The paediatric foot: prevalence and differentiation of sonographic and podiatric findings in juvenile arthritis and healthy children

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Abstract

Objective

We aimed to, first, determine the prevalence of ultrasound (US) findings and podiatric anomalies in the paediatric foot, and to compare these findings between healthy and asymptomatic juvenile idiopathic arthritis (JIA) subjects, and then to analyse the associations between US and podiatric findings.

Methods

Healthy children and asymptomatic JIA patients underwent US and podiatric assessments. Grey-scale (GS) findings and Doppler signal in the joint recess, the tendon sheath and the enthesis of paediatric feet were assessed as present or absent. The podiatry assessment included: Foot Posture Index (FPI), footprint, standing heel-rise test, mobility of first toe and the Jack test.

Results

Forty-six children had at least one US finding (25 of 54 healthy children and 20 of 28 asymptomatic JIA patients). GSUS findings at the first metatarsophalangeal joint recess and physiological vascularisation at several locations were the most frequently detected findings in both groups. GSUS findings at the tibiotalar and subtalar joints were only detected in the JIA group. In comparison to the healthy group, the JIA group showed a trend towards pronated foot with abnormal footprint. However, the tibiotalar synovitis was significantly associated with supinated FPI.

Conclusion

Improving the knowledge of US findings in the paediatric foot is crucial to evaluate properly children with suspected inflammatory diseases. US, in addition to podiatric assessment, would enable paediatric rheumatologists to discriminate between normal physiological findings and pathological abnormalities in asymptomatic children having JIA. Further studies are needed to confirm it.

Key words

children, feet, synovitis, Doppler ultrasonography, podiatry

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Introduction

In addition to podiatric assessment, ultrasound (US) becomes a promising tool in the foot care in juvenile idiopathic arthritis (JIA (1, 2). It is a well-tolerated and accurate modality for assessing joints and the surrounding soft-tissues. Arthritis of the foot occurs commonly in JIA and might cause considerable morbidity (3, 4). Inflammation leads children to look for pain relieving positions with anomalies in foot posture and possible secondary structural damage. Nowadays the paediatric rheumatologist perceives a lower incidence of foot disease in daily practice than literature describes, mainly after the introduction of biologic disease-modifying antirheumatic drugs (DMARD). Besides inflammation, some anomalies detected by podiatrists are modifiable contributing factors for foot diseases. It is important for paediatric rheumatologists to discern when a child's foot with JIA should be monitored with growth or intensely treated. Children rarely complain about symptoms, so imaging and podiatrist assessments are becoming complementary tools in the foot evaluation.

Despite US is able to show children's age-related variations in the sonoanatomy of healthy joints, its validity for the discrimination between physiologic and pathologic findings has not been established yet. A deep knowledge of the normal sonoanatomy is paramount for a correct interpretation of images in childhood. To improve the US specificity in the management of JIA, the paediatric sub-task force of the Outcome Measures in Rheumatology (OMERACT) Ultrasound Working Group has outlined US definitions for normal and pathologic paediatric joints (5-8). Nevertheless, what constitutes a "normal" sonographic appearance in the asymptomatic paediatric foot is an unanswered question. To the best of our knowledge, there is no normal variant atlas for paediatric US, and therefore becoming familiar with the appearance at the different ages is a large part of the learning curve for the paediatric rheumatologist interested in US.

The main objective of the study was to determine the prevalence of US findings and podiatric anomalies in the paediatric foot, and to compare these findings between healthy and asymptomatic JIA subjects. The second objective was to analyse associations between US and podiatric findings.

Methods

Study design

This study included 82 children (164 feet), distributed in 54 healthy children (108 feet) and 28 asymptomatic JIA patients (56 feet). The study was conducted in compliance with the Declaration of Helsinki and approved by the Hospital Universitario Severo Ochoa (HUSO) Research Ethics Committee. All of the participants and parents gave their written informed consent.

- The healthy group

Healthy volunteers were consecutive recruited and most of them were children and relatives of the hospital staff of our institution. The main criteria for including the children in the study was a healthy status and also that their parents were willing to contribute to the study. On arrival at the examination room, a clinician asked the children whether they had pain or injuries in their feet. The exclusion criteria were history of trauma, rheumatic or neuromuscular disorders.

- The JIA group

Consecutive JIA patients visiting our Paediatric Rheumatology outpatient clinic between January and December 2014 were invited to participate (9). They all have to be clinically inactive with history of foot involvement documented at the patient's chart.

Demographic characteristics and the age when started walking were collected in all children, and clinical characteristics in the JIA group.

US assessment

All participants underwent an US assessment that was conducted by an experienced sonographer, who was blinded to podiatric findings. Parents helped to make easy the US scanning showing smartphone animations to increase compliance. Foot examination was performed with the child in the supine position and the child's sole on

the bed with plantar flexion of ankle at 20° for the anterior, medial and lateral aspect of the foot. The posterior and plantar aspects of the foot were examined with the patient prone, its sole out of bed with light dorsiflexion of ankle.

The equipment (Logiq E; General Electric (GE) Medical Systems, USA) was equipped with a linear transducer (8-13MHZ) and the Doppler function. The frequency used in B-mode was from 10-13MHZ (depending on the structure). The Power Doppler (PD) settings were the following: pulse repetition frequency (PRF) of 600HZ and low-wall filter, and gain was adjusted until the background signal was removed. All children were first investigated on grey-scale (GS) US and, afterwards, on PDUS for scanning joints and enthesis. Whereas PD function was just applied on tendons when an abnormal finding was displayed on GSUS due to the absence of information about it in childhood. Eight joints (tibiotalar, subtalar, talonavicular, calcaneocuboid, navicular cuneiform, cuneiform-1st metatarsus, and 1st and 2nd metatarsophalangeal joints), eight tendons (tibialis anterior, extensor hallucis longus, extensor digitorum longus, tibialis posterior, flexor digitorum longus, flexor hallucis longus and peroneus tendons) and two insertions (Achilles' tendon and plantar aponeurosis) were bilaterally assessed. To make US evaluation more feasible, just one plane was used (the longitudinal plane for joint and enthesis, the transverse plane for tendon) (10, 11). Nevertheless, every suspected US finding had to be documented in two perpendicular planes. It has to be noted that the toes were only evaluated at the dorsal side.

Given the limited data describing standardised definitions of US pathology in children and the US definitions for synovitis in JIA have been published after starting the current study (8), it was investigated the presence of any suspected US finding based on the definitions proposed by the OMERACT US group for adults (12). From a US point of view, synovitis can be defined (consequently, it was named like this even in healthy children) on the basis of B-mode abnormalities (synovial hypertrophy and/or increased synovial fluid) with or without Doppler signal causing changes of the shape of the joint recess (from the usual angle-shaped to a plateau-shaped or capsule distention). An abnormal thickening of the tendon sheath with or without PD was considered as tenosynovitis (Fig. 1), and abnormally hypoechoic (loss of fibrillar architecture) and/or thickened enthesis with or without PD as enthesitis (12). Because of the peculiar characteristics of an immature skeleton, such as the high ratio of cartilage in relation to the bone and the physiologic vascularity in the paediatric joint, a dynamic examination was performed to discriminate between the non-ossified cartilage and synovitis (8, 10). Every Doppler signal detected in the enthesis and within the joint capsule was recorded for the current study. However, the PD signal was only considered pathologic/positive when an abnormal structural finding was visualised on GSUS.

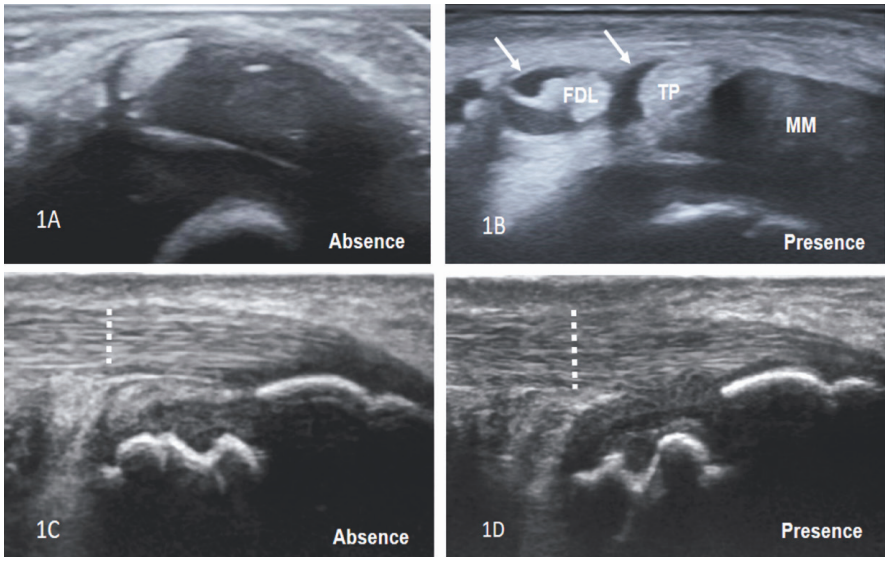

Fig. 1. The composed picture shows the absence or presence of US findings at different locations.
1A: Healthy tibialis posterior (TP) and flexor digitorum longus (FDL) tendons at the level of medial malleolus (MM) in transvese scan.
1B: Tenosynovitis of TP and FDL tendons in transvese scan. Note an abnormal hypoechoic tendon sheath widening (arrow).
1C: A healthy Achilles tendon insertion in longitudinal scan.
1D: Enthesitis of Achilles tendon. Note the loss of normal fibrillar echogenicity of tendon insertion, which appears as hypoechoic, with an increase in thickness (comparing the white dots). See also a wavy interface between the apophyseal tuberosity and calcaneal bone.

Podiatric assessment

All participants underwent a podiatric examination of both feet by a podiatrist blinded to the US data. It included the following methods: 1. Footprint evaluation on podoscope (13); 2. The Foot Posture (FPI) (14, 15); 3. The standing heel-rise test (16, 17); 4. Mobility of first MTP joint; 5. The Jack test (18).

Footprint evaluation on podoscope. The footprint was analysed using an Podoscope 50cmx50cm (Herbitas, Spain). While the child is standing on the glass of the podoscope, the footprint is reflected in the mirror. "Normal footprint" was defined when the isthmus (width of the half foot) was 1/3 the width of the forefoot. Conversely, both flat footprint and cava footprint were considered as "pathological footprint". Flat footprint was defined when the isthmus was greater than 1/3 of the width of the forefoot, and cava footprint when it was minor to those values.

The Foot Posture Index (FPI) quantifies the degree to which a foot is pronated, supinated or physiological (15). The FPI was assessed with all subjects barefoot, in a relaxed standing position, and using 6 clinical items: 1) talar head palpation, 2) curvature at the lateral malleoli, 3) inversion/eversion of the calcaneus, 4) talonavicular bulging, 5) congruence of the medical longitudinal arch, and 6) abduction/adduction of the forefoot on the hindfoot. Each item of

the FPI is scored between –2 and +2 (-2 for clear signs of supination, 0 for neutral and +2 for clear signs of pronation). The final score ranged from -12 to +12. Three FPI-6 scores levels were used to assess the range supinated (-12 to -1), neutral or physiological, (0 to 6), pronated (+6 to +12).

The heel rise test (HRT) determines flexibility of the foot. To evaluate the hindfoot the child is examined from behind, while standing, the heel is typically in the valgus position. When the patient actively stands on tip toes to lift the heel, the medial longitudinal arch is raised and the hindfoot changes from valgus to a neutral or varus position. This indicates that the flatfoot deformity is flexible and that in addition the subtalar joint has good mobility. Otherwise, if it is rigid, the arch will not rise. Also, the hindfoot will not be corrected and will remain in valgus during the heel rise It might also indicate presence of bone synostosis, subtalar joint involvement, tibialis posterior lesions or any such combination. (17). Thus, a pathological result was recorded as positive, whilst a physiological result was recorded as negative.

Mobility of the first metatarsophalangeal joint (MTP1) was subjectively measured by passively moving the hallux; a range of 45º extension to 80ª flexion was considered as normal mobility; more range was identified as hypermobility. As the hypermobility of the first metatarsophalangeal joint (MTP1) is related to the flat/pronated foot (19, 20), only this data was evaluated.

The Jack test (JT) is a method of evaluating the flexibility of the flatfoot. The test is performed with the patient weight bearing, with the foot on the floor, while the clinician dorsiflexes the hallux and observes an increase in the longitudinal medial arch, an external rotation of the tibia and a position of the calcaneus varus; this result is negative or physiological. It was considered positive or a pathological result when there was no arch formation, thus the flatfoot was rigid.

Statistical analysis

A dichotomous scoring system was employed to classify each structure as a "normal" sonographic appearance (absence of US findings) or "abnormal" (presence of suggestive US features of disease). Except the variable FPI, which was quantified in normal, pronated and supinated foot, the rest of podiatric variables (Footprint, HRT, mobility of the MTP1 joint; and Jack test) were recorded as dichotomous qualitative variables in two strata: "normal" when the results from the podiatric assessment where within the physiological range, and "pathological" when those results were outside the physiological ranges.

All data were analysed using the SPSS v. 21.0 software. Quantitative variables were presented as mean (standard deviation, SD) or median (interquartile range, IQR) depending on the variable distribution that satisfied the condition of normality. Qualitative variables were presented as absolute frequencies and percentages. The student's t-test was employed for continuous variables and the chi-squared test or the Fisher's exact test for dichotomous variables. Haberman's adjusted standardised residuals were used to identify cells with observed frequencies higher or lower than expected under independence hypothesis. The Mantel-Haenszel test was used to control the effect of unmatched age over the possible association between group and findings; the sample was dichotomised in two strata by the median age (7yo)-due to differences of age between groups and a common odds. A p-value ≤0.05 was considered statistically significant.

Results

Characteristics of the population

We included 82 children into the study (Table I). The healthy group showed a mild predominance of males. The mean age of the JIA patients was higher than age of the healthy group (p=0.001), and consequently, their body weight and height were larger. However, there were not significant differences between the two groups in terms of body mass index (BMI) (p=0.09). The study population was within the ideal range of BMI (less than the 90th percentile) that was calculated from the children's height and weight, using the Orbegozo BMI classification (21). The age when they started walking was similar in the two groups (≈13 months).

Table I. Demographic and clinical characteristics of the study population.

	Healthy group (n=54)	JIA group (n=28)
Age (SD), years	6.3 (3)	11 (4.8)
Female; n (%)	20 (37)	15 (53)
BMI, kg/m^{2*}	17 (4)	20 (6)
Oligoarthritis, n (%)		12 (43)
Poliarthritis, n (%)		3 (18)
ERA, n (%)		11 (39)
JIA duration, years*		4.5 (5)
PCR, mg/dl*		2 (7)
ESR, mm/hour*		7 (6)

JIA: juvenile idiopathic arthritis; Data are presented as the mean (SD) unless indicated by asterisk: median (IQR); IQR: interquartile range; JIA: juvenile idiopathic arthritis; BMI: body mass index; n (%): number and percentage of patients; ERA: enthesitis related arthritis; PCR: protein C reactive; ESR: erythrocyte sedimentation rate.

Clinical characteristics of the JIA group are shown in Table I. Data obtained from the patient's chart proved inactive disease (normal/low values of protein C-reactive and erythrocyte sedimentation rate) and a history of mild foot disease (median disease duration of 0.7 months, IQR, 6.3). Antinuclear antibodies (ANAs) were positive in 12/28 (43%) patients, with positive rheumatoid factor in 2/28 (7%) and positive anti–citrullinated peptide antibodies (ACPAs) in one patient. Twenty (71.4%) patients were taking conventional DMARDs. Ten (35.7%) patients were taking biologic DMARD for a median time of 13 months (IQR, 28).

US assessment

In total, 164 joints of 82 children were examined. Twenty of the 28 (70%) JIA patients and 25 of 54 (46%) healthy volunteers presented at least one joint with findings on GSUS. The tibiotalar and the subtalar joints were the most frequently joints affected by GS-synovitis (6/56 joints, 11%), followed by the talonavicular joint (1.7%) in the JIA group. The volunteers, unlike JIA patients, did not show any finding in these joints (Table II). GS-synovitis (mainly, synovial fluid) at the MTP1 joint was commonly seen in both groups. The incidence of MTP2 involvement was found significantly more frequent in the JIA group

(p<0.001). Moreover, the simultaneous occurrence of the MTP1 involvement and the MTP2 synovitis was frequently seen in the JIA group (p=0.002). Our results indicated that MTP2 synovitis in isolation is much less common than its occurrence in conjunction with MTP1 involvement (p=0.4). No US anomaly was recorded for the rest of joints of the study.

Intracapsular PD signal was seen in a total of 29 tibiotalar joints (including both groups), although most signals were related to physiologic vascularity of the unossified epiphyseal cartilage of tibia (up to 3 joints, 10.3%) and fat pad tissue (25 joints, 86.2%). Only one patient with JIA presented pathologic PD signal at the tibiotalar synovitis (Table II).

To analyse the surrounding soft-tissue findings, each tendon and entheses was counted individually. The detection of enthesitis was significantly different between the two groups (p=0.005). Enthesitis changes, characterised by increased thickness and hypoechogenicity, were seen in 8 patients with JIA at the Achilles tendon (3 of which were also PD positive) (Table III). Structural lesion (enthesophyte) associated to Achilles enthesitis was visualised in a 16-year-old girl with ERA. Besides PD in insertions, physiologic vascularisation was detected near insertion (Table III). None of the children had retrocalcaneal bursitis. No US anomaly was detected in the plantar fascia. The prevalence of tenosynovitis was different between the two groups (p<0.001); it was only seen in the JIA group, mainly unilateral (6/8 patients, 3 of which were also PD positive). Twelve tendons, among the 164 assessed feet, showed GS-tenosynovitis involving the anterior (n=2), the medial (n=5) and the lateral (n=5) compartments of the ankle.

Table II. Prevalence and distribution of the US findings in the foot joints in the healthy group and the JIA group.

US findings		Healthy group	JIA group	p-value*
Tibiotalar GS-S		0 (0)	6 (11)	0.01
Tibiotalar PD		23 (21)	6 (11)	<0.001
PD Location	Cartilage	3 (13)	0 (0)	
	Intracapsular soft-tissue[£]	20 (87)	5 (83)	
	SH	0 (0)	1 (17)	
Subtalar GS-S		0 (0)	6 (11)	0.01
Talonavicular GS-S		0 (0)	1 (2)	0.4
Talonavicular PD		9 (8)	0 (0)	0.3
PD Location	Cartílago	6 (75)	0 (0)	
	Intracapsular soft-tissue[£]	2 (25)	0 (0)	
MTP1 GS-S		45 (41)	32 (57)	0.7
PD Location: SH		0 (0)	2 (4)	0.4
MTP2 GS-S		1 (1)	14 (25)	<0.001
PD Location: SH		0 (0)	1 (2)	0.9

JIA: juvenile idiopathic arthritis; GS-S: grey-scale synovitis; PD: power Doppler; SH: synovial hypertrophy.
[£]Intracapsular but extrasynovial soft tissue (usually fat pad tissue).
Percentages refer to the total number of feet (Healthy group=108, JIA group=56).
*Mantel-Haenszel χ^2 p-value.

Table III. Prevalence and distribution of the US findings in the Achilles tendon in the healthy group and the JIA group.

US finding		Healthy group	JIA group
GS Enthesitis	No	108 (100)	48 (86)*
	Yes	0 (0)	8 (14)
PD Enthesitis	No	92 (85)	47 (92)
	Yes	16 (15)[£]	9 (8)[£]
PD Location	1. Insertion	0 (0)	3 (5.3)
	2. Cartilage	10 (9.3)	6 (10.7)
	3. Fat Pad	7 (6.5)	4 (7)

JIA: juvenile idiopathic arthritis; GS: grey-scale; PD: power Doppler.
[£]PD was detected in one location or both (2,3). Percentages refer to the total number of feet (Healthy group=108, JIA group=56). *Mantel-Haenszel χ^2 p-value, *p=0.005.

Table IV. Prevalence of the podiatric findings in the foot joints in the healthy group and the JIA group.

	Healthy group	JIA group	OR	CI95%
Hypermobility-MTP1	6 (5.6%)	12 (21%)[§]	3.5	(1.2–10)
FPI- Neutral	78 (72%)	22 (39%)*	0.2	(0.1–0.5)
FPI- Pronated	28 (26%)	26 (46.4%)*	2.8	(1.3–5.9)
FPI- Supinated	2 (1.9%)	8 (14.3%)	4.5	(0.8–22.5)
Abnormal footprint	39 (36%)	40 (71%)*	4.6	(2.1–9.8)

JIA: juvenile idiopathic arthritis; MTP1: the first metatarsophalangeal joint; FPI: foot postural index; OR: Odds ratio de Mantel-Haenszel; CI: confidence interval;
Breslow test was not significant in any contrast. Percentages refer to the total number of feet (Healthy group=108, JIA group=56). [§]p=0.02; *p<0.005.

Podiatric assessment

Comparing with the healthy group, the JIA group demonstrated a trend towards pronated foot with abnormal footprint. Detailed podiatric results are reported in Table IV. Mantel-Haenszel chi-quared p-values showed significant association between the group and the podiatric finding after controlling the age effect. Common Mantel-Haenszel odds ratio denoted how much greater were the age-adjusted odds of abnormal findings in the JIA group with respect to healthy volunteers. The number of podiatric changes in the JIA group per each change in the healthy group was of 2.8 in the FPI (pronation). Hypermobility of the first toe and abnormal footprint were more frequently seen in the JIA group than in the healthy volunteers (p<0.005). Regarding SHRT and JT results, no significant differences were found between the JIA group and volunteers (p=0.19 and p=0.95, respectively).

Table V shows the association between the relevant podiatric and US findings in the feet of the JIA group. The tibiotalar synovitis was associated with FPI (supination) and MTP1 synovitis with

the footprint and the first finger hypermobility. No significant association was found between the subtalar synovitis and podiatric features.

Table V. Association between US findings and podiatric assessment in a total of 56 feet of the JIA patients.

		Tibiotalar, GS-synovitis			
		Total (n=56)	No (n= 50)	Yes (n=6)	*p*
FPI Md, IQR		3.5 (1.0–7.0)	5 (1.0–7.0)	-6 (-3.0–3.8)	0.03
		MTP1, GS-synovitis			
		Total (n=56)	No (n= 24)	Yes (n=32)	
MTP1*	Normal	44 (79)	22 (92)	22 (69)	0.04
	Hypermobility	12 (21)	2 (8)	10 (31)	
Footprint*	Normal	16 (29)	10 (42)	6 (19)	0.06
	Anomaly	40 (71)	14 (58)	26 (81)	

GS: grey-scale; n: number of feet; FPI: foot postural index; Md: Median; IQR: interquartile range; MTP1: the first metatarsophalangeal joint;
*numbers and percentages refer to the total number of feet in the JIA group without (No) and with (Yes) synovitis showing the podiatric findings.

Discussion

We have evaluated systematically the prevalence of the US (joints, enthesis and tendons) and podiatric findings in asymptomatic paediatric feet. Paediatric rheumatologist is in charge of taking care of children with JIA, who is incorporating the use of US in the daily practice. Currently, learning to recognise normal and abnormal findings is part of US training in Paediatric Rheumatology.

The study provides that there are US findings involving specific joints in JIA that should be looked for and recognised as really pathologic and to take other findings seen in healthy children, such as MTP1 GS-synovitis, before prescribing medication. Those US findings in addition to foot posture anomalies would point out the need of early aggressive treatment to paediatric rheumatologists.

Several findings of the present study are of importance. First, among healthy children, observation of mild finding suggestive of pathology at the MTP1 joint was an unexpectedly frequent finding on GSUS images of the foot. Published normative data (22) nevertheless suggest that no US findings should be present in healthy children. The question arises whether such finding at MTP1 joint was overcalled, *i.e.* whether healthy volunteers would show some degree of GS-abnormality, and then, the term synovitis should not be initially applied before evaluating other parameters and podiatric assessment. It may possibly be explained by biomechanical factors (MTP1 joint loading in running games and other typical activities of children). In line with our explanation, others authors have reported the occurrence of mild synovitis at MTP1 joint in healthy adults related to degenerative age-related changes and caused by an overload (23, 24).

Second, among the JIA patients, observation of abnormalities involving specific joints (the tibiotalar and the subtalar joints) and tenosynovitis at the ankle on either GS or PD US that are not seen in healthy children (7, 10, 22). In line to some studies assessing patients with inactive disease (25, 26), our study also showed a low prevalence of involvement. Magni-Manzoni *et al*. detected synovitis in the tibiotalar (9/78; 11.5% with positive PD in 3 patients), subtalar (3/78; 3.8%) joints. Similarly, we saw positive PD at the tibiotalar joint in a low number of patients. Doppler signals have been shown to be more accurate in the assessment of active synovitis than GS abnormalities alone in adults (27), whereas, information on Doppler-US from literature is scarce in children to consider any Doppler signal a sign of active synovitis. In our study, the presence of GS synovial hypertrophy was required in order to consider a joint PD positive, as some degree of normal or physiologic blood flow can be expected in children (7, 28).

In line with the US evaluation, the podiatric assessment of JIA patients showed a higher prevalence of anomalies than the healthy volunteers, particularly FPI-pronated and non-physiological footprints. Children's foot posture has been interpreted with footprint assessments in many studies, with inference of a problematic when the footprint area is modified (29). Volpon *et al*. have reported that most healthy children develop a normal plantar arch with spontaneous resolution of the flatfoot between the ages of 2 and 6 (30). Given that the mean age of the JIA group was 11 years, quiescent pathology could be a relevant factor for developing it. Similarly, we rule out obesity as a contributor factor (31, 32). The contribution of obesity has been nevertheless refuted by some authors using the FPI measures (33, 34).

Comparing our FPI results with Evans' results (55.2% for neutral in healthy children aged 3–15 years) (15), our healthy sample showed up to 72% neutral FPI, and the feet of JIA patients showed a prevalence higher of pathology than volunteers. The JIA group showed significantly an occurrence mildly higher of hypermobility of the first toe than the healthy children. It might mean that certain laxity/weakness at the MTP1 could be involved during the foot active disease. In fact, it been described as an underlying risk factor for the pronation and flattering of the child's foot (35). Despite podiatric anomalies reported in the JIA group, the results of the Jack test clearly denoted the flexibility of the foot without structural damage.

We also attempted to analyse associations between the detected US and podiatric findings within the JIA group. The study shows that GS-synovitis at the tibiotalar joint was significantly associated with supinated FPI rather than pronation. Consequently, even if the child was asymptomatic, the presence of US findings at tibiotalar joint in conjunction with supinated foot would lead the paediatric rheumatologist towards a more aggressive treatment. We found association between the MTP1 syno-

vitis and the hypermobility of the first toe that could create somewhat instability resulting in the foot's mechanics alterations and progressively transfers the weight from the head of the first metatarsal to the central metatarsal bones, especially the second one (19). In fact, the simultaneous presence of the MTP1 synovitis and the MTP2 synovitis was only seen in the JIA group.

The small number of JIA patients could represent a limitation particularly for analysing associations. However, the inclusion of a larger sample of healthy volunteers strengthened the study and ensured that the US evaluation did not provide false results.

Conclusion

Improving the knowledge of US findings in the paediatric foot is crucial to evaluate properly children with suspected inflammatory diseases. In addition to podiatric assessment, US would enable paediatric rheumatologists to discriminate between normal and pathological findings in asymptomatic children.

Nevertheless, further longitudinal studies are needed to evaluate the interaction between US and podiatric assessment from larger representative samples.

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