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Ultrasonographic and resistance index evaluation of nails in psoriatic arthritis, psoriasis, and control groups: a cross-sectional study

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Abstract

Background: Nail psoriasis occurs frequently in patients with psoriatic disease, it can lead to functional impairment, pain, discomfort, decreased quality of life and can also be a predictor for the development of arthritis. Early recognition of this condition can provide early and effective treatment and prevent structural impairment. This study aims to identify nail ultrasonographic characteristics in three groups: psoriasis (PsO), psoriatic arthritis (PsA) and controls patients, to determine if the ultrasonography (US) can identify early signs of nail psoriatic impairment or local inflammation. We conducted nail US to determine nail matrix resistance index (NMRI), nail bed resistance index (NBRI), and power Doppler (PD) and grayscale (GS) parameters in these 3 groups.

Methods: Single-center, cross-sectional study. GS, PD, and spectral doppler images of bilateral 2nd and 3rd fingernails were acquired from 35 PsO, 31 PsA, and 35 controls patients. An US equipment with an 18 MHz linear transducer for GS and 8.0 MHz for PD was used. PD, NMRI, NBRI, nail plate thickness (NPT), nail bed thickness (NBT), nail matrix thickness (NMT), and morphostructural characteristics of the trilaminar structure (TS) were evaluated in saved images, blind.

Results: Mean NMRI and NBRI did not differ between groups. Linear regression analysis detected no relationships between PsO or PsA and NMRI or NBRI. Nail PD grade did not differ between groups. Type I and IV TS changes were more frequent in PsO; types II and III changes were more frequent in PsA ($p < 0.001$). NPT was greater in PsA and PsO groups than controls: PsA 0.73 ± 0.14 mm, PsO 0.72 ± 0.15 mm, Controls 0.67 ± 0.10 mm ($p = 0.001$).

Conclusion: Echographic TS characteristics of the nail plate and NPT evaluated by GS are useful and can distinguish PsO and PsA nails from controls. NMRI, NBRI, and US nail microcirculation parameters could not distinguish psoriatic nails.

Trial registration: 72762317.4.0000.5327 (Certificate of Presentation of Ethical Appreciation – CAAE - Plataforma Brasil) Avaiable in https://plataformabrasil.saude.gov.br/login.jsf.

Keywords: Doppler ultrasonography, Nails, Psoriasis, Psoriatic arthritis, Ultrasonography

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Background

Nail involvement by psoriatic disease occurs in 40–45% of patients with skin psoriasis (PsO) and in around 80.5% of patients with psoriatic arthritis (PsA) [1, 2]. The lifetime incidence of nail involvement in psoriatic patients is estimated to be between 80 and 90% [3]. Furthermore, nail psoriasis can lead to functional impairment, pain, discomfort, decreased quality of life and can also be a predictor for the development of arthritis [4, 5]. Therefore, early recognition of this condition is essential to facilitate early and effective treatment and to prevent structural impairment.

Ultrasonography (US) is considered a highly promising method to visualize nail disease. However, there is no consensus yet about which parameters and features can provide accuracy in the evaluation of nail psoriasis [6].

Examination of the normal structure of the nail on grayscale (GS) US images can identify the nail plate (NP), the nail bed (NB), and the nail matrix (NM). The NP is a trilaminar structure (TS) comprising dorsal and ventral plates that appear as 2 hyperechoic parallel lines with a virtual hypoechoic space in between. The nail bed is a hypoechoic band between the ventral nail plate and the distal phalanx margin. The nail matrix is an isoechoic (soft gray) region at the proximal end of the nail bed in the region below the proximal nail fold. The phalanx is the deepest structure, appearing as a hyperechoic band, located immediately below the nail bed [7, 8].

US examination can detect many changes to psoriatic nails, even in the absence of clinical findings [9–13]. Wortsman et al. described and classified 4 types of US TS changes, ranging from the earliest to the most severe: focal hyperechoic involvement of the ventral plate without involvement of the dorsal plate (type I), loosening of the borders of the ventral plate (type II), appearance of wavy plates (type III), and loss of definition on both plates (type IV) (Fig. 1) [8]. The NB is usually thickened in psoriatic nails (2.0–3.0 mm) [11, 14].
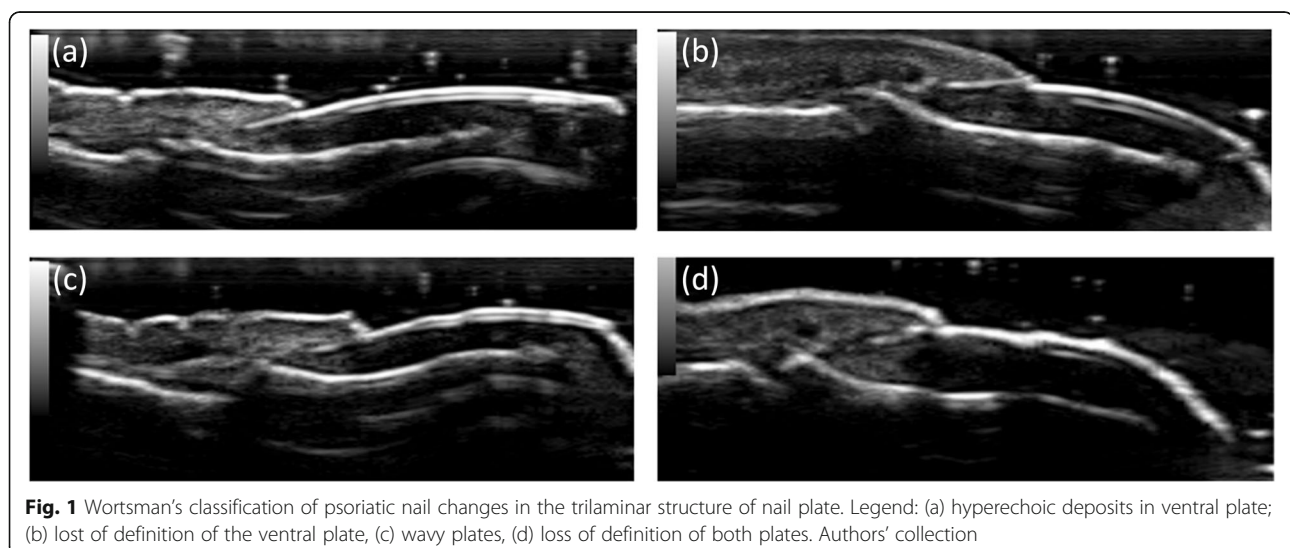
Power Doppler (PD) can identify signals in psoriatic nails [14]. Gutierrez et al. have developed a scoring system to quantify PD signal activity, as follows: 0 = no signal, 1 = confluent signal in < 25% of the area evaluated, 2 = confluent signal in > 25% and < 50%, 3 = confluent signal in > 50% [15].
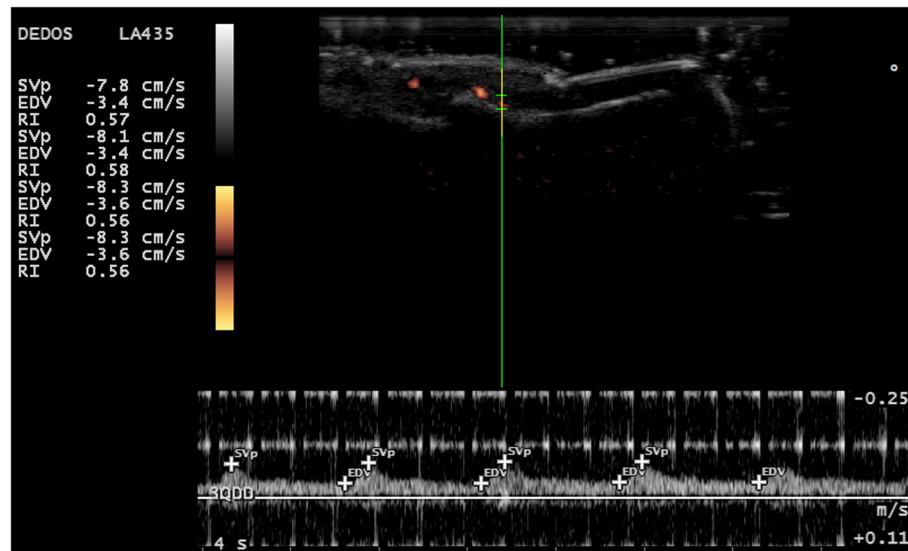
The Spectral Doppler (SDo) technique can differentiate between low and high peripheral resistance by assessing the movement of red blood cells in small blood vessels with low velocity flow. Peripheral resistance is expressed numerically by the Resistance Index (RI), which is assessed as the following ratio: $(Qs - Qd) / Qs$, where Qs represents the maximum flow velocity in systole and Qd the end diastolic flow velocity (Fig. 2). In synovitis, RI ratios range from 0 to 1, high values mean high resistance, which is normal in resting musculoskeletal tissues [16–19].

This study is designed to identify differences between PsO and PsA patients and controls in terms of NM and NB microcirculation and US nail anatomy, using GS, PD, and SDo, with a primary focus on RI measurement. If present, such differences could provide the basis for a noninvasive method for early detection of inflammation in nail apparatus of PsA and PsO patients, enabling early treatment and prevention of joint deterioration.

Methods

This was a single-center, cross-sectional, observational study, conducted in the Rheumatology and Dermatology outpatient clinics at the Hospital de Clínicas de Porto Alegre, RS, Brazil, from October 2017 to June 2018.

Fig. 1 Wortsman's classification of psoriatic nail changes in the trilaminar structure of nail plate. Legend: (a) hyperechoic deposits in ventral plate; (b) lost of definition of the ventral plate, (c) wavy plates, (d) loss of definition of both plates. Authors' collection

Fig. 2 RI measure by spectral doppler. Legend: SVp: maximum blood flow velocity in systole. EDV: diastolic blood flow velocity. RI: resistence index. Authors' collection

Sample size was calculated to detect an effect size of 0.36 in NMRI measures between groups, considering a Standard Deviation (SD) of 0.41 [20]. This calculation was performed using SAS Studio and considering power of 80% and α = 0.05. Age was included as a covariate in the sample size calculation because previous studies suggest that it can influence evaluation of nail structure with Doppler [12, 21]. A low degree of correlation (0.2) was used because there is no data in the literature regarding the correlation between age and RI. The result of the sample size calculation was 81 patients, 27 in each group.

PsA patients were consecutively enrolled during their routine medical consultations. PsO patients without joint symptoms or complaints and controls were matched to the PsA group by age and gender. Participants for the control group were selected from among patients at dermatology and anesthesia outpatients clinics and hospital staff.

Participants were at least 18 years-old; to be eligible for the PsA group, they had to fulfill the CASPAR criteria [22]; for the PsO group, patients should have a diagnosis of cutaneous PsO and no signs or symptoms of present or past joint disease (arthritis, enthesitis or synovitis). Patients with fibromyalgia were excluded from the PsA group because it is difficult to differentiate between pain caused by this condition and enthesitic pain. Additional exclusion criteria for all groups included: other inflammatory joint diseases, dermatological or systemic diseases that could modify the nail structure; and severe pulmonary, vascular or hematological diseases that can interfere with circulatory evaluation [21]. Diabetes Mellitus (DM), High Blood Pressure (HBP) and smoking were not exclusion criteria for any of the groups.

The National Research Ethics Committee of Brazil approved this study under registration number 72762317.4.0000.5327, and informed consent was obtained from all participants before clinical and sonographic examinations.

Clinical evaluation

Patients answered a questionnaire about demographic and disease characteristics. On the same day, a dermatologist assessed the percentage of affected body surface area (BSA) and calculated the Psoriasis Area and Severity Index (PASI) [23] and the Nail Psoriasis Severity Index (NAPSI) [24]. Psoriatic arthritis activity was assessed by a rheumatologist during the medical consultation, using the Disease Activity in Psoriatic Arthritis (DAPSA) score [25], the Maastricht Ankylosing Spondylitis Enthesis Score (MASES) [26], the Minimal Disease Activity (MDA) criteria [27], a patient Visual Analog Scale (VAS) for pain, and a global patient VAS [28], plus blood test results for C reactive protein (CRP) and Erythrocyte Sedimentation Rate (ESR).

Ultrasonographic assessment of nails

Examinations were performed using a MyLab 50 system (Esaote Biomedica, Genova, Italy), equipped with a linear 10 to 18 MHz transducer for GS and a 6.6 to 8.0 MHz transducer for PD. The imaging parameters for Doppler ultrasound examinations were pulse repetition frequency of 700 Hz with color gain maximized for optimal sensitivity while avoiding excessive color noise.

Sonographic examinations were performed in a room with temperature between 22 °C and 26 °C, after a 10 min period at rest. The patient was seated, with forearms, hands and fingers in a neutral and relaxed position on the table and nails were scanned in the longitudinal plane. A thick gel layer was applied to provide an adequate acoustic interface and to avoid compression of the structures. The 2nd and 3rd fingernails of both hands were evaluated.

Images were saved and measures and evaluations were performed at a later date, without identification of the patient, by the same researcher who conducted the US examinations. In GS, the following structures were assessed: 1) the trilaminar appearance of the NP, graded according to Wortsman's classification of changes in psoriatic nails [8], 2) nail plate thickness (NPT), measured at the thickest point, 3) nail bed thickness (NBT), measured at the middle third of the NP, 4) nail matrix thickness (NMT), defined as the hypoechoic region below the proximal nailfold, above the cortex of the distal phalanx, determined by a perpendicular line to the bone profile [8, 12, 29] (Fig. 3).

Presence or absence of blood flow signal in the NM and the NB were evaluated in PD images and classified according to the Gutierrez score [15]. The MyLabDesktop software enables automatic calculation of RI in Spectral wave analysis of a saved image when the cursor is placed at maximum systolic velocity and end diastolic flow velocity (Fig. 2). Three measurements were taken and the arithmetic mean was considered the RI. All measurements were taken and all scores were calculated by the same researcher and agreement with an experienced sonographer was tested for 20 selected images of the nail unit. Cohen's Kappa [30] was 0.51.

Statistical analyses

Quantitative variables are expressed as mean ± SD and categorical variables as absolute frequencies and percentages. Comparisons between independent means were analyzed using ANOVA or the Kruskal-Wallis test. Associations between categorical variables were calculated using the chi-squared test or Fisher's exact test. Correlations between quantitative variables were analyzed with Spearman's correlation coefficients. Linear regression analysis was performed with each of the quantitative variables. Statistical significance was defined as a p value ≤0.05. SPSS 21.0 was used for statistical analysis.

Results

Thirty-five patients with PsO; 31 with PsA, and 35 controls were enrolled on the study. One hundred and twenty-three nails were evaluated in the PsA group (76 with clinical nail psoriasis); 139 in the PsO group (60 with clinical nail psoriasis); and 138 in the control group. Patient's demographic and disease characteristics are summarized in Table 1. No gender or age differences were found between groups.

There were no differences between the groups in terms of mean NMRI, NBRI, NBT, or NMT. There was no statistical difference between groups in nail PD grades. Mean NPT ± SD (mm) was higher in the PsA and PsO groups than in the control group: 0.73 ± 0.14 in the PsA group, 0.72 ± 0.15 in the PsO group, and 0.67 ± 0.10 in the control group (p = 0.001). (Table 2).

Patients undergoing systemic treatment for either PsO or PsA did not present differences in NMRI, NBRI, NPT, NBT and NMT measurements when compared to patients not undergoing systemic treatment. The same comparison was made both within and between PsO and PsA groups and no differences were found.

NPT was the only measurement to show different results when patients with clinical nail psoriasis - mean 0.75 mm (CI 0.71–0.80) - and patients without clinical nail involvement - 0.68 mm (CI 0.67–0.72) - were compared (p = 0,042). No differences were found when the same comparison was made between PsO and PsA groups.

The TS evaluation was conducted using the Wortsman classification [8]. In the control group, 137 (99.3%) nails
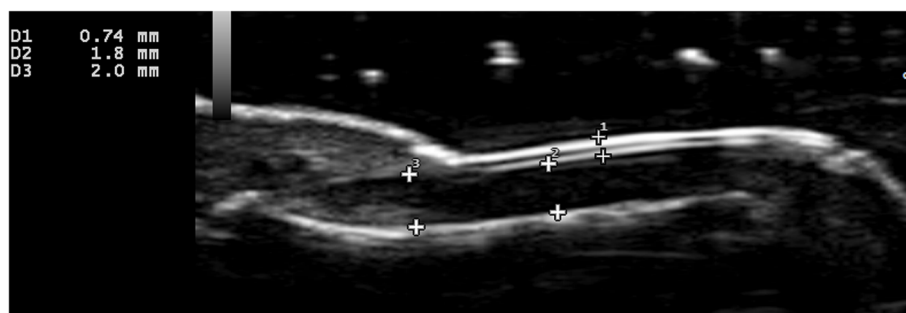
Fig. 3 Measures of nail plate, nail bed and nail matrix thickness in US gray scale. Legend: Nail plate thickness measure (1); nail bed thickness measure (2) and nail matrix thickness measure (3). Authors' collection

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Table 1 Demographic and Disease characteristics in each group

	PsA (n = 31)	PsO (n = 35)	Controls (n = 35)	p value*
Gender – n(%)				
Female	16 (51.6)	18 (51.4)	21 (60.0)	0.767
Male	15 (48.4)	17 (48.6)	14 (40.0)	
Age (years) –				
mean ± SD	53.03 ± 9.64	54.46 ± 11.43	53.37 ± 10.80	0.521
Havy manual labor – n(%)	25 (80.6)	28 (80.0)	25 (71.4)	0.692
Comorbidities – n(%)				
HBP	12 (38.7)	13 (37.1)	13 (37.1)	0.99
DM	7 (22.6)	8 (22.9)	3 (8.6)	0.217
Smoking	5 (16.1)	5 (14.3)	3 (8.6)	0.627
PsO Family History– n(%)	11 (35.5)	19 (54.3)	3 (8.6)	< 0.001
Mean duration of cutaneous PsO (years) – mean ± SD	18.81 ± 10.73	16.16 ± 10.33	–	0.311
PASI – m [P25% - P75%]	(n = 13) 1.0 [0.70–4.15]	(n = 24) 3.75 [1.15–5.83]	–	0.171
With clinical nail involvment – n(%)	15 (48.4)	19 (54.3)	–	0.805
NAPSI – m [P25% - P75%]	(n = 15) 20 [4–34]	(n = 19) 11 [5–33]	–	0.891
PsO/PsA Current Treatment n(%)				
MTX	18 (58.1)	17 (48.6)	–	0.600
Phototherapy	3 (9.7)	7 (20.0)	–	0.410
Immunobiological	10 (32.3)	4 (11.4)	–	0.078
Corticosteroids	6 (19.3)	0 (0.0)	–	0.003
Any systemic treatment	27 (77.1)	21 (60.0)	–	0.029

Legend: *n* absolute frequency of patients, *SD* standard deviation, *m* median, *[P25% - P75%]* percentile 25% - percentile 75%), *PsO* psoriasis, *PsA* psoriatic arthritis, *HBP* high blood pressure, *DM* diabetes mellitus, *PASI* psoriasis area severity index, *NAPSI* nail psoriasis severity index, *MTX* methotrexate, * significance fixed on *p* < 0,05

had no TS changes. In the PsO group, 32 nails had changes in this structure, 9 type I, 5 type II, 7 type III, and 11 type IV. In the PsA group, there were also 32 nails with TS changes, 4 type I, 15 type II, 9 type III and 4 type IV.

Correlations between disease activity classifications and the variables studied were as follows: NBT with MASES ($r_s = 0.228$ $p < 0.001$); NPT with NAPSI ($r_s = 0.258$ $p < 0.001$) and with MASES ($r_s = 0.246$ $p = 0.006$). Patients in MDA (Minimal Disease Activity) had lower NPT ($r_s = -0.307$, $p = 0.002$). Patients with higher NAPSI had a higher frequency of TS changes ($r_s = 0.459$, $p < 0.001$). Trilaminar structure changes were also correlated with presence of clinical nail psoriasis ($r_s = 0.328$ $p < 0.001$) and with MASES ($r_s = 0.249$ $p = 0.006$).

Independent variables explaining the main ultrasonographic nail changes according to the linear regression model are shown in Table 3.

Discussion

Ultrasonography can be employed as a method for early detection and careful characterization of the inflammatory process in different anatomical structures and different stages of the disease in patients with PsO and PsA [11]. Since the nail apparatus can be considered a part of the musculoskeletal system and a link between joint and tegument [31], US nail evaluation has emerged as a promising tool for early identification of nail psoriasis, as a possible technique for distinguishing PsO from PsA patients and for differentiating psoriatic patients from control group patients [6].

Our study compared gray scale (NPT, NBT, NMT and TS) and power Doppler (NMRI, NBRI) nail measures among PsA, PsO, and control subjects and found that TS and NPT were different in psoriatic patients.

In previous studies, NMRI was higher in PsO patients compared to controls. The authors explained their results by the endothelial disfunction in patients with psoriasis and by capillaroscopic findings in nail folds showing greater tortuosity and decreased capillary density in psoriatic patients [18, 32, 33]. Another study found lower NMRI in PsA patients compared to control subjects, probably due to the close relationship between distal interphalangeal (DIP) enthesis and the nail matrix.

Table 2 Prevalences and means of outcomes among groups

	PsA (n = 123)	PsO (n = 139)	Controls (n = 138)	p * value
Trilaminar Structure (Wortsman's Classification) – n(%) [†]				
0	91 (74.0)	107 (77.0)	137 (99.3)**	< 0.001
I	4 (3.3)	9 (6.5)**	1 (0.7)	
II	15 (12.2)**	5 (3.6)	0 (0.0)	
III	9 (7.3)**	7 (5.0)	0 (0.0)	
IV	4 (3.3)	11 (7.9)**	0 (0.0)	
Degree of PD Nail Matrix and Bed Together– n(%) [†]				
0	19 (17.8)	7 (6.5)	10 (9.4)	p = 0.133
1	77 (72.0)	91 (85.0)	84 (79.2)	
2	7 (6.5)	8 (7.5)	8 (7.5)	
3	4 (3.7)	1 (0.9)	4 (3.8)	
NPT – mean ± SD [‡]	0.73 ± 0.14^a	0.72 ± 0.15^a	0.67 ± 0.10^b	=0.001
NBT – mean ± SD [‡]	1.88 ± 0.34	1.97 ± 0.38	1.90 ± 0.31	=0.085
NMT – mean ± SD [‡]	2.00 ± 0.32	2.07 ± 0.37	1.97 ± 0.36	=0.068
NMRI – mean ± SD [‡]	(n = 84) 0.49 ± 0.06	(n = 95) 0.50 ± 0.07	(n = 91) 0.49 ± 0.06	=0.415
NBRI – mean ± SD [‡]	(n = 46) 0.51 ± 0.07	(n = 83) 0.53 ± 0.07	(n = 79) 0.52 ± 0.06	=0.115

Legend: *n* absolute frequency of patients, *SD* standard deviation, *PsO* psoriasis, *PsA* psoriatic arthritis, *NPT* nail plate thickness, *NBT* nail bed thickness, *NMT* nail matrix thickness, *NMRI* resistance index in nail matrix, *NBRI* resistance index in nail bed. [†] Chi-Square Analysis of qualitative variables. [‡] One-Way ANOVA $p < 0.001$, post hoc Turkey. [a, b]: equal letters means there is no difference between means with $p > 0.05$; different letters means there is a difference between means with $p < 0.05$. * significance fixed on $p < 0,05$, **with statistically significant difference

According to those authors, the DIP enthesis inflammation extends into the nail matrix, resulting in vasodilatation and decreased RI [19, 20].

Our results did not confirm previous studies' findings of differences in mean NMRI between PsA, PsO, and control groups. The linear regression analysis did not show any associations between RI measures and PsO or PsA diagnoses, despite the > 80% power to detect an effect size of 0.05. This confirms the conclusion that, in our sample, there is no difference in NMRI among groups.

Analyzing mean NMRI data available in the literature, there is a considerable variation in nail RI reported by different authors, particularly for control groups [18, 20, 32, 33]. Measurement of RI is operator dependent and difficult to standardize, which makes it difficult to compare the results. More studies, with larger samples, that clarify the behavior of NMRI measurement and identify factors that can influence NMRI measures in healthy patients are important to enable study of this parameter in disease.

In larger vessels such as the renal and umbilical arteries, RI has exhibited influence from gender, age, DM, and smoking [21]. However, it still remains to be

Table 3 Linear regression analysis of quantitative outcomes

Nail Matrix RI		
Variable	Standardized β	p value*
Multivariate model	(Adjusted R^2) = 0,125	
Age	0.002	< 0.001
Nail Bed RI		
Variable	Standardized β	p value*
Multivariate model	(Adjusted R^2) = 0,175	
Age	0.002	< 0.001
Gender [a]	−0.021	0.017
Tabagism	0.031	0.015
Nail Matrix Thickness		
Variable	Standardized β	p value*
Multivariate model	(Adjusted R^2) = 0,332	
Age	0.008	< 0.001
Gender [a]	0.359	< 0.001
Havy manual labor	0.148	0.003
Hand Side [b]	−0.332	< 0.001
Nail Bed Thickness		
Variable	Standardized β	p value*
Multivariate model	(Adjusted R^2) = 0,270	
Age	0.005	< 0.001
Havy manual labor	0.167	< 0.001
Hand Side [b]	−0.220	< 0.001
Fingernail [c]	0.142	< 0.001
HBP	0.140	< 0.001
DM	−0.113	0.006
Nail Plate Thickness		
Variable	Standardized β	p value*
Multivariate model	(Adjusted R^2) = 0,189	
PsA	0,051	0,001
PsO	0,041	0,006
Age	0.002	< 0.001
Havy Manual Labor	0.037	0.012
Hand Side [b]	0.035	0.004
Smoking	0.099	< 0.001
DM	−0.057	0.001

Legend: *PsO* psoriasis, *PsA* psoriatic arthritis, *RI* resistance index, *HBP* high blood pressure, *DM* diabetes mellitus.
[a] Gender: positive β: variable higher in male gender, negative β: variable higher in female gender.
[b] Hand Side: positive β: variable higher in left side, negative β: variable higher in right side.
[c] Fingernail: positive β: variable higher in 2nd fingernal, negative β: variable higher in 3rd fingernail.
* significance fixed on $p < 0,05$

determined which factors can influence this measure in microcirculation. In the linear regression analysis, NMRI ($R^2 = 0.125$) was related to age and NBRI ($R^2 = 0.175$),

increasing with age, and was higher in females and smokers.

Several authors have shown that NPT, NMT, and NBT were greater in psoriatic patients than controls [9, 11, 13, 14, 32, 34–38]. The present study only detected this increase in NPT. However, the mean NPT in each group was higher than those found by previous studies and it is possible that the great variation in measurements in the literature is partly related to ethnic differences [35, 36]. Larger samples could possibly reveal increases in NMT and NBT in psoriatic patients. There was no difference in NPT, NMT, or NBT between PsO and PsA patients. Our results reproduce the higher NPT measures on patients with clinical signs of nail psoriasis found in previous studies. However, our analyses did not result in higher NBT and NMT measures on these patients, as demonstrated in previous studies [32, 36, 37]..

Linear regression analysis demonstrated that NPT values were directly related (R^2 0.189) to age, presence of PsA, having PsO, right hand, heavy manual labor, and smoking habit, and inversely related to DM. A relationship between heavy manual labor and increased NPT and NBT is expected as a result of triggering of the cycle of local microdamage and repair that results in a deep Koebner phenomenon, as occurs in skin [31]. The analysis also revealed a direct relationship between NBT (adjusted for age, HBP, DM, hand side, and fingernail) and heavy manual labor ($R^2 = 0.189$).

The TS changes in the NP of psoriatic patients described by Wortsman et al. [8] were evident in the results and although the frequencies of each grade of change in each group of patients were different to those reported in previous studies [11, 36], this study was able to differentiate psoriatic patients from control patients on the basis of the presence of these changes. Presence of TS changes had direct correlations with clinical nail involvement, NAPSI, MASES, and NPT. Other authors have shown relationships between TS changes and clinical nail involvement previously [32, 38, 39].

Even though the majority of studies have reported increased PD signal in the NB and NM of psoriatic patients [11, 13, 14, 32, 36, 40], capillaroscopic evaluation of the proximal nailfold of these patients has shown decreased number and diameter of capillaries and increased vessel tortuosity [41, 42]. In our study, the grade of NMPD signal and PD assessed in the NB and NM together failed to reveal differences between groups and the NBPD signal was more frequently absent in the PsA group. Recently, Naredo et al. [34] demonstrated that neither NBPD or NMPD classified as per Gutierrez et al. [15], nor PD evaluated in the NB and NM together, could discriminate between control and psoriatic groups, or between clinically involved and clinically non-involved nails. These authors, in common with Aydin et al. [43], demonstrated that the amount of blood flow detected in control subjects is highly variable.

The discrepancies found between our results and those of previous studies may be related to the diversity in ultrasound equipment employed during the data collection phase, especially concerning frequency range, which may have affected the precision of the measurements. Some cited studies [8, 36, 33] also only focused on PsO and PsA patients with current clinical psoriatic nails, another possible cause for measurement variations.

Our study has some limitations, such as the equipment used, that had lower frequency, both for GS and PD, when compared with more recent studies, although it is high frequency. The fact that we analyzed only 4 fingernails of which patients also can be considered a limitation. Our study is the first to that compare NMRI and NBRI among these three groups (PsO, PsA, and controls).

Conclusions

In conclusion, echographic TS characteristics and NPT seem capable of distinguishing between psoriatic nails and controls nails, but not between PsO and PsA patients. Neither NMRI nor the other measures and parameters evaluated in the study could distinguish between psoriatic nails and control nails. Although US nail microcirculation parameters did not demonstrate utility for diagnostic of psoriatic nail, nail GS US is helpful and allows nails from psoriatic patients to be distinguished from those of control patients, even in the absence of clinical signs of nail psoriasis. Future studies are needed to clarify the characteristics and variations of the parameters of nail US in PsO and PsA patients, since there is no consensus to date.

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in writing the manuscript, in collected the data and in statistical analysis. All authors read and approved the final manuscript.

Availability of data and materials
The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
The study was approved by the National Research Ethics Committee of Plataforma Brasil (n° 72762317.4.0000.5327).
All participants consented the participation in the study.

Consent for publication
All participants consented the publication of the data and collected ultrasonography images.

Competing interests
The authors declare that they have no competing interests.

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