Arthroscopic Findings in Children's and Adolescents' Knees

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Purpose. To perform a retrospective statistical study on knee arthroscopies performed on children and adolescents under the age of 18 by the same surgeon over an 8-year period.

Materials and methods. Between 1996 and 2003 53 knee arthroscopies were performed on youths under 18 by the same surgeon in a public hospital. We analyzed the patients' demographic characteristics (gender, age, etiology, clinical status) as well as the arthroscopic findings and the treatment indicated.

Results. The most usual pathology in our series was meniscal injury (there were 25 meniscal tears, which accounts for 47% of arthroscopic findings). The second most frequent condition was chondral or osteochondral pathology (26 cases), followed by ligamentous injuries (19) and synovial pathology (5). The correlation rate between presumptive diagnosis and final confirmation was 79.23%.

Discussion and conclusions. Knee conditions are one of the most frequent reasons medical consultation. The advent of MRi has meant an improvement in the diagnosis of injuries in the young and adolescent population, but many errors are still committed when making presumptive diagnosis. Arthroscopy is a safe and reliable method for diagnosing and treating a wide range of injuries that affect the young population.

Key words: *endoscopy, arthroscopy, knee, child.*

Hallazgos artroscópicos en rodillas de niños y adolescentes

Objetivo. Realizar un estudio estadístico retrospectivo sobre las artroscopias de rodilla realizadas en niños y adolescentes de menos de 18 años por un mismo cirujano durante un período de 8 años.

Material y método. Entre 1996 y 2003 fueron realizadas 53 artroscopias de rodilla en jóvenes de menos de 18 años por un mismo cirujano en un hospital de la red pública. Analizamos las características demográficas de los pacientes (sexo, edad, etiología, clínica), los hallazgos artroscópicos y el tratamiento realizado.

Resultados. La patología más frecuentemente hallada en nuestra serie fue la lesión meniscal (25 roturas meniscales, lo que supone el 47% de los hallazgos artroscópicos); le siguen la patología condral u osteocondral (26), lesiones ligamentosas (19) y patología sinovial (5). La correlación entre el diagnóstico de presunción y hallazgo definitivo se situó en el 79,23%.

Discusión y conclusiones. La patología de rodilla es uno de los motivos de consulta más frecuentes. La introducción de la resonancia magnética nuclear ha supuesto un avance en el diagnóstico de las lesiones en la población infantil y adolescente, pero aún persiste un alto porcentaje de diagnósticos de presunción erróneos. La artroscopia constituye un método fiable y seguro en el diagnóstico y tratamiento de una gran variedad de lesiones en la población joven.

Palabras clave: *endoscopia, artroscopia, rodilla, niño.*

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Since the introduction of arthroscopic techniques for the knee in the 1960's, this procedure has become one of the most usual ones in Spanish public hospitals. The diagnostic value of these techniques as well as the sheer amount of treatment possibilities it offers have made it a safe and efficient method for treating numerous conditions.

The number of children and adolescents that take up sports or enter some sort of sporting competition has in-

creased in the last few years, which has in turn led to an increase in the number of arthroscopic procedures performed in younger patients[1]. The vagueness with which children tend to report their symptoms and their typical unwillingness to collaborate in their physical examination normally make it impossible in most cases to determine the mechanism of injury, which results in the need to perform a nuclear magnetic resonance (NMRi), for which patients have to be administered general anesthesia. All of these are obstacles that need to be overcome when it comes to diagnosis and treating the different pathologies.

Arthroscopy had contributed to overcoming this barrier and has provided us with a reliable method to diagnose and treat a large number of conditions, most of which remained unresolved in the past. But this development has also revealed the low correlation that exists between a presumptive diagnosis and the actual findings, with a range of discrepancy that goes from 36 to as much as 73% in the series consulted[2-4]. This should obviously put us on our guard whenever we are confronted with a potential lesion in a child's knee.

We reviewed 53 arthroscopies in children under 18 years of age, carried out in our hospital over an 8-year period by a single surgeon in order to analyze etiology, symptoms, findings, treatment performed and results obtained.

MATERIALS AND METHODS

We retrospectively analyzed 53 arthroscopies carried out in our center by a single surgeon over the period between January 1996 and December 2003. The equipment used for these procedures was the same one used for adult procedures, i.e. 4 mm scopes at a 30° angle. General anesthesia was used in 18 cases (34%), whereas in 35 patients (66%) local/regional anesthesia was employed. Mean hospitalization was 3.64 days (range: 1-19 days), with minimum hospitalization time being 1 day as an outpatient surgery clinic was unavailable at the time of the study. Mean post-op follow-up was 1 year (range: 6-36 months).

Sex distribution was 33 males (62.26%) and 20 females (37.74%). The operated knee was the left one in 21 patients (39.62%) and the left one in 32 (60.38%). Mean age was 15.43 years (range: 11-17), with 6 patients of 13 years of age or less (11.32%) and 47 patients over 13 and younger than 17 (88.68%) (Fig. 1).

Etiology (Figs. 2A and B) was traumatic in 42 patients (79.25%) and non-traumatic in 11 (20.75%). Among the traumatic lesions the most frequent ones were those resulting from sports activities, a total of 26 cases in our series

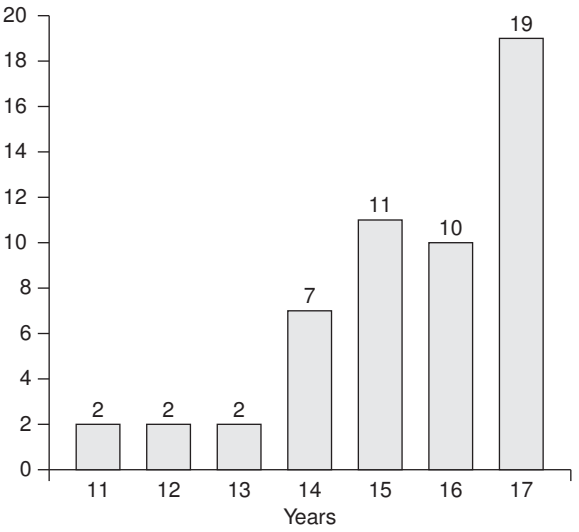

Figure 1. *Age distribution/Years.*

(61.9%). The type of sport most commonly involved was soccer, with 13 cases (30.95%), followed by basketball with (11.9%). Other sports were handball, volleyball, skate-boarding, hockey, rugby and aerobics. The second most frequent cause for a traumatic etiology was fortuitous injuries with 9 knees involved (21.42%). Road accidents accounted occupied the third position with 7 cases (16.66%), 4 of them resulting from a motorcycle fall, 2 from a bicycle fall and one from being run over by a motor vehicle.

Etiology was considered non traumatic in those patients for whom there was no known previous trauma that could have triggered the symptoms and who did not play sports on a regular basis. Pain was the predominant symptom in 10 of these non-traumatic knees (90.91%), followed by inflammation in 4 (36.36%), the feeling that the knee might fail in 3, and knee blocks in 3 (27.27%). Other symptoms were stiffness, tumors and snapping noise.

If we consider the global symptoms of all knees analyzed, in spite of the fact that their specificity is low, they are sometimes downplayed and the knee pain is at times secondary to a hip condition, the most frequent symptom was pain, present in by 36 patients (67.92%), followed by 21 knee blocks (39.62%), 11 reports of instability (20.75%), and 9 inflammatory episodes (16.98%) (Fig. 3).

The most frequent finding further to clinical examination (Fig. 4) was joint-line pain in 21 cases (39.62%). Pain in other locations like the femoral condyles (6 patients, 11.32%) or the patella (4 patients, 7.55%) was found less often. One of the latter showed a tilted low-riding patella with a positive apprehension sign. In two patients the pain originated in the lateral tibial plateau.

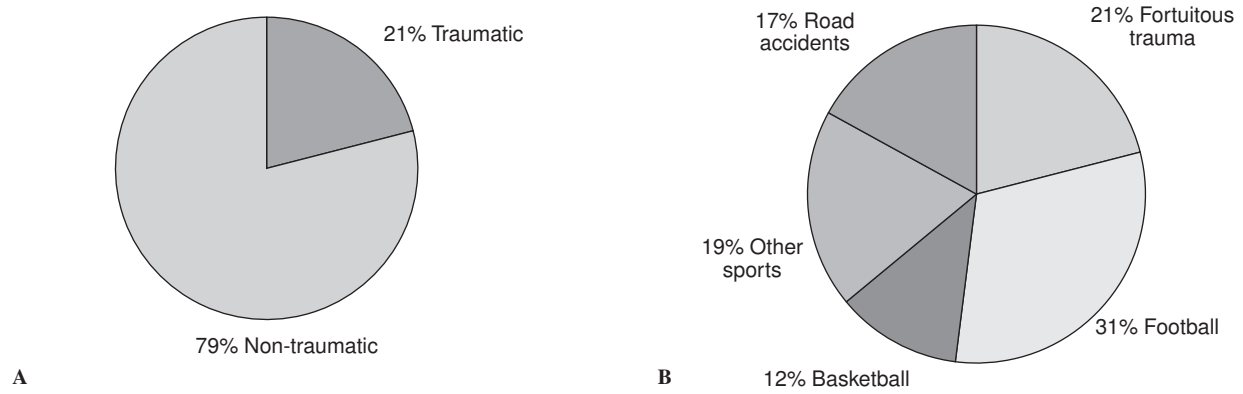

Figure 2. *(A) Traumatic/ non-traumatic etiology. (B) Causes for a traumatic etiology.*

Positive meniscal maneuvers (McMurray) were the clinical sign that patients responded to most frequently (16 knees, 30.19%). Another frequent finding during patient assessment was a flexion or extension deficit (15 cases in total, 28.30%). A certain degree of muscle atrophy was also quite usual (14 symptomatic knees, 26.42%). A clinical diagnosis of anterior instability by means of the Lachman and Pívot maneuvers was made in 12 patients (22.64%). Unequivocal inflammatory sings were observed in 7 cases (13.21%), whereas in 5 knees (9.43%) arthrocentesis was performed and serosanguineous fluid obtained in all cases. In 4 subjects a positive valgus stress test was obtained, which was never the main symptom but a secondary one. One patient that had sustained a direct high-energy trauma showed on exploration a significant valgus deformity of the knee that was painful to immobi-

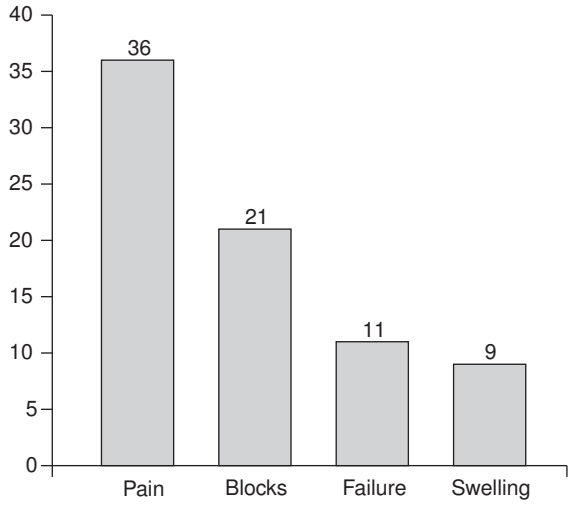

Figure 3. *Symptoms at presentation in this series*

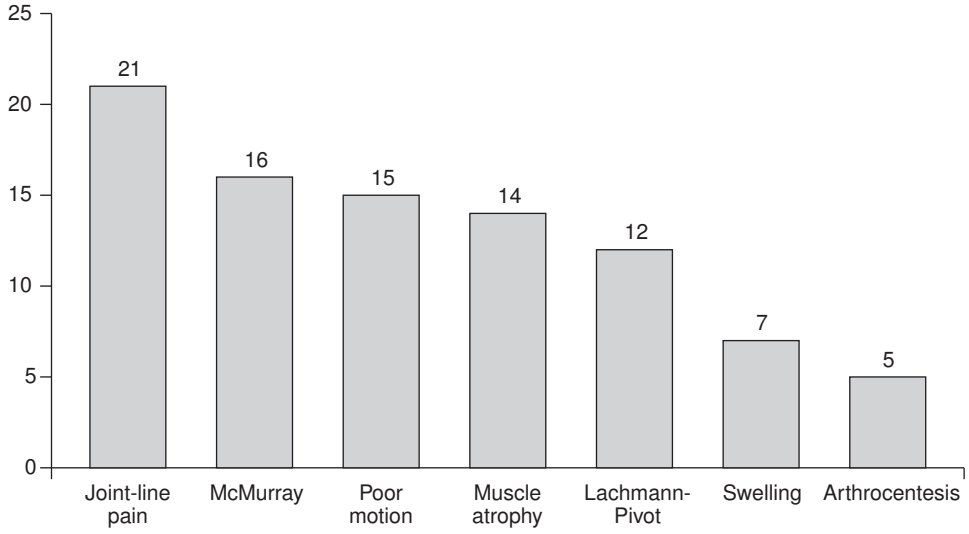

Figure 4. *Clinical signs in this study.*

lization and to palpation of the medial plateau; after an x-ray study a fracture was diagnosed with subsidence of the lateral tibial plateau.

Supplementary tests used included a basic x-ray workup (A/P, lateral and an axial patellar film) and NMRi. In selected cases a bone CT-scan (2 cases) and a knee ultrasound were performed. Plain films showed the following findings (Fig. 5):

1. Five cases of osteochondritis dissecans (OD) in the medial femoral condyle.

2. Two cases of OD in the lateral femoral condyle femoral.

3. Five instances of an intra-articular loose body.

4. Four tibial spine fracture-avulsions, one of which was an old fracture and another was associated to an undisplaced subsidence-facture of the medial tibial plateau.

5. Three tibial plateau fractures, 2 of them involving the lateral tibial plateau and one the medial one.

On the other hand, the main findings obtained through NMRi were as follows (fig. 6):

1. Eleven medial meniscal tears.

2. Six lateral meniscal tears.

3. Ten cases of OD, 5 of them in the medial condyle (3 with signs of instability and 2 stable ones) and another 5 in the lateral condyle, all of them stable.

4. Complete anterior cruciate ligament (ACL) tears were detected in 7 cases, whereas 6 patients showed partial tears or sprains.

5. Nine cartilage injuries.

6. Six cases of bone contusion (5 femoral and 1 tibial).

7. Three intra-articular loose bodies.

8. Three discoid lateral menisci, one of hem torn.

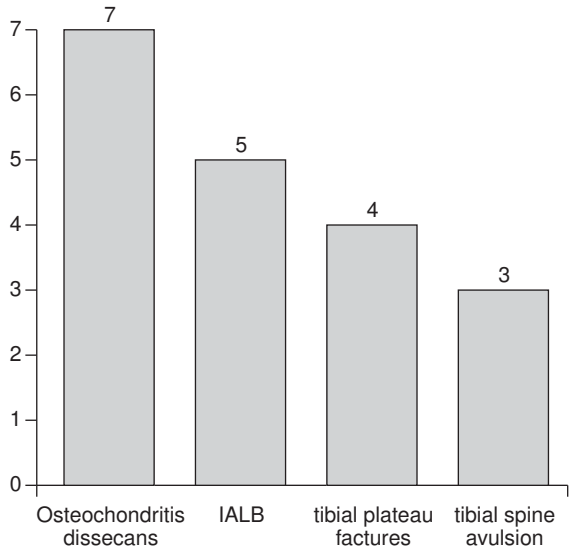

Figure 5. *X-ray findings. IALB: intra-articular loose body.*

The two cases in which a CT-scan was performed were two tibial plateau fractures, one lateral and one medial, where this imaging technique was requested after the x-ray workup in order to decide between surgical and orthopedic treatment. In one case a knee ultrasound was requested as the knee was painful with obvious clinical signs and an NMRi was out of the question. The diagnosis was a possible lateral meniscal tear.

The indication of operating a child's or an adolescent's knee is not straightforward with several algorithms having been proposed[5,6]. The intensity of symptoms was assessed

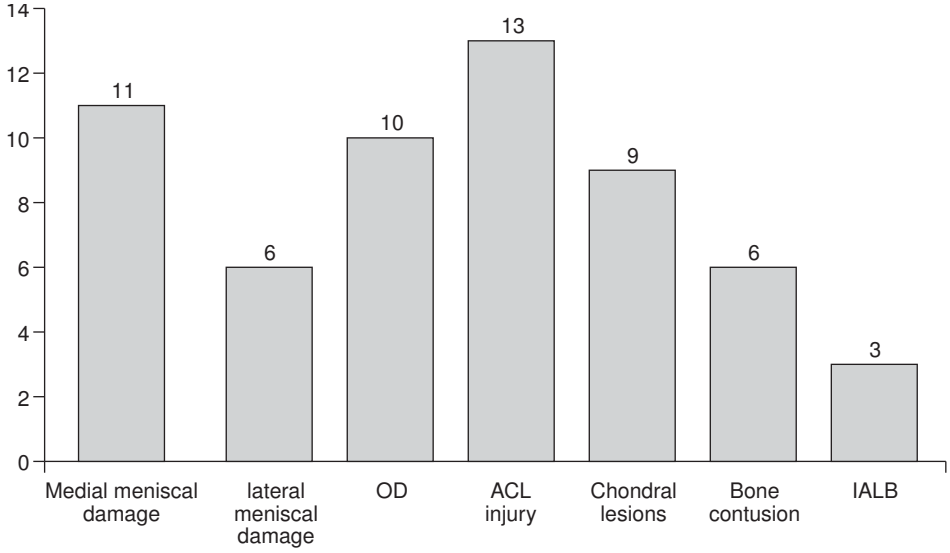

Figure 6. *NMRi findings. IALB: intra-articular loose body; ACL: anterior cruciate ligament; OD: osteochondritis dissecans.*

as well as their evolution, in the exploratory findings and in any supplementary tests performed (chiefly radiographs and NMRi).

As a general rule, no emergency arthroscopies were performed, except in the cases of disabling meniscal fractures or blocks. The procedures were deferred 4-6 weeks on average, during which time supplementary tests were carried out for those patients who needed them and a careful monitoring of symptoms was performed with a surgical indication being established for those patients who showed no improvement after 4-6 weeks of conservative treatment.

RESULTS

Meniscal pathology was, by far, the most frequent in our series with 25 lesions (47.16%). Medial and medial meniscopathies had a similar incidence (13 and 12 lesions respectively). The most usual tears were bucket handle tears (10), followed by peripheral tears (8), two of them in discoid menisci, parrot beak tears (3), 2 horizontal tears, one radial and one transverse one. The treatment performed generally consisted in a partial meniscectomy, except for two patients were a suture was performed with resorbable PDS-type material.

ACL injuries were found in 19 patients, 13 of which were complete tears where 6 were partial tears or sprains. Artrhoscopic ligamentoplasty was performed in 7 patients with 4 (patellar) bone-tendon-bone (BTB) autograft, 2 BTB allografts and one ligamentoplasty with a four-strand plasty of the pes anserine tendons. A case of a detachment of the ACL from its tibial insertion was addressed by fixation by means o an Asnis type III cannulated screw. In cases without manifest clinical instability it was decided to wait until the end of the growth period to carry out the surgical correction.

Ten arthroscopic procedures were performed in patients for whom an NMRi OD diagnosis was made; the initial diagnosis was correlated with the arthroscopic finding in all cases. The 5 lateral condylar lesions were considered stable lesions on the basis of the images obtained, although at surgery instability signs were observed in three cases. Of the medial condyle osteochondrites, three were instable and two stable, which coincided with the findings of the diagnostic study. Treatment in cases with instability consisted in Pridie drilling in 3 patients, two excisions of loose fragments with a posterior regularization and one instance of a fragment fixation with cannulated screws.

Sixteen knees showed signs of chondral pathology, which in 9 of them was found in the femoral condyles (6 in the medial condyle and 3 in the lateral one) and in 7 in the patella; one in of the cases both sites were involved. Five cases were osteochondral fractures (3 in the medial patellar aspect and 2 in the lateral femoral condyle). The degree of involvement was variable, with 9 grade I lesions (5 condylar and 4 patellar) and 7 grade II ones (5 condylar and 2 patellar), without any grade III or IV lesions being observed.

Treatment included shaving (9 cases) and excision of unstable lesions (4) cases. In the three remaining cases no arthroscopic therapy was provided. Five arthroscopies with a previous intra-articular loose body diagnosis were performed, all of them showing loose cartilage fragments, which were excised. All symptoms evolved satisfactorily.

We used arthroscopy to view the knee joint in 4 instances of tibial spine avulsion. In two of them undisplaced stable fractures were observed, one of them associated to a tibial plateau fracture, that did not require any sort of fixation. One of the cases was an old slightly displaced avulsion that was also stable at the time of surgery so it did not require stabilization. Only in one case did we observe an avulsion with displaced fragments, which was synthesized by means of cannulated screws. In three tibial plateau fractures, two lateral and one medial, we used arthroscopy to monitor the reduction of the joint surface; one of the cases required approaching the site to achieve reduction, place he graft and fixate the fracture.

Unexpected findings included 3 discoid menisci, all of them lateral and full-blown according to Watanabe's classification[7], in cases that had not been subjected to a NMRi; two of them showed a bucket handle tear that required a partial meniscectomy.

We only operated 4 knees with a synovial pathology. Two of them were instances of unspecific hypertrophic synovitis that required an arthroscopic synovectomy. Simples were taken to the pathology lab, which confirmed a diagnosis of pigmented villonodular synovfitis. The remaining two operations corresponded to a pathological synovial plica at the lateral recess where we performed a surgical release that led to an improvement of the symptoms in both cases.

In one single case we used arthroplasty to perform an arthrolysis: it was an instance of knee stiffness brought about by a patellar fracture sustained one year before and treated surgically with cerclage wiring which in the immediate post-op evolved into what was construed as septic arthritis although the causative germ could not be isolated in any of the samples taken. The patient's joint balance ranged between –10° to 85° intraoperatively and between 0° and 120° posoperatively. Subsequently the patient lost 10°, which means that his final joint balance

Table 1. Arthroscopic findings

	Number	Percentage
Medial meniscus	13	24.52%
Lateral meniscus	12	22.64%
ACL	19	35.84%
Osteochondritis dissecans	10	18.86%
Chondral lesions	16	30.18%
IALB	5	9.43%
Synovial pathology	4	7.54%
Spine avulsion	4	7.54%
Plateau fractures	3	5.66%
Arthrolysis	1	1.88%
No lesion	2	3.77%

IALB: intra-articular loose body; ACL: anterior cruciate ligament.

was 0°-110°. In two cases of painful knees with no specific clinical signs no arthroscopic findings were obtained (Table 1).

DISCUSSION

In children's and adolescents' knees, characterized by open growth plates, highly spongy metaphyseal bone tissue and weak cortices, thick cartilage, lax menisco-ligamentous structures and a greater tissue regeneration potential, injuries tend to be different from those found in adults. So much so that with De Pablos[8], we can state that these lesions are not only of a different nature but they also react differently from those in the adult patient.

In our series, the correlation between the presumptive diagnosis and the final finding was 79.23%, with the highest error rate being found in the suspected medial meniscopathies that turned out to be chondral pathologies; this was in like with what is stated by other authors[9,10]. Meniscal conditions were those presenting the highest incidence (46%), a similar level to that found by Romero et al[11] but higher than those found by authors like Cerero et a[112], which could be explained by the fact that traumatic knees tend to be operated more commonly than chronically painful ones. The amount of injured meniscus to be resected is still a moot point in these cases.

Treatment of ACL injury is still today the subject of controversy. Although these injuries are rare in persons under 14[13], in the last few years there has been an increase in the rate of diagnosis of this condition as well as in the number of surgeries performed. This is the result of the widespread introduction of NMRi for the diagnosis and overall assessment of children suffering from ligament lesions similar to those sustained by adults[14,15]. When opting for surgical repair, we follow the guidelines laid down by Canosa[16], which includes determining the clinical instability experienced by the patient during their everyday life and sporting activities, deferring surgical treatment until the end of puberty in those cases with no instability. In the remaining patients, we opted for surgical treatment previously conducting an assessment of the patients' remaining growth potential since we were fully aware of the risk they face of sustaining a growth plate lesion. We prefer reconstruction with a BTB allograft in patients approaching skeletal maturity where the risk of growth plate lesion is low and we use BTB allograft or a pes anserine tendon-plasty in cases with a higher growth potential. We have not used other commonly used approaches such as the extraarticular plasties described by Marshall et al[17], which do not fully eliminate the risk of growth plate lesions and which in the long term lead to a feeling of instability that on many occasions requires further surgery[18]. In the cases surgically treated in our hospital we did not observe any growth plate lesion that interfered with the patients' growth, which in our view is not only due to the surgical technique used, but mainly to the extreme care that we take with indications. The incidence obtained in our series is not much different from that of other authors[7,9,19], confirming that ACL pathology in children and adolescents is at present a common injury that should be addressed by the surgeon given the risk of secondary meniscus or cartilage lesions. The time of surgery as well as the technique to be used are still open to controversy.

The role placed by arthroscopy in the diagnosis and treatment of cartilage lesions is beyond doubt. In a series of NMRi's, Calcedo et al[20] found up to 71% osteochondral contusions in patients with hemarthros of the knee joint after sustaining trauma. In our series, chondral lesions are in line with the 10-20% rate reported by several authors[21-23], which seems to indicate that a large proportion of these lesions remain undiagnosed. For this reason, we join Calcedo in recommending the use of NMRi in cases of significant trauma. OD is another pathology common during this period of life. Normally originating in the classic Aichroth area, this condition tends to affect males between 10-20 years and is the most usual cause of intraarticular loose bodies. As the treatment of cartilage disorders is still beset by several limitations, we attach particular importance to an accurate and timely diagnosis in order to prevent any unfavorable development that could complicate treatment.

For some authors, most child ACL injuries occur as a result of avulsions from its tibial insertion[24], a lower resistance of the tibial spine to the traction forces imposed on the ACL[25]. Following the classification by Meyers and McKeever[26], we found two undisplaced non-displaced type I fractures, an old type II fracture and a displaced type III

fracture with full elevation of the tibial eminence that was treated through stabilization with screws.

The use of arthroscopy for monitoring and reducing tibial plateau fractures is an increasingly widespread practice[27,28] since it permits a simultaneous exam of meniscoligamentous and cartilaginous structures often associated to tibial plateau fractures[29].

The use of arthroscopic procedures for synovial conditions may significantly contribute to the diagnosis if such conditions. This is the case of synovitis refractory to medical treatment since, in addition to carrying out a synovectomy, in these cases we can take samples to be sent to the pathology lab. Pathological synovial plicae are a rather frequent pathology for some authors[8]. We have not found such a high prevalence in our series and believe that this is often an exclusion diagnosis when no other findings are obtained, in spite of the fact that the characteristics of this condition have been well documented by other authors[30-32]. Lastly we should highlight the growing role played by arthroscopic techniques in the treatment of joint stiffness as they make it possible to carry out an arthrolysis without having to open the joint[33,34].

To conclude, arthroscopy is currently a reliable and safe method for the diagnosis and treatment of a Wide variety of knee injuries in the young population, especially if we take into account the difficulties inherent in determining the clinical background and physically examining these patients. The high percentage of erroneous presumptive diagnoses and the high frequency of unexpected findings should make us wary of any case in which we suspect an injury may be present and lead us to exhaustively determine the patient's health record carry out a thorough physical examination.

The introduction of NMRi has constituted a groundbreaking development in the understanding of knee conditions and provides a valuable element for the diagnosis of the (mainly traumatic) lesions affecting younger patients. For that reason we recommend its use in cases similar to those reported in this study.

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