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Letter to the editor

Static peak pressure under the sole is unrelated to gait alteration in rheumatoid arthritis

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Dear Editor

In an epidemiologic study of patients with rheumatoid arthritis (RA), [1] for about 35.4%, the feet were the first symptomatic articular site, 90.3% endured pain for more than one day since the beginning of the disease and 69.2% experienced the same pain during the previous month; 64% had been to a podiatrist and 54.2% had foot orthotics.

Podiatry monitoring and the prescription of good-fitting shoes and foot orthotics are recommended after an evaluation [2], but consensus on how this evaluation should be performed is lacking. Various tools that allow for assessing foot pressure include force plate, or dynamic, foot pressure measurement [3], but we have no guidelines on how to use these tools or how to adjust the therapy.

Many studies have evaluated foot pressure in RA [4], but the relation between foot pressure and foot pain in RA has not been established [5]. The ability of foot specialists to recognize areas of high peak pressure has been evaluated [6]: the study underlined the need to elaborate an objective evaluation in light of foot pressure being underestimated under the hallux and overestimated under the metatarsal heads.

Joint damage of the fore foot in RA is correlated with an increase in plantar pressure, specifically under the first and fourth metatarsi-phalangeal joints [7]. High plantar pressure under the fore foot is associated with pain during toe walking. We lack evidence of correlations between plantar pressure and other clinical or functional data. Guldemond et al. [6] also mentioned a threshold of high foot pressure, at 700 kPa or 7,1137 g/cm^2, but this value lacks consensus in the literature, especially for the diabetic feet and risk of skin lesion [8].

The primary objective of this study was to determine any correlations between plantar peak pressure and functional evaluation of the RA foot according to the International Classification of Functioning, Disability and Health (ICF model). The secondary objective was to evaluate correlations between podo-barometric and clinical data.

Patients were recruited from consultations in Physical and Rehabilitation Medicine or Rheumatology. The primary aim was to assess podo-barometric data and search for correlations with functional outcome. Podo-barometric data were analyzed by using the force plate Fusyo (Medicapteurs France SAS, Balma, France): peak pressure under each foot and localization (g/cm^2), total surface area under each foot (cm^2), and distribution (%) between the fore and rear foot. Static data were used and patients were barefoot. Plantar peak pressure was the main parameter used for assessing a correlation with functional outcome.

To evaluate the function of the RA foot according to the ICF model, patients completed the Foot Function Index-French version (FFI-F) [9]; a visual analog scale (VAS) to measure foot pain twice, a week apart; the Health Assessment Questionnaire (HAQ); and the McMaster Toronto Arthritis (MACTAR) patient preference questionnaire modified for the foot.

We also searched for correlations between clinical data and other podo-barometric parameters such as peak pressure localization, total surface area under each foot, and distribution between the fore and rear foot. Clinical data were gathered during the same consultation.

The CPP Sud-Est VI Ethics Committee approved the study on 12/15/2011 (IRB number 5044). Written consent was obtained from each participant before inclusion. The study was performed according to the clinical good practice and complied with the declaration of Helsinki.

The statistical analysis is purely descriptive and should lead to a first study of the correlation between podo-barometric and clinical data. Correlation between quantitative parameters was assessed by Pearson or Spearman correlation coefficients. With the size of the sample, if the coefficient was > 0.4, then the association was considered significant at the 5% threshold (for power $> 80\%$). Quantitative data were compared by Student t test or Mann-Whitney test (normality was insured by the Shapiro-Wilk test and equality of variances by the Fisher-Snedecor test). All analyses involved using STATA 10 (StataCorp, College Station, TX). $P < 0.05$ was considered statistically significant.

The study included 51 patients (Table 1). All patients fulfilled the 2010 American College of Rheumatology criteria for a diagnosis of RA with or without foot localization. This was an ancillary study of the French validation of the FFI [9].

All patients received biotherapies. Only 13 had had a pedicure since the start of their disease, 34 had orthoses and 7 had therapeutic custom-fit shoes (Table 1). Two patients had undergone foot surgery. The mean (SD) disease duration was 15.4 (11.4) years, 41% of the population had a low DAS28-erythrocyte sedimentation rate score (< 2.6); however, 51.9% expressed difficulty in daily activities (HAQ score > 1) and 28.8% had much difficulty (HAQ score > 2) (Table 2). This trend was also found in

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Table 1
Podiatric and podoscopic descriptions ($n = 51$).

Pedicure history, n (%)	13 (24.5)
Wearing plantar orthosis, n (%)	34 (64.1)
Wearing custom-made therapeutic footwear, n (%)	7 (13.2)
Surgery history, n	2
Foot pain during the day, VAS, mean (SD) [range]	34.4 (26.8) [0–100]
Foot pain for the past week, VAS, mean (SD) [range]	35.3 (25.6) [0–100]
Patients with active synovitis, n (%)	23 (43.3)
Foot pain location left or right, n (%)	
Forefoot	42 (79.2)
Midfoot	12 (22.6)
Hindfoot	20 (37.7)
Metatarsalgia	42 (79.2)
Podoscopic data (right/left)	
Hind foot varus (n/N)	8/7
Hind foot valgus (n/N)	30/32
Flat foot 1st degree (n/N)	12/11
Flat foot 2nd degree (n/N)	15/14
Flat foot 3rd degree (n/N)	2/1

VAS: visual analog scale.

Table 2
Descriptive data for patients with rheumatoid arthritis (n = 51).

Age (years), mean (SD) [range]	60 (12) [17–78]
Female, n (%)	38 (74.5)
Disease duration (years), mean (SD) [range]	15.4 (11.4) [1.5-44]
Professionally active/not active, n (%)	19 (35.8)/34
DAS28-ERS, mean (SD) [range]	2.65 (1.5) [0–5.24]
> 5.1, n (%)	4 (8)
3.2–5.1, n (%)	9 (17)
2.6–3.2, n (%)	9 (17)
< 2.6, n (%)	18 (34)
Unknown, n (%)	13 (25)
DAS28-CRP, mean (SD) [range]	2.75 (1.6) [0–5.8]
> 5.1, n (%)	2 (4)
3.2–5.1, n (%)	12 (23)
2.6–3.2, n (%)	1 (2)
< 2.6, n (%)	19 (36)
unknown, n (%)	19 (36)
200 m walk test (s), mean (SD) [range]	141 (27.3) [103–234]
10 m walk test (m/s), mean (SD) [range]	1.36 (0.46) [0.51–2.34]
Walk perimeter (m), mean (SD) [range]	2873 (3323) [20–12000]
HAQ, mean (SD) [range]	1.22 (0.93) [0–2.75]
< 1 (%)	48.1
> 1 (%)	23.1
> 2 (%)	28.8
MACTAR, mean (SD) [range]	5.28 (3.0) [0–10]
FFI-F, mean (SD) [range] (0–230)	(61.5) [0–208]
FFI-F Pain (0–90)	(5.5) [0–90]
FFI-F Disability (0–90)	43.2 (27.2) [0–88]
FFI-F Limitation (0–50)	12.9 (12.4) [0–41]

DAS28: Disease Activity Score in 28 joints; DAS28-CRP: DAS28-C-reactive protein; DAS28-ERS: erythrocyte sedimentation rate; HAQ: Health Assessment Questionnaire; MACTAR: McMaster Toronto Arthritis scale; FFI-F: Foot Functional Index-French version.

Table 3
Podo-barometric data ($n = 51$).

	Mean	SD	Median	Min	Max
Right foot					
Foot surface (cm^2)	66.47	18.51	61	38	112
Fore foot surface (cm^2)	32.70	10.29	32	12	61
Hind foot surface (cm^2)	33.90	10.83	33	19	71
Fore foot distribution (%)	36.23	13.74	35	10	72
Hind foot distribution (%)	63.76	13.74	65	28	90
Left foot					
Foot surface (cm^2)	67.47	18.11	67	28	110
Fore foot surface (cm^2)	33.86	11.33	33	6	58
Hind foot surface (cm^2)	33.52	9.94	33	15	65
Fore foot distribution (%)	35.54	13.59	35	8	77
Hind foot distribution (%)	63.86	14.16	64	23	92
Plantar peak pressure					
Right foot (g/cm^2)	2791	7874	1569	987	57785
Left foot (g/cm^2)	3024	10655	1520	774	77554

the FFI subscales for pain and disability, with mean (SD) scores of 43.5 (5.5) and 43.2 (27.2) out of 90, a high score indicating maximum difficulty (Table 2).

For each foot, the number and site of metatarsal pain on clinical examination were recorded, as was the number of synovitis locations (23 patients had at least 1 active synovitis) (Table 1). The main location of pain was the fore foot, which concerned 42 patients (79.2%). Podoscopic examination allowed for a description of each foot: valgus or varus of the hindfoot, flat or claw foot, and number of hyper-pressure zones (Table 3).

High peak pressure in each foot was not correlated with functional assessment by the VAS for pain, HAQ, MACTAR or FFI. Correlations were negative for all FFI subscales (Table S1, Supplementary data). Also, plantar peak pressure was not correlated with walk perimeter, speed, number of synovitis locations, or DAS28 status (data not shown). Plantar peak pressure was not correlated with number of metatarsal pain locations or number of hyper-pressure zones, nor was plantar surface correlated with number of hyper-pressure zones or counter lateral metatarsal pain (data not shown). We found no correlation between distribution on the fore foot and number of hyper-pressure zones or number of metatarsal pain joints (data not shown).

The lack of correlations can be linked to the static component of our study; most studies in the literature used dynamic evaluations. Some authors [5] consider that static and dynamic tests do not differ in evaluating forces responsible for pain. The use of the force platform confers different results than dynamic foot pressure measurement. In addition, we did not find any evidence of correlation between plantar pressure and functional or foot pain parameters in RA. Hodge et al. [5] did not show any correlation between plantar peak pressure and pain, possibly because inflammation that could lower the threshold perception of pain. However, the authors found a significant correlation between pain and mean pressure under the second metatarsal head, which suggests that mean pressure could be the best indicator in treating metatarsal pain. For Van der Leeden et al. [7], the only evidence of correlation concerned high plantar pressure and static pain or tiptoe walking pain (FFI item).

An important parameter not evaluated in this work is the notion of time passed with high plantar pressure. This dimension is often correlated with foot pain parameters [8]. A long-lasting pressure on a given area of the foot is sometimes more limiting and painful than high pressure in a short time [10]. In the literature, most evaluations involved a dynamic force plate [7] or an in-shoe system [3].

We found no correlation between plantar pressure repartition (right versus left foot, rear versus fore foot) and number of painful metatarsals or between high peak plantar pressure and RA inflammatory status, but there is little information in the literature regarding this subject.

The interpretation of plantar pressure in routine clinical practice is difficult [11]. It appears not to be a predictive factor of the use of plantar orthotics or even its conception, but to establish such a prescription, a prospective study must be performed. The observational design of our study is a limitation. Nevertheless, the evaluation of plantar pressure remains relevant for screening hyper-pressure zones, often mis-evaluated with a simple clinical examination and for patients receiving medical treatment for the foot [5].

Schmiegel et al. [12] suggested that the evaluation of plantar pressure is useful in early RA or when the level of handicap

according to the HAQ is low. This suggestion was highlighted by a comparison of 3 groups of patients by their HAQ score. It would be relevant to perform an equivalent statistical analysis in our population based on the FFI score. Complementary analysis could be done, to search for correlations between plantar pressures and metatarsal pain location, hyper-pressure zones and also high peak plantar pressure and pain described by the patient. The systematic search of a threshold for plantar pressure appears relevant to improve the evaluation of feet in RA.

This clinical, functional or instrumental analysis of 51 patients with RA did not find any correlation between podo-barometric parameters and function of the foot. Instrumental analysis can be attractive in clinical practice, but the relevance of a systematic and objective evaluation of plantar pressure has yet to be proven.

Disclosure of interest

The authors declare that they have no competing interest.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.rehab.2018.07.009

References

[1] Otter SJ, Lucas K, Springett K, Moore A, Davies K, Cheek L, et al. Foot pain in rheumatoid arthritis prevalence, risk factors and management: an epidemiological study. Clin Rheumatol 2010;29:255–71.
[2] ForestierF R., André-Vert J, Guillez P, Coudeyre E, Lefevre-Colau MM, Combe B, et al. Non-drug treatment (excluding surgery) in rheumatoid arthritis: clinical practice guidelines. Joint Bone Spine 2009;76:691–8.
[3] Hennessy K, Burns J, Penkala S. Reducing plantar pressure in rheumatoid arthritis: a comparison of running versus off-the-shelf orthopaedic footwear. Clin Biomech (Bristol Avon) 2007;22:917–23.
[4] Baan H, Dubbeldam R, Nene AV, van de Laar MA. Gait analysis of the lower limb in patients with rheumatoid arthritis: a systematic review. Semin Arthritis Rheum 2012;41:768–88.
[5] Hodge MC, Bach TM, Carter GM. Novel Award First Prize Paper. Orthotic management of plantar pressure and pain in rheumatoid arthritis. Clin Biomech (Bristol Avon) 1999;14:567–75.
[6] Guldemond NA, Leffers P, Nieman FH, Sanders AP, Schaper NC, Walenkamp GH. Testing the proficiency to distinguish locations with elevated plantar pressure within and between professional groups of foot therapists. BMC Musculoskelet Disord 2006;7:93.
[7] Van der Leeden M, Steultjens M, Dekker JH, Prins AP, Dekker J. Forefoot joint damage, pain and disability in rheumatoid arthritis patients with foot complaints: the role of plantar pressure and gait characteristics. Rheumatology (Oxford) 2006;45:465–9.
[8] Waldecker U. Pedographic classification and ulcer detection in the diabetic foot. Foot Ankle Surg 2012;18:42–9. http://dx.doi.org/10.1016/j.fas.2011.03.004.
[9] Pourtier-Piotte C, Pereira B, Soubrier M, Thomas E, Gerbaud L, Coudeyre E. French validation of the Foot Function Index (FFI). Ann Phys Rehabil Med 2015;58:276–82.
[10] Otter SJ, Bowen CJ, Young AK. Forefoot plantar pressures in rheumatoid arthritis. J Am Podiatr Med Assoc 2004;94:255–60.
[11] Van der Leeden M, Fiedler K, Jonkman A, Dahmen R, Roorda LD, van Schaardenburg D, et al. Factors predicting the outcome of customised foot orthoses in patients with rheumatoid arthritis: a prospective cohort study. J Foot Ankle Res 2011;4:8.
[12] Schmiegel A, Rosenbaum D, Schorat A, Hilker A, Gaubitz M. Assessment of foot impairment in rheumatoid arthritis patients by dynamic pedobarography. Gait Posture 2008;27:110–4.

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