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ORIGINAL ARTICLE

Anterior cruciate ligament failure: Diagnostic value of the clinical examination and magnetic resonance imaging

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Abstract
Objective: The clinical diagnosis of anterior cruciate ligament (ACL) failure uses subjective criteria and its sensitivity is low. Magnetic resonance imaging (MRI) has become the standard in the non-invasive evaluation of knee injuries. It is important to determine the diagnosis by clinical examination (CE) and MR versus the arthroscopy pattern in the ACL injuries, and to know and specify their objective exploratory parameters.
Materials and Methods: A total of 101 medical records were reviewed: CE-radiological suspicion of ACL failure, examination using a subjective/objective test protocol, MR, objective CE under anaesthesia and diagnostic/therapeutic arthroscopy. We selected epidemiological data, times from the ACL to surgery, previous operation on the affected knee, subjective data, objective data including arthrometry, number of centres that performed MR, the number of MR per centre, observations and arthroscopy.
Results: A statistical study was performed comparing quantitative and qualitative variables, precision, reliability and consistency between actions. A total of 94%, 100% and 83% were diagnosed using EC without anaesthesia, with anaesthesia and MR, with a sensitivity of 94.06%, 100% and 83.17%, respectively.
Discussion: The CE with/without-anaesthesia, diagnosed ACL failure more often than MR. MR diagnoses the total number of concomitant injuries and detects more external meniscus injuries. The Lachman test and arthrometry are the most significant diagnostic methods in ACL failure.

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PALABRAS CLAVE
Ligamento cruzado anterior;
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Resonancia magnética;
Artroscopia;
Artrómetria

Insuficiencia del ligamento cruzado anterior. Valor diagnóstico de la exploración clinica y RM

Resumen
Objetivo: El diagnóstico clínico de la insuficiencia del LCA está sometido a criterios subjetivos y su sensibilidad es baja. La RM se ha convertido en el estándar en la evaluación no invasiva de las lesiones de rodilla. Es importante determinar el valor diagnóstico de la exploración clínica (EC) y resonancia magnética (RM) frente al patrón artroscopia en lesiones del LCA y conocer y precisar sus parámetros exploratorios objetivos.
Material y método: Se han revisado 101 H. Clínicas con las condiciones: EC-radiológica sospechosa de patología LCA, exploración protocolizada con test subjetivos/objetivos, RMN, EC objetiva bajo anestesia y artroscopia diagnóstica/terapéutica. Se seleccionaron datos epidemiológicos, tiempos desde la lesión del LCA hasta la cirugía, intervenciones previas sobre rodilla afecta, datos subjetivos, datos objetivos incluyendo artrometría, número de centros que realizaron la RM, número de RM por centro y observadores, y artroscopia.
Se ha realizado estudio estadístico comparando variables cuantitativas y cualitativas, precisión, fiabilidad y consistencia entre medidas.
Resultados: Respectivamente el 94%, el 100% y el 83% fueron diagnosticados mediante EC-sin-anestesia, con-anestesia y RM, con una sensibilidad del 94,06%, 100%, y 83,17%.
Discusión: La EC, con/sin-anestesia, diagnóstica más veces la insuficiencia del LCA que la RM. La RM diagnostica un número total mayor de lesiones concomitantes y detecta más lesiones del menisco externo. El test de Lachman y la artrometría son los métodos diagnósticos más significativos en la insuficiencia del LCA.

Introduction

Due to its location and biomechanics, the knee is the joint in our body that suffers most injuries[16,49] and, within the knee, the anterior cruciate ligament (ACL), whether in isolation or in combination.[7,12,39,49] Most patients attending a clinic with intra-articular pathology of the knee are male athletes in the second or third decade of life.[39,49] The natural course of undiagnosed ACL failure is instability and, in the longer term, early arthrosis. An early diagnosis is important since ligament repair techniques can achieve a return to normal in a high percentage of cases.

A suspected diagnosis of ACL lesions is based on a clinical examination (CE), functional assessment scales and/or arthrometrics, with MRI and arthroscopy being reserved for a definitive diagnosis. MRI has the advantage of being a non-invasive technique, does not require ionizing radiation and has become the diagnostic method of choice.[37] Many publications[13,37,41,42] have highlighted the low sensitivity and specificity of MRI and the fact that the presence of false positives and false negatives may lead us to take inappropriate therapeutic decisions.

Our experience indicates that the sequence of a suspicious case report, CE with Lachman's test (with/without anaesthesia) and arthrometry (with/without anaesthesia) leads to an early, effective and low-cost diagnosis of ACL lesions and allows the speedy choice of the appropriate treatment.

Material and method

We have reviewed 101 patients with clinical signs suggesting an ACL lesion. Mean age 29.65±10.43 years (max.: 57, min.: 16). Seventy-five patients (74.26%) were male and 26 (25.74%) female. The mean age in men was 30.28±10.54 years (max.: 57, min.: 16) and in women was 27.54±9.82 years (max.: 52, min.: 17). Sixty-five (64.36%) were sports-related lesions (mostly football: 30 cases [46.15% of sports lesions and 29.70% of all cases] and skiing: 14 patients [21.54% and 13.86% respectively]). In 36 patients (35.64%), the causes were not related with sports, mostly accidental falls in 24 cases (66.67% of non-sports lesions, 23.76% of all cases), followed by traffic accidents on 9 occasions (25.00% and 8.91% respectively).

The mean time between the date of the lesion and the arthroscopy was 957.96±1,601.71 days (max. 7,585 and min. 5). Thirty-one patients (30.69%) had previously undergone surgery for pathology in the knees: 25 patients (24.75%) on the knee affected (3 on two occasions) and 8 patients (7.90%) on the contralateral knee (1 on two occasions), 2 patients (1.98%) in both knees. The reasons for the prior surgery on the affected knee were: ACL pathology and meniscal tears in 3 cases (12%), diagnostic 3 (12%), 3 (12%) meniscectomies on two occasions, 14 (56.00%) were due to meniscectomy accompanied in one case by pathology in the medial ligament, 1 (4.00%) for a tear in the medial ligament and 1 (4.00%) through having previously presented a fracture of the tibial plateau. The mean time between the prior surgery and the diagnostic tests was 2,074.08±2,136.65 days, maximum 5,710 days, minimum 1 day. Seventeen patients (70.83%) said that they believed they had suffered the ACL lesion before the previous surgery and in 2 cases (11.76%) they were treated with surgery. Seven (29.16%) reported they had had the ACL lesion after the previous surgery and 1 of these (14.28%) after having undergone a previous ligamentoplasty. The mean time between the surgical action and the ACL lesion was 1,828±1,647.81 days

with a maximum of 3,987 and a minimum of 191 days. The degree of independence between the prior surgery and the ACL lesion is not significant with a χ^2 value of 69.92 with 1 degree of freedom and the χ^2 test=1.8151 E^{-21}.

All patients were subjected to a protocolized study with Lysholm's Test[28,29] and forms C (Kennedy LAD protocol) and D (Kennedy LADTM Examination Preop Protocol [without anaesthesia]), MRI examination and a protocolized CE under anaesthesia using Form E (Kennedy LADTM Examination Preop Protocol [with anaesthesia]) with the patient anaesthetized before and after the surgery.[24] Finally, a diagnostic/therapeutic arthroscopy was carried out. MRIs were performed at different radiological centres and reported by different radiologists. All of the arthroscopies were done by the same surgeon and the data obtained were recorded following a protocol.

The CE (Lachman's test plus arthrometry using a KT-1000®) was considered diagnostic for ACL failure if the anterior displacement of the tibia was greater with respect to the contralateral (Lachman's test) and the anterior displacement of the tibia was greater than 3 mm with respect to the contralateral using arthrometry (KT-1000®, without anaesthesia and with 67N, 89N, 134N and maximum manual pressure).

Results

All of them were diagnosed as having an ACL tear or failure in one knee (58 the right knee [57.43%] and 43 the left knee [42.86%]) and in most cases a arthroscopic ligamentoplasty was performed using homologous Achilles tendon strengthened with Kennedy LAD fibre (24).

Clinical study. The data obtained in the physical examination and the natural course of the lesions showed pathology in all patients (tables 1-9) with 92.63% reporting instability in Lysholm's test and 69.28% presenting some kind of instability reflected on form C. Only 4.35% mentioned stability on cut and pivot and 11.96% were stable when jumping. The most significant examination parameters in the diagnosis of ACL failure generated the following results:

Using Lachman's test, the results on the affected knee were without anaesthesia on the affected knee in 1 case (0.99%) the displacement was 0 mm, 4 (3.96%) equal to or less than 5 mm, 41 (40.59%) comprised between 5 and 10 mm, 54 (53.47%) equal to or more than 10 mm and it could not be obtained in one case (0.99%).

Table 1 Pain with daily-life activity (N=96)

	N	%
No	27	28.13
Only with some movements	21	21.88
Occasionally	31	32.29
Mild/continuous	8	8.33
Moderate/continuous	7	7.29
Severe/continuous	2	2.08
At rest/during the night /continuous	0	0.00

Table 2 Pain with athletic activity (N=94)

	N	%
Unable to compete	66	70.21
Only with some movements	14	14.89
In no case	5	5.32
Did not want to compete	4	4.26
During the activity. Execution affected	4	4.26
After or during activity	1	1.06

Table 3 Inflammation (N=96)

	N	%
No report	41	42.71
Only with some movements	30	31.25
Continuous	10	10.42
Occasional	6	6.25
With activities of daily life	6	6.25
After athletic activity	3	3.13

Table 4 Level of activity

	N	%
Unable to engage in sport	62	65.96
Sports activity 100% as before the lesion	11	11.70
Recreational sport	7	7.45
Unable to perform activities of daily life	7	7.45
Unable to work	5	5.32
Activity prior to the lesion less than 100%	2	2.13

Verification of homogeneity by application of Pearson's chi square (χ^2) test for Lachman's test between the affected and unaffected knee: χ^2=159.92, χ^2 test=1.9046 E^{-34}, highly significant (p=0.05). Under anaesthesia in the affected knee, the knee presents the following results: 2 (1.98%) equal to or less than 5 mm, 20 (19.80%) comprised between 5 and 10 mm, 79 (78.22%) equal to or more than 10 mm. Verification of homogeneity by χ^2 study and application of the χ^2 test for Lachman's test between the affected and unaffected knee: χ^2=164.24, χ^2 test=2.224 E^{-35}, highly significant (p=0.05). The verification of homogeneity between affected joints, with/without anaesthesia, for Lachman's test shows the following results: χ^2=13.5907843, χ^2 test=0.00351855, significant (p=0.05).

The examination data from the anterior drawer, for the affected knee without anaesthesia, were as follows: 1 case (0.99%) code 0, 9 cases (8.91%) code 1, 53 (52.48%) code 2 and 36 (35.64%) code 3. Verification of homogeneity by χ^2 study and application of the χ^2 test for the CAN test between the affected/unaffected knee: χ^2=138.30, χ^2 test=8.75 E^{-30}, highly significant (p=0.05). With anaesthesia in the knee, the results were as follows: 1 case (0.99%), 11 (10.89%), 37 (36.63%), 52 (51.49%) respectively. Verification of

Table 5 Instability

	Stable		Unstable		On moving		Don't even try	
	N	%	N	%	N	%	N	%
Cut. Pivot	4	4.35	7	7.61	34	36.96	47	51.09
Jump	11	11.96	11	11.96	17	18.48	53	57.61
Stops. Starts	16	17.39	17	18.48	10	10.87	49	53.26
Displacement on a flat surface	28	30.11	17	18.28	8	8.60	40	43.01
Displacement on an uneven surface	18	19.57	17	18.48	11	11.83	47	50.54
Stairs	58	61.70	25	26.60	8	8.51	3	3.19
Walking	66	70.21	23	24.47	4	4.26	1	1.06

Table 6 Comparison of function before/after the lesion

	Nº of cases	%
Less than 25%	27	28.72
Between 26%and 50%	45	47.87
Between 51%and 80%	22	23.40

Table 7 Sensation of loss

Sensation of loss (%)	Nº of cases	%
< 25	6	6.38
25	15	15.96
30	5	5.32
40	7	7.45
50	33	35.11
60	12	12.77
70	4	4.26
75	5	5.32
80	1	1.06

homogeneity by χ^2 study and application of the χ^2 test for the CAN test between the affected/unaffected knee: χ^2=136.94, χ^2=1.99 E^{-29}, highly significant (p=0.05). The verification of homogeneity between affected joints for the CAN test with and without anaesthesia shows the following results: χ^2=5.93412877, χ^2=0.11485934, significant (p=0.05).

Using the Pivot Shift Test, the results in the affected knee without anaesthesia were as follows: 4 patients (3.96%) code 0, 31 (30.69%) code 1, 46 (45.54%) code 3 and 10 (9.90%) code 4, in 10 (9.90%) it was not possible to perform the test. The verification of homogeneity by χ^2 study and application of the χ^2 test for the CAN test between the affected/unaffected knee was χ^2=145.062917, χ^2=3.0596 E^{-31}, highly significant (p=0.05). With anaesthesia in the affected knee, on the other hand, the results were: 2 patients (1.98%), 22 (21.78%), 39 (38.61%) and 38 (37.62%) code 3. Verification of homogeneity by χ^2 study and application of the χ^2 test for the CAN test between the affected/unaffected knee: χ^2=155.668864, χ^2=1.5767 E^{-33}, highly significant (p=0.05). The verification of homogeneity between affected joints for the CAN test with and without anaesthesia shows the following results: χ^2=18.6344884, χ^2=0.00032534, significant (p=0.05).

The data from anterior laxity tests obtained using KT-1000 arthrometry (67N, 89N, 134N and maximum manual displacement) were significant between the affected and the unaffected knee, both with and without anaesthesia and the comparison of means was significant (p<0.001 and p<0.01) (tables 10-13). The posterior laxity tests were not significant with or without anaesthesia. The presence of a drawer due to the active contraction of the quadriceps presented a significant comparison between means for p<0.001 (table 14).

On the basis of these data, 95 patients (94.06%) have been diagnosed as having ACL failure without anaesthesia and 101 (100%) under anaesthesia. There is a significant difference, by means of χ^2 (6.1836734) and the χ^2 test (0.012893), between the examination with/without anaesthesia.

The MRI examinations were performed in 26 different centres (mean of 3.88 per centre) and two of them were responsible for 53.47%(54) of the examinations, 32 (31.68%) in one and 22 (21.78%) in the other. The reports have been drafted by 35 different radiologists (2.97 tests per observer) and the maximum number of examinations reported by a single observer is 28 (27.72%).

Reports were submitted on 83 lesions of the ACL (82.18%), of these 62 (61.39%of the knees studied, 74.70%of the ACL alterations) were described as complete ruptures, 20 as partial (19.80%and 24.10%, respectively) and 1 (0.99%and 1.20%, respectively) as an elongation of the ACL.

Using arthroscopy, the presence of ACL alterations was confirmed in all patients, with 82 cases (81.19%) of total ruptures, 11 (10.89%) of complete ruptures adhering to the posterior cruciate ligament, 4 (3.96%) partial ruptures, 1 (0.99%) with ligament laxity and 3 (2.97%) lax anteriorly performed plasties.

The sensitivity of the CE for ACL was 94.06% without anaesthesia and 100%under anaesthesia. In both cases, the specificity does not generate a numerical value for the existence of true negative (TN) or false positive (FP) cases. A PPV of 100%was obtained with and without anaesthesia. NPV without anaesthesia 0%. The non-existence of TN prevented us from obtaining a numerical NPV. An IK of 0% was obtained with IO 94.06% and Ia 94.06% without anaesthesia and it has not been possible to obtain any

Table 8 Evaluation of jump. Comparison between unaffected and affected knees

	Knee not affected				Knee affected			
	1st jump	2nd jump	3rd jump	Sum	1st jump	2nd jump	3rd jump	Sum
Mean	133.53	138.55	141.33	411.46	107.09	110.64	110.52	326.49
N	57.00	53.00	52.00	52.00	57.00	53.00	52.00	52.00
Maximum	230.00	220.00	220.00	670.00	208.00	205.00	215.00	628.00
Minimum	71.00	72.00	69.00	212.00	0.00	0.00	0.00	0.00
Standard deviation	31.05	30.62	30.69	86.45	43.24	43.13	46.89	124.80

Table 9 Difference between jumps

	1st jump	2nd jump	3rd jump	Sum
Difference between means	26.43	27.90	30.80	84.97
Difference between maximums	22	15	5	42
Difference between minimums	71	72	69	212

numerical value for IK as there were no TN, FN or FP cases, giving an IO of 100% and Ia of 100%. The following values were obtained for sensitivity, specificity, PPV, NPV, IO and Ia for MRI: ACL sensitivity 83.17% and nil specificity as no TN case was found, PPV 100% and NPV 0%. IK for ACL lesions was 83.17% with con IO and Ia 83.17%.

Discussion

The series presents a greater incidence in the male sex (75 patients [74.26%]), ages under 30 years (61 cases [61.61%]) and a predominance of sports-related lesions (65 cases [64.36%]), with football the most frequent (30 cases [46.15%]) followed by skiing (14 cases corresponding to 21.54%), similar to other studies.[3,38,39,43] Twenty-five patients (24.75%) presented with previous surgical treatments on the same knee, mainly due to presenting meniscal alterations, and it cannot be stated that such surgery has favoured the subsequent ACL pathology as shown by the χ^2 test. It is noteworthy that the presence of a meniscal lesion diminishes stability[18,27,49] and alters the transmission of weight[22,48-50] which might facilitate the alteration in the ACL, although it may also happen that the alteration in the ACL occurs at the same time as the meniscal lesion. The sample shows a high interval between the date of the lesion and the diagnosis, which may be due to the fact that most of them are not high-level athletes, a failure to detect the lesions or else the large number of patients with chronic ACL lesions indicates a high index of failures through non-surgical treatments.[19,33]

There is no significant difference between the number of lesions found in the right or left knee although the lesions on the right predominate.

Instability is the main symptom for suspecting ligament failure but its presentation is highly variable, even in patients diagnosed by arthroscopy who have had conservative treatment10. Using Lysholm's test, 92.63% of the patients reported instability and 69.28%±23.52% did so on form C, similar to values in other series[12] (χ^2=0.981, a=0.95). Many of these patients may practise high-level competitive sport even with their insufficient ligament without requiring surgical stabilization.[16,48,33,40,49] Among the 7.37% of patients reporting complete stability in Lysholm's test and on form C, we found only 4.35% of patients reporting stability on cut and pivot and 11.96% were stable in the jump. These results are lower than in other series, which may be due to the long interval between date on which the lesion occurred and that of the diagnostic study; in addition, some of them knew their diagnosis or reported a feeling of lesion, which may have constrained their statements.[10] A vast majority reported loss of activity, loss of function and a feeling of lesion as shown in the various sections of the Lysholm's test and form C.

This is a consequence of the joint's instability since patients demand a normal level of activity of their knee and it may fail.[10] No significant differences were found on examination in the medial or lateral laxity (at 0° or at 30°) with or without anaesthesia or between the affected and unaffected leg, the incidence is minimal and coincides with the association of acute pathology, particularly in the medial ligament.

In Lachman's test, the difference between the affected and unaffected knee is significant both with and without anaesthesia as shown by the verification of homogeneity using χ^2, this corroborates the need to perform Lachman's test in both knees.[17,45,46] Significant displacements were seen in 94.06% of patients in the anaesthesia-free test, a higher result than that obtained in other studies[8,9,17,25] with an incidence of around 85%. The 100% result under anaesthesia is similar to that obtained in other series.[8,9,17] The verification of homogeneity using χ^2 (0.14) and the χ^2 test (0.98, a=0.050) in relation to prior studies by Gómez-Castresana et al.[14] without anaesthesia show no significant differences, although the present series is displaced to the right. Lachman's test, with or without anaesthesia, presents a larger number of cases in the affected knee and assessment codes with higher scores. This test has been described as the most reliable clinical method for diagnosis of ACL integrity,[15] superior to the other diagnostic manoeuvres with or without anaesthesia.[8,9]

In the CAN test, a significant difference was found between the affected and the unaffected knee both with

Table 10 Arthrometry. KT-1000. Anterior test at 67N and 89N. Without anaesthesia

	Anterior 67N			Anterior 89N		
	Not affected	Affected	Difference	Not affected	Affected	Difference
N. R.	2	2		2	2	
N	99	99		99	99	
Mean	6.69 mm	10.68 mm	3.98 mm	7.68 mm	12.29 mm	4.61 mm
Std. Dev.	2.20 mm	2.42 mm	2.70 mm	2.25 mm	2.61 mm	2.87 mm
Maximum	12.00 mm	15.00 mm	10.00 mm	14.00 mm	18.00 mm	11.00 mm
Minimum	3.00 mm	4.00 mm	—4.00 mm	4.00 mm	5.00 mm	—4.00 mm
Nº of cases with inverted values			6			6

Table 11 Arthrometry. KT-1000. Anterior test at 134N and MDM. Without anaesthesia

	Anterior 134N			Anterior MDM		
	Not affected	Affected	Difference	Not affected	Affected	Difference
N.R.	2	2		6	6	
N	99	99		95	95	
Mean	8.93 mm	14.56 mm	5.68 mm	13.07 mm	18.05 mm	4.97 mm
Std. Dev.	2.44 mm	2.81 mm	2.99 mm	2.81 mm	3.05 mm	3.24 mm
Maximum	17.00 mm	20.00 mm	12.00 mm	21.00 mm	25.00 mm	14.00 mm
Minimum	4.50 mm	6.00 mm	—4.00 mm	5.00 mm	12.00 mm	—4.00 mm
Nº of cases with inverted values			5			4

Table 12 Arthrometry. KT-1000. Anterior test at 67N and 89N. With anaesthesia

	Anterior 67N			Anterior 89N		
	Not affected	Affected	Difference	Not affected	Affected	Difference
N.R.	0	0		0	0	
N	101	101		101	101	
Mean	6.43 mm	11.87 mm	5.44 mm	7.36 mm	13.38 mm	6.02 mm
Std. Dev.	2.04 mm	2.54 mm	2.54 mm	2.13 mm	2.74 mm	2.69 mm
Maximum	14.00 mm	19.00 mm	12.00 mm	15.00 mm	20.00 mm	12.00 mm
Minimum	3.00 mm	5.00 mm	0.00 mm	3.5 mm	6.00 mm	0.00 mm
Nº of cases with inverted values			0			0

Table 13 Arthrometry. KT-1000. Anterior test at 134N and MDM. With anaesthesia

	Anterior 134N			Anterior MDM		
	Not affected	Affected	Difference	Not affected	Affected	Difference
N.R.	0	0		0	0	
N	101	101	101	101	101	101
Mean	8.43 mm	15.48 mm	7.04 mm	12.68 mm	19.51 mm	6.83 mm
Std. Dev.	2.34 mm	3.06 mm	3.07 mm	2.55 mm	3.23 mm	3.15 mm
Maximum	18.00 mm	23.00 mm	15.00 mm	22.00 mm	29.00 mm	13.00 mm
Minimum	4.00 mm	7.00 mm	—2.00 mm	7.00 mm	10.00 mm	—4.00
Nº of cases with inverted values			1			2

Table 14 Arthrometry. KT-1000. Drawer with active quadriceps

Not affected	Affected	Difference
4	4	
97	97	
5.89 mm	8.80 mm	2.91 mm
2.01 mm	2.30 mm	2.44 mm
11.00 mm	15.00 mm	11.00 mm
2.00	3.00 mm	—2.00 mm 5

and without anaesthesia, and there is significant displacement to the right when performed under anaesthesia as shown by the verification of homogeneity (χ^2 test, a=0.050). The sample presents a deviation to the right with respect to previous studies without anaesthesia[14] (a=0.050, χ^2=12.93, χ^2 test=0.004) and in the Lachman's test. The absence of positive tests is connected with the presence of acute ACL lesions hindering its performance, producing false negatives because of pain, haemarthros, muscular defensive reaction[25] and tears in which the ACL adheres to the PCL. It must be recalled that the conservation of the anteromedial fascia in partial ruptures may prevent the CAN test; the posterolateral fasciculus may prevent Lachman's test.

In the Pivot Shift test, the differences between the affected and unaffected knee are significant both with and without anaesthesia. In addition, there are significant differences between the affected knee with or without anaesthesia as shown by the χ^2 test and the homogeneity test using distribution of χ^2 (a=0.050). In connection with the study without anaesthesia by Gómez-Castresana,[14] there is a significant difference, with χ^2=0.03 and χ^2 distribution=8.40 [a=0.050]). This increase in encoding in Lachman's, CAN and Pivot tests in comparison with a previous study may be due to greater expertise by the observer, as indicated by Anderson1.

In the arthrometry with KT-1000, it was seen that the mean displacement value at 67N found in the sample of healthy knees is 6.69±2.20 mm. There is a significant difference (p<0.001) with the study by Myrer[31] conducted with KT-2000. There is no significant difference between the examination with and without anaesthesia. The mean in the affected knee is 10.68±2.42 mm, with a significant difference compared to the contralateral knee (mean difference of 3.98±2.70 mm). The presence of FN may be due to reflex muscle contracture[49] or to the percentage of cases in which the displacement of the normal knee exceeds that of the pathological knee as reported by King.[26] The FN cases disappear when the examination is carried out under anaesthesia. The difference between the methods is significant with an increase of 10.1% with respect to the anaesthesia-free examination, figures similar to other studies[20]

At 89N, the mean displacement ion the unaffected knee is 7.68±2.25 mm without anaesthesia and 7.36±2.13 mm with anaesthesia, figures similar to other series[4-6,20,21,30] with the comparison of means being almost significant (p<0.1) and greater than those obtained by Myrer[31] and Daniel[5] with KT-2000. In the affected knee we have found a mean displacement of 12.29±2.61 mm without anaesthesia and 13.38±2.74 mm with anaesthesia versus 11.4±2.9 mm obtained by Daniel[6] and similar to that obtained by Gómez-Castresana (6.01±0.29)[14] without finding any significant difference between the two studies (pro=0.98); the difference between the affected and unaffected knee was 4.61±2.87 mm without anaesthesia and 6.02±2.69 mm under anaesthesia and these values were significant (p<0.01 and p<0.001).

At 134N, in the unaffected knee, the mean displacement obtained by Myrer[31] using an KT-2000 arthrometer was 7.08±1.98 mm, lower than in our sample (8.93±2.44 mm without anaesthesia and 8.43±2.34 mm with anaesthesia), whereas Paccini[34] reflected values of less than 2 mm in 62.79% of the examinations and only reported values in excess of 5.1 mm in 6.98%. The affected knee presented displacements of 14.56±2.81 mm without anaesthesia and 15.48±3.06 mm under anaesthesia, with a significant difference (5.63±2.99 mm without anaesthesia and 7.04±3.07 mm with anaesthesia) in connection with the contralateral knee (p<0.01 and p<0.001, respectively).

Using MDM, Myrer[31] presented a mean of 8.01±1.94 mm in healthy knees, less than that reflected in this study both with and without anaesthesia (12.68±2.55 mm and 13.07±2.81 mm, respectively). The difference between the two is significant for both the affected and unaffected knees, regardless of whether or not it is performed under anaesthesia (p<0.01 and p<0.001).

The values obtained during the drawer manoeuvre due to active contraction of the quadriceps have been significant (p<0.001). The presence of FN may be due to reflex muscle contraction,[11] the percentage of cases in which the displacement of the normal knee exceeds that of the pathological one,[26] the inclusion of acute and sub-acute cases, a difference between observers, and the model of arthrometer.

There are no significant differences at the patellar level or in the leg diameter, but the same did not happen 10 cm above the patella where the difference was 1.55±1.30 cm. Quadricipital atrophy is a constant and is an easy datum to quantify.[12]

The number of patients with antialgic flexion is not significant, an expected result as most patients present chronic lesions.[1] This symptom diminished when the examination was conducted under anaesthesia, coinciding with the theory that the reflex muscle contraction is the main party responsible for the diagnostic difficulty of ACL failure.[11]

Of some significance is the presence of hyperextension in 41.58% of patients without anaesthesia as well as its increase in examinations under anaesthesia (44.55%) (p<0.01) so we have to evaluate the presence of hyperextension and ACL pathology.

There is a significant reduction in the joint movement arch (p<0.001), both with and without anaesthesia, related with pain and joint effusion, present in 54.46% of patients.

There are other alterations following the chronic alteration of the ACL at patellar level, as shown by the presence of grinding in 19.80% of patients, pain on patellar pressure in 18.81%, pain in the patellar joint facets (12.87% medial, 13.86% lateral) or at the femoral or inter-articular level (37.62% medial, 12.87% lateral). The association of cartilaginous lesions varies depending on the literature reviewed[10,23,39] but they all coincide in the increase in chondral lesions in chronic

ACL lesions. There is a frequent association with meniscal alterations[9,23,32,39] which also increases over time.[23]

The diagnosis of ACL lesions presents varying degrees of sensitivity, specificity, PPV, NPV and IK depending on whether the diagnosis is reached using physical examination or MRI. Unlike what is reflected in other studies,[6,11] we found a high sensitivity for CE when assessing ACL failure, with or without anaesthesia (94.06% without anaesthesia and 100% under anaesthesia). In the CE without anaesthesia, the sensitivity obtained is less than that reported by Rose37 and is similar to that found by Gelb,[13] whereas under anaesthesia the result can be superimposed on the values found by both investigators.[13,37]

The sensitivity found using MRI was 83.17%, less than in other series[13,37,42] that report a sensitivity in excess of 90% and similar to that presented by Sanfeliú (83%). The sensitivity values for MRI are lower than those found for CE in all cases.[13,37,41,42] The sensitivity of diagnosis in ACL failure through CE is greater than that obtained using MRI,[13,37,41] indicating that physical examination is more effective in the diagnosis of ACL failure than MRI both in this study and in previous ones. We must bear in mind that the observer's experience and ability to perceive the results are decisive in reaching a diagnosis by either method.

It is not possible to determine the specificity value for CE or for MRI. The lack of TN and FP leads to the impossibility of obtaining a numerical value. But this does not mean that the CE is incapable of ruling out the presence of ACL alterations. Gelb[13] and Rose[37] have presented papers in which the specificity ranges from 99% to 100% for CE or in MRI whereas other studies show a specificity between 88% and 100%.[13,37,41,42] It is worth noting that the specificity found for CE is greater than that obtained for MRI in all cases[13,37] except for the study by Sanfeliú[41] who reported a specificity of 100% for diagnosis of ACL alterations using MRI but did not provide any data on CE.

CE shows a PPV of 100% for ACL, in the examination both with and without anaesthesia; this is similar to the result obtained by Gelb[13] and greater than that of Rose.[37] For MRI, the PPV in this series is 100%, higher than those achieved by Fischer (42% to 85%),[44] Schweitzer (80.04%),[42] Gelb (90%)[13] and Rose (93%),[37] and the same as Sanfeliú (100%).[41] In all the papers, PPV is greater for the physical examination than for MRI and in both cases is greater than 90%

The PPV for anaesthesia-free CE is 0% and it has not been possible to obtain a value under anaesthesia due to the lack of TN and FP. On the other hand, Rose[37] and Gelb[13] provide values of 100%. The PPV for MRI is 0%, as in CE, also due to the absence of true negatives. This result shows a clear discrepancy with the values obtained by Gelb (100%),[13] Rose (99%),[37] Sanfeliú (91%)[41] and Schweitzer (95.8%).[42]

It is possible that obtaining such positive statistic values, in the case of CE, may be due to the presence of clearly specific clinical signs[10] and the absence of any cases with total or partial rupture of the cruciate ligaments hidden by an intact sinovial membrane.[2,35,36,47] The differences found with other studies may be due to the characteristics of the sampling.

The IO results (index for observed agreement) and the Ia results (index of agreement due to random chance) are identical, in examination both with and without anaesthesia, and these generate an IK (Kappa Index) of 0 in the first case and a non-assessable value in the second case. One of the limitations of this index is that its value changes depending on the prevalence of the condition and that in the case of extreme values, whether they are very low or very high, the index tends to diminish. For MRI, the IK value obtained for ACL is 0 as Ia and IO are the same, as in the case of CE.

Conclusions

A complete, correct anamnesis helps in the effective study and diagnosis of patients with ACL failure, highlighting the functional importance of the different clinical findings in an unstable knee. Suspected ACL failure following careful anamnesis must lead to the patient's inclusion in a protocol-led study including assessment scales, an adequate CE including Lachman's test, CAN, Pivot Shift and the corresponding arthrometric evaluation. The CAN, Lachman and Pivot Shift manoeuvres and the arthrometry allow a reliable diagnosis of ACL failure and may be complemented by performance under anaesthesia so as to avoid reflex muscle contraction, responsible for the diagnostic difficulty of the ACL failure. The execution of the arthrometry must be considered in a standardized way. Lachman's test as a clinical sign of ACL lesion and arthrometry are the most significant diagnostic methods. Whether or not under anaesthesia, the CE has a greater diagnostic ability for ACL failure than examination using MRI.

MRI is not the method of choice in the diagnosis of ACL lesions but it may be used in patients with non-specific and/or chronic complaints following an examination that neither rules out nor confirms the presence of ACL failure in high-level competitive athletes requiring immediate diagnosis or confirmation of the same and in high-risk surgical patients or with difficulty for conducting the clinical examination.

Arthroscopy must be considered within the therapeutic arsenal and not as a means to reach a diagnosis, except in the case of persistence of a sensation of instability in the presence of negative CE and MRI. The term diagnostic arthroscopy should be eradicated from the assessment of ACL failure.

Conflict of interest

The authors have declared they have no conflict of interest.

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