 87%. For a score above 8, the ACL injury was highly probable with a specificity of 88% and a positive predictive value of 83%.

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Discussion/conclusion: The score was able to distinguish a population of patients with a ruptured ACL from a population of patients with other knee injuries. These preliminary results confirm that the selected items are relevant and that the score can help improve the diagnostic orientation of patients with recent knee trauma. Increasing the sample size in combination with an analysis of influencing factors will determine whether the performance of this score can be refined.
Level of evidence: II prospective multicenter study.

1. Introduction

Knee injuries are constantly increasing in parallel with the development of sports practice in the general population of Western nations, and this has been linked to sport promotion and health concepts [1]. Damage to the ACL renders the knee vulnerable to laxity which endangers its long-term function [2]. The diagnosis of an ACL tear can be affirmed by clinical examination as shown by the Kostov study, with a sensitivity of 94.5% [3], subject to mastering the dynamic ligament testing maneuvers (Lachman and pivot shift tests). The level of precision depends on the operator's expertise, although the initial management is rarely provided by specialists. The context of the emergency, with an anxious patient who is often in pain, impedes manipulation of the traumatized joint. Magnetic resonance imaging (MRI), with its oblique sequences, is a powerful diagnostic tool with a sensitivity of up to 98.6% as per the study of Navali et al. [4]. Currently, the fear of an inaccurate initial diagnosis leads to almost systematic use of MRI with the adverse effects of: encumbering the MRI taskforce with superfluous requests, increasing the time required to obtain this investigation (CEMKA [5]) and increasing healthcare costs.

Post-traumatic knee diagnoses are challenging to make in an emergency context, and according to the studies of Noyes and Guillodo [6,7], the diagnosis of an ACL injury is only made in 10 to 25% of initial consultations. The article by Frobel [8] underlines the low diagnostic value of the first clinical examination after acute knee trauma. An erroneous initial diagnosis leads to two problems. On the one hand, in the event of minor trauma, it is possible to observe excessive treatment (immobilization, cessation of work, unjustified MRIs). On the other hand, a missed ACL rupture exposes patients to iterative accidents of instability, potentially generating meniscal and/or cartilage lesions, and accelerated degradation of the knee joint [9–11].

The objective of this study was to construct and validate a functional score for clinical screening of ACL tears in the knee in the immediate post-traumatic period. In order to avoid any clinical maneuvers, this score was based on a simple questioning which had to be carried out early by any type of doctor in order to improve the detection of ACL tears. Our criterion for analyzing the performance of this score was comparison with the results of MRI, which remain the gold standard for the diagnosis of ACL tears [12]. The hypothesis was that this score made it possible to distinguish patients with a ruptured ACL from those with an intact ACL. The secondary objective was to identify thresholds to propose strategies for using MRI.

2. Materiel and methods

2.1. Patients

This prospective, non-randomized and non-comparative, multicenter study included 12 centers, for the validation phase, chosen because they were French-speaking and managed knee trauma. The physicians who included the patients were emergency physicians or general practitioners, sports physicians and orthopedic surgeons undertaking trauma consultations. This was an observational study in routine care. All the patients gave informed consent for the anonymous processing of their data and the declaration was made to the French Data Protection Agency (CNIL) according to an MR03 protocol with the reference 20015651. Authorization from the ethics and protection of persons committee was obtained for this study (issue 2016-A00126-45). This clinical research protocol has been declared to ClinicalTrials.Gov and registered with the following number: NCT03113734 [13].

The inclusion criteria were as follows: age between 18 and 55 years old, trauma to the knee occurring less than 9 days before the consultation with the doctor carrying out the inclusion assessment, absence of bone injuries (fractures) on the standard radiographic assessment, apart from indirect signs of damage to the ligaments (avulsion fracture or Segond fracture), patient affiliated to a social security scheme and informed consent gained.

The non-inclusion criteria were: trauma requiring immediate surgical treatment (fracture, dislocation), trauma history on one of the two knees, unable to have an MRI (contraindication, refusal or claustrophobia), inability to understand the information or refusal to participate in the study, impossibility of ensuring follow-up in the same center.

In total, for this preliminary study, 219 patients were included with 166 complete usable files. Nineteen patients were excluded for reasons of eligibility criteria (5 outside the age criteria, 12 for trauma history on one of the knees not mentioned during the inclusion visit, 2 patients from foreign origin not affiliated to social security). Fifteen were excluded for a lack of MRI and 19 were excluded for a lack of consultation with the orthopedic surgeon. Patients who did not show up for their bone appointments were contacted by telephone. The main reasons for not showing up for the appointment were the change of region or the lack of availability (Fig. 1).

2.2. Construction of the score

The construction of the score was based on a literature search to identify the clinical signs most frequently found in ACL injuries [14–16]. An initial analysis identified 5 items with a variable degree of sensitivity and significance (Table 1):

- The feeling of instability;
- The notion of a "pop";
- Functional impairment;
- Pain;
- Effusion.

Each item was further associated to several variables culminating in Table 1 with a minimum score of 0 and a maximum of 12. The vocabulary retained for the construction of the questions was the result of the work of a group of experts from the Francophone Arthroscopy Society (SFA).

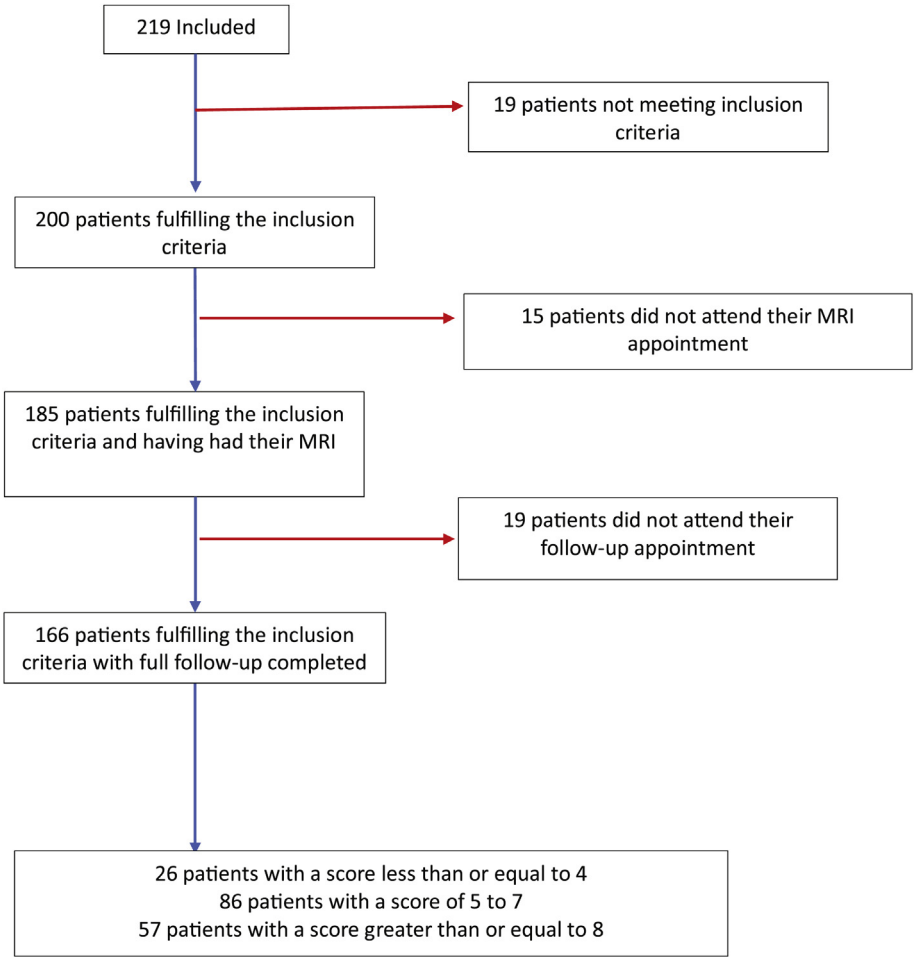


Fig. 1. Flowchart.

Table 1
Item and score value out of 12 points.

Value/item	0	1	2	3	4
Pain Visual Analogue Scale	0–1–2	3–4	5–6	7–8	9–10
Functional impairment	Possible resumption	Temporary resumption	Cessation of activity	Weight-bearing not possible	
Popping	No	Perceived by the patient	Audible		
Instability	No	Sensation of giving way when weight bearing	Sensation of dislocation during the accident		
Effusion observed by the patient	Absent	Present			

2.3. Diagnostic and therapeutic care

In this observational study in routine care, data were collected during 3 visits.

2.3.1. Inclusion visit

During the initial consultation in one of the participating centers, the investigating doctor checked the patient's eligibility criteria. Information was entered on computer or on paper, depending on the center. Patient data (height, weight, sports level, mechanism of the accident and verification of the normality of the standard radiographic assessment with at least one anterior and one lateral image) and the score itself, out of 12 points, were recorded.

2.3.2. Performing an MRI

The MRIs were performed in the structures affiliated with the study, then the anonymized access code for each examination was sent to the referring radiologist with the sole question, is the ACL intact? Thus, warranting a yes or no answer.

2.3.3. Specialized consultation

This consultation was carried out by an expert specializing in knee traumatology (sports doctor or orthopedic surgeon) who was required to intervene no later than 8 weeks after the trauma. The consultation made it possible to compare the initial score, the MRI and the results of the clinical examination, thus allowing them to make the definitive diagnosis.

For this preliminary study, each center remained free to apply their own therapeutic approach (duration and type of immo-

Table 2
Statistical values per item analyzed.

	Threshold	Ruptured ACL	Intact ACL	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	FP (%)	FN (%)
Pain	> 2 (VAS > 7)	36	20	42	75	64	54	25	58
	≤ 2(VAS ≤ 7)	50	60						
Functional impairment	> 1	74	46	86	43	62	73	57	14
	≤ 1	12	34						
Popping	≥ 1	62	36	72	55	64	65	45	28
	< 1	24	44						
Instability	≥ 1	58	27	68	66	68	66	34	32,5
	< 1	28	53						
Effusion	Present	75	55	87	31.5	58	31	69	13
	Absent	11	25						

PPV: positive predictive value; VPN: negative predictive value; FP: false positives; FN: false negatives.

bilization, discharge procedure, analgesic and anti-inflammatory treatment, other).

2.4. Statistical analyzes

The methodological framework was that of the evaluation of a new diagnostic test according to the STARD checklist (standards for reporting of diagnostic accuracy).

The results of the quantitative variables are presented in the form of mean ± standard deviation, minimum, maximum and median. While those of the qualitative variables are expressed in frequencies and percentages. The Shapiro-Wilk test was used to verify the normality of distribution of the quantitative variables. The distributions of the quantitative variables were compared by nonparametric Mann and Whitney tests for unpaired series. Sensitivity (Se), specificity (Spe), positive predictive value (PPV) and negative predictive value (NPV) calculations were performed after determining a score threshold corresponding to the appearance of an ACL tear.

Each of the score items was studied by a receiver operating characteristic (ROC) curve with determination of a threshold (Youden Index). A univariate analysis was then performed and all the data was demonstrated by another ROC curve for the total score.

The significance threshold chosen for all of the statistical analyzes was 0.05. The software used was SAS 9.1.3 (SAS Institute, Cary, USA).

3. Results

Of the 166 patients included, 86 had a ruptured ACL (confirmed by MRI and clinical examination performed during the follow-up consultation) and 80 had an intact ACL. Analysis of the ROC curve made it possible to determine that a score > 6 made it possible to best distinguish between a ruptured and non-ruptured ACL (Fig. 2). Each item could then be analyzed independently using the same principle (Fig. 3). A threshold could be determined for each item and the corresponding statistical values are shown in Table 2.

Functional impairment, effusion and popping are the most sensitive criteria. Pain and instability are the most specific. This highlights the utility of a score based on the sum of these criteria. The population was finally able to be divided into 3 subgroups according to the significance thresholds.

Univariate analysis shows that all the items chosen differed significantly between the presence or absence of ACL tears (Table 3).

The existence of immediate impairment and/or a feeling of instability or dislocation confers a 4 times greater probability that the patient has an ACL rupture.

The analysis of the data makes it possible to identify 2 contributory thresholds (Table 4):

Table 3
Odd ratio, 95% CI and *P*-value by score item.

Item	Odds ratio	95% Confidence interval	*p*-value
Effusion	2.78	[1.25–6.20]	0.0125
Pain	2.16	[1.09–4.28]	0.0274
Popping	3.47	[1.82–6.64]	0.0002
Functional impairment	4.08	[1.95–8.56]	0.0002
Instability	4.28	[2.23–8.20]	< 0.0001

Table 4
Table of sensitivity, specificity, positive and negative predictive values used to determine the score thresholds.

Positive if greater than or equal to	Sensitivity	Specificity	PPV	NPV
0	1.00	0	0.5	–
1.5	1.00	0.045	0.51	1
2.5	0.988	0.114	0.53	0.9
3.5[a]	0.964	0.239	0.56	0.87
4.5	0.909	0.364	0.59	0.80
5.5	0.861	0.557	0.66	0.80
6.5	0.697	0.750	0.74	0.71
7.5[b]	0.564	0.886	0.83	0.67
8.5	0.406	0.909	0.82	0.60
9.5	0.242	0.932	0.78	0.55
10.5	0.103	0.977	0.82	0.52
11.5	0.18	1.00	1	0.5

[a] Strictly less than 4.
[b] Greater than or equal to 8.

Table 5
Distribution of patients by threshold.

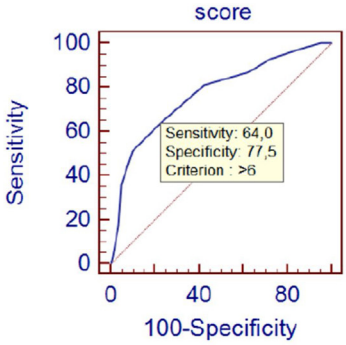
Thresholds	Ruptured ACL	Intact ACL	Total
≤ 4	3	20	23
5, 6 or 7	36	50	86
≥ 8	47	10	57
Total	86	80	166

- 4 or a total score less than or equal to 4, an ACL rupture is unlikely with a sensitivity of 96%, a specificity of 24% and a negative predictive value of 87%;
- 4 or a score greater than or equal to 8, an ACL rupture becomes very probable with a specificity of 88% and a positive predictive value of 83%.

Based on these thresholds, the distribution of patients is shown in Table 5.

An analysis of this table demonstrates that the risk of having an ACL tear with a score less than or equal to 4 is less than 2%. On the other hand, for a score greater than or equal to 8, no benign lesions were identified. This represented 9 patients with:

- A bucket handle meniscus tear;
- Two radial meniscus tears;



Variable: score
Classification variable: Ruptured ACL

Area under the curve	0.771584
Standard error	0.0362
95% Confidence Interval	0.700143 t0 0.833068
Z Statistic	7.497
p-value (area = 0.5)	< 0.0001

Fig. 2. ROC curve score/ACL rupture curve.

- Two injuries of the Posterior Cruciate Ligament;
- Three patella dislocations;
- Damage to the medial collateral ligament with laxity.

4. Discussion

4.1. Inclusion criteria

Our inclusion criteria were based on the Ottawa ankle rules with the aim of studying a comparable population in terms of activity profile. A standard radiographic assessment was required to ensure there were no fractures necessitating different therapeutic management. The routine use of the Ottawa or Pittsburgh criteria in standard radiographic assessment remains appropriate in the context of knee trauma [17]. The meta-analysis by Cheung et al. [18] attributes an identical sensitivity of 86% to the 2 tests, although, with better specificity for the Pittsburgh score (51% versus 27%).

4.2. Items comprising the score

The choice of items, based on the literature analyzed, proved to be relevant. The score is based on questions asked by a doctor, who may need to use synonyms to make the meaning of the questions clear to the patient. This score aims to improve the diagnostic scores of ACL damage in the early post-traumatic period because the answers lose accuracy with time. The pain item is the most affected by the delay between the trauma and score questions, and this is linked to the diminishing memory of the trauma. Effusion is also an item subject to variation, in particular depending on early post-traumatic therapy (icing, for example) [19]. The work of the Wagemakers team [14] reinforces our approach by showing that the association of several signs increases their clinical value. They studied different combinations of 2 items, then the following 3 signs: effusion ± popping sensation ± the sensation of giving way. These different combinations show that the association of the 3 items increases specificity to the detriment of sensitivity, which is something that we also observed (Table 6).

The construction of a functional score based on relevant items collected during an interview is therefore consistent, and our study confirms the significance of this. However, due to a lack of sufficient numbers, the multivariate analysis of the items did not allow, in this preliminary study, to increase the statistical performance of this score.

4.3. Thresholds and MRI

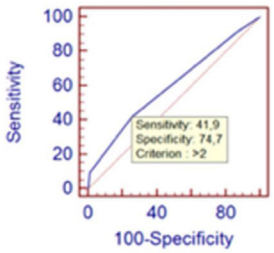
A threshold less than or equal to 4 represents a small part of the series. For this population, the risk of not recognizing an ACL rupture is then less than 2%. If the recommendation is not to request an MRI for these patients, this would have represented 14% fewer examinations.

For a score between 5 and 7, it is more difficult to decide. The performance of the clinical examination carried out by an expert (Table 7) leads us to recommend a consultation prior to the request for MRI [20–22]. The sensitivity and specificity of a clinical examination conducted by an expert, which is often completed sometime after the initial painful phase, should make it possible to reduce the number of MRIs requested. In our series, a score of 5 to 7 represents 85 patients including 35 with an ACL tear. In fact, 50 patients did not present with an ACL tear and therefore a certain number of MRIs could not have been requested. This could represent a 30% reduction in MRIs. In current practice, experts use MRI less often to study the ACL than to assess lesions associated with ACL tear [23].

For a threshold greater than or equal to 8 (57 patients in our series), there were no benign lesions (one bucket handle meniscus tear, two radial lesions, three patella dislocations, two posterior cruciate ligament lesions and an isolated grade 3 sprain of the medial collateral ligament). It is therefore logical, for such a score, to request an MRI and a specialist consultation (sports medicine or surgery). Using this framework, the MRI must be requested quickly, and before the specialist consultation, so that the medical expert has it available during the consultation. This investigation will confirm the state of the ACL and will allow the diagnosis to be refined (assessments of the meniscus, cartilage, cruciate ligaments and capsule). The trend in this preliminary study was that an increase in lesion severity correlates to an increase in the score, but the size of the sample limited the number of conclusions that could be made.

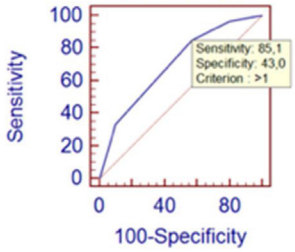
The use of MRI is therefore not routinely recommended. Based on the thresholds identified by our study, there would have been up to 44% fewer MRIs. This figure remains an approximation because a clinical examination with an element of uncertainty can lead to the secondary recommendation of an MRI and in everyday life, some

1- Pain



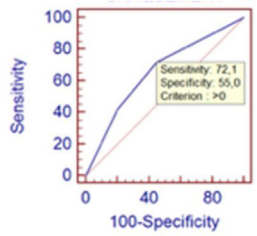
Criterion	Sensitivity	95% CI	Specificity	95% CI	+LR	-LR
≥0	100,00	95,8 - 100,0	0,00	0,0 - 4,6	1,00	
>0	91,86	83,9 - 96,7	12,66	6,2 - 22,0	1,05	0,64
>1	66,28	55,3 - 76,1	44,30	33,1 - 55,9	1,19	0,76
>2	41,86	31,3 - 53,0	74,68	63,6 - 83,8	1,65	0,78
>3	9,30	4,1 - 17,5	98,73	93,1 - 100,0	7,35	0,92
>4	0,00	0,0 - 4,2	100,00	95,4 - 100,0		1,00

2- Functional impairment



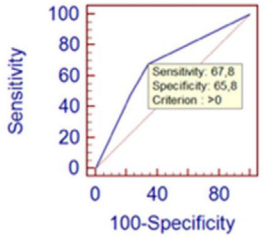
Criterion	Sensitivity	95% CI	Specificity	95% CI	+LR	-LR
≥0	100,00	95,8 - 100,0	0,00	0,0 - 4,6	1,00	
>0	96,55	90,3 - 99,3	20,25	12,0 - 30,8	1,21	0,17
>1	85,06	75,8 - 91,8	43,04	31,9 - 54,7	1,49	0,35
>2	33,33	23,6 - 44,3	89,87	81,0 - 95,5	3,29	0,74
>3	0,00	0,0 - 4,2	100,00	95,4 - 100,0		1,00

3- Popping



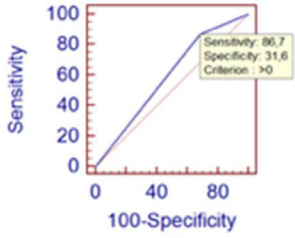
Criterion	Sensitivity	95% CI	Specificity	95% CI	+LR	-LR
≥0	100,00	95,8 - 100,0	0,00	0,0 - 4,5	1,00	
>0	72,09	61,4 - 81,2	55,00	43,5 - 66,2	1,60	0,51
>1	41,86	31,3 - 53,0	80,00	69,6 - 88,1	2,09	0,73
>2	0,00	0,0 - 4,2	100,00	95,5 - 100,0		1,00

4- Instability



Criterion	Sensitivity	95% CI	Specificity	95% CI	+LR	-LR
≥0	100,00	95,8 - 100,0	0,00	0,0 - 4,6	1,00	
>0	67,82	56,9 - 77,4	65,82	54,3 - 76,1	1,98	0,49
>1	48,28	37,4 - 59,2	77,22	66,4 - 85,9	2,12	0,67
>2	0,00	0,0 - 4,2	100,00	95,4 - 100,0		1,00

5- Effusion



Criterion	Sensitivity	95% CI	Specificity	95% CI	+LR	-LR
≥0	100,00	95,2 - 100,0	0,00	0,0 - 4,7	1,00	
>0	86,67	76,8 - 93,4	31,58	21,4 - 43,3	1,27	0,42
>1	0,00	0,0 - 4,8	100,00	95,3 - 100,0		1,00

Fig. 3. ROC curve for determining thresholds by item.

Table 6
Statistical variation according to sign combinations, 95% CI in brackets.

	Sensitivity	Specificity	NPV	PPV
2 signs	0.71 (0.62–0.80)	0.71 (0.38–0.56)	0.90 (0.83–0.96)	0.42 (0.28–0.56)
3 signs	0.18 (0.04–0.32)	0.99 (0.98–1.00)	0.81 (0.74–0.88)	0.83 (0.66–1.00)

Table 7
Meta-analysis comparisons of dynamic knee ligament tests.

Meta-analysis	Lachman	Pivot shift	Anterior drawer
Benjaminse et al., 2006 [20]	Se 85% (95% CI 0.83–0.87) Spe 94% (95% CI 0.92–0.95)	Se 32% (95% CI 0.25–0.38) Spe 98% (95% CI 0.96–0.99)	Se 49% (95% CI 0.43–0.55) Spe 58% (95% CI 0.39–0.76)
Scholten et al.,2003 [21]	Se 86% (95% CI. 0.76–0.92) Spe 91% (95% CI. 0.89–0.96)	Se 18%–48%[a] Spe 97%–99%[a]	Se 62% (95% CI 0.42–0.78) Spe 88% (95% CI 0.83–0.92)
Huang et al.,2016 [22]	Se 87% (95% CI 0.84–0.90) Spe 91% (95% CI 0.89–0.93)	Se 49% (95% CI 0.43–0.45) Spe 98% (95% CI 0.95–0.99)	Se 73% (95% CI 0.69–0.76) Spe 93% (95% CI 0.91–0.94)

References [20–22]. Se: sensitivity; Spe: specificity.
[a] Bivariate analysis calculation not performed.

Table 8
Percentage of correctly diagnosed ACL ruptures at first consultation.

Studies	Percentage of correctly identified diagnoses of ACL ruptures	Average time to diagnosis
Parwaiz et al., (2016) [15]	14.4% (GP and E)	10 weeks
Perera et al., (2013) [24]	19.2% (E)	9 weeks
Arastu et al., (2015) [25]	13.5% (GP and E)	5 to 20 weeks
Guillodo et al., (2008) [7]	25% (E)	8 weeks
SFA Score	87% NPV if ≤ 4 (ACL not ruptured) 83% PPV if ≥ 8 (ruptured ACL)	The day of the consultation: < at day 10 in our study

References [7,15,24,25]. GP: general practitioner; E: emergency medicine physician.

patients would not have had an MRI, although they were systematically used in this study. The generalized use of this score can help reduce healthcare costs through the reduction of MRI requests, and it can decrease waiting times for a knee MRI in the setting of trauma, which justifies this urgent investigation.

The average time to obtain a bone and joint MRI was 30.4 days in 2015, and remains stable despite the increase in the number of machines [5]. According to epidemiological and statistical studies, one of the causes of this delay is the increase in requests and the low number of machines dedicated to bone and joint investigations. This study aims to decrease this delay, by freeing up access through the reduction of requests and allowing the patients with the highest scores to have an MRI more promptly.

4.4. Performance of the diagnostic tool and recommendations

Dynamic maneuvers performed by an expert are the golf standard for diagnosing an ACL injury. MRI remains necessary, however, less so to confirm the diagnosis than to assess the associated lesions [6,8,23].

We aimed to improve initial management by constructing a score based solely on a questionnaire to avoid any mobilization of the knee. This score is intended for doctors but its use could be extended to any health professional confronted with sports traumatology (physiotherapists in particular). According to the literature, at present, an accurate initial diagnosis is made only once out of 5 times on average [7,15,24,25] (Table 8).

The SFA score eliminates the diagnosis of a severe ACL tear if it is less than or equal to 4 with a NPV of 87%. Conversely, it indicates an ACL injury, if it is greater than 8, with a PPV of 83%. It should be emphasized that no benign trauma existed for a score greater than 8 and therefore such a score should prompt the practitioner to request an urgent MRI and to seek an early specialist opinion.

This score for early detection of ACL ruptures fulfills the objective initially set. If it does not confirm an ACL rupture, it remains an excellent tool and diagnostic aid. It must be used within 10 days of the accident and it makes it possible to rationalize the use of MRI.

The small sample size represents one of the main limitations of this study, which, despite significant results, did not improve the statistical performance of the score by a multivariate analysis. The loss of follow-up represents the other limitation of this study: 15 patients did not have their MRI and 19 did not attend their follow-up consultation. Of these 34 patients, 31 had a score less than or equal to 4. They were all contacted via telephone and the main reason for stopping their participation was the lack of time and the rapid improvement in their clinical condition. In our series, the risk of loss of follow-up linked to the absence of an MRI therefore seems very low, but the evaluation of this risk would require a specific prospective and randomized study.

5. Conclusion

The diagnosis of an ACL rupture in the emergency setting remains difficult, which is why the SFA piloted this multicenter prospective study leading to the creation and validation of a score serving as a diagnostic aid in knee trauma. This tool is a reliable diagnostic aid and is effective provided it is carried out in the days following the trauma. Without relying on an MRI or the precision of an expert examiner, this score makes it possible to orient the patient to the relevant management within a few minutes:

- For a score below 4: an ACL tear is unlikely with a risk of 2%.
- For a score between 5 and 7: a margin of uncertainty is permitted, and the patient should be encouraged to seek expert advice for a new clinical examination.
- For a score greater than or equal to 8: an ACL tear is very likely (with a positive predictive value of 83%) and even in the absence of an ACL tear, a score greater than 8 was systematically associated with serious knee injuries. We therefore recommend the early use of an MRI coupled with an urgent specialist consultation.

Disclosure of interest

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Authors' contribution

François Xavier Gunepin: principal investigator and head of the clinical study.

Romain Letartre: head of the investigation center in Lille.

Caroline Mouton: head of the investigation center in Luxembourg.

Pierrick Guillemot and Harold Common: joint leaders of the Rennes investigation center.

Patricia Thoreux: head of the investigation center in Paris.

Rémi Di Francia: head of the investigation center in Brest.

Nicolas Graveleau: head of the investigation center in Bordeaux.

Use of AI

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