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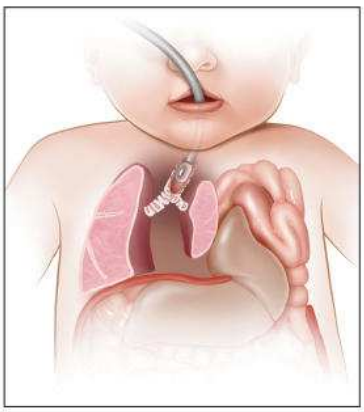

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Ultrasonographic Criteria for Diagnosing Unilateral and Bilateral Retronychia

Javier Fernández, MD, Francisco Reyes-Baraona, MD, Ximena Wortsman, MD

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Objectives—To assess the main characteristics of retronychia on ultrasonography (US) and to propose US criteria for diagnosing unilateral and bilateral cases according to the digit.

Methods—We conducted a case-control study with retrospective, descriptive, and statistical analyses of the US images of 210 nails: 43 with retronychia and 167 normal nails. The Student *t* test, Fisher exact test, and Kruskal-Wallis test, among other tests, were performed. $P < .05$ was considered significant.

Results—Seventy percent of the patients were females, and the most affected digit was the big toe. Significant US diagnostic criteria were as follows: criterion 1, hypoechoic halo surrounding the origin of the nail plate; criterion 2, distance between the origin of the nail plate and the base of the distal phalanx of 5.1 mm or less in big toes and thumbs and/or a difference of 0.5 mm of this distance or greater between the affected nail and the contralateral healthy nail; and criterion 3, proximal nail fold thickness of 2.2 mm or greater for male patients or 1.9 mm or greater for female patients and/or a proximal nail fold 0.3 mm thicker or greater in comparison with the contralateral healthy nail. Cutoff points, sensitivity, and specificity with a 95% confidence interval were defined for each criterion according to the digit in cases with unilateral and bilateral involvement.

Conclusions—Ultrasonography can support the diagnosis of retronychia in unilateral and bilateral cases.

Key Words—dermatologic ultrasound; dermatology; paronychia ultrasound; nail ultrasound; proximal ingrowing nail; retronychia; retronychia ultrasound

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Address correspondence to Ximena Wortsman, MD, Department of Imaging, Institute for Diagnostic Imaging and Research of the Skin and Soft Tissues, Lo Fontecilla 201, Of 734, Las Condes, 7591018 Santiago, Chile.

E-mail: xworts@yahoo.com

Abbreviations

AUROC, area under the receiver operating characteristic curve; CI, confidence interval; US, ultrasonography

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Retronychia is a nail disorder characterized by embedding of the proximal nail plate into the proximal nail fold, which clinically appears as an apparent halt to nail growth with a chronic proximal paronychia.[1–4] It may be an underestimated condition that can appear after or concomitant to a severe illness, can be related to stress-relevant situations, can be secondary to trauma, including sports injuries, or can appear as an idiopathic episode.[2–10] Additionally, it has been reported that retronychia may have a similar etiology as Beau lines and onychomadesis. Thus, in addition to the previously described potential conditions, it can include stress in utero, medications, and hereditary causes, among others.[2]

So far, the diagnosis has been essentially clinical, which may represent a challenge because retronychia can easily mimic other nail disorders such as infections, psoriasis, tumors, and other common causes of nail dystrophy.[1–4] Thus, because of its simulative nature, retronychia can generate several consultations to a wide range of specialists, which include dermatologists and orthopedic surgeons, and can demand consultations in emergency departments.[9] Moreover,

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this condition is usually unresponsive to only antibiotics, and commonly, management is surgical (onysectomy: ie, proximal avulsion of the nail).[11] Retronychia can appear in association with onychomadesis (ie, fragmentation of the nail plate),[5] and since its original description in 1999,[1] there have been an increasing number of case reports.[2–18]

Ultrasonography (US) has been shown to be useful for supporting the diagnosis of this condition.[5–10] For example, a decreased distance between the origin of the nail plate and the base of the distal phalanx in comparison with the contralateral side has been reported in retronychia.[5,6] Other described US features include thickening, decreased echogenicity, and increased blood flow in the dermis of the proximal nail fold and nail bed.[5,6] However, these findings may be difficult to interpret in bilateral retronychia because a US comparison of these characteristics with the contralateral side may not be useful. Additionally, comparisons of the distances may vary between digits because there are relevant anatomic differences in the sizes of the digits (eg, between the thumb and index finger).

Therefore, specific US diagnostic criteria that could allow an earlier and more precise diagnosis seem to be necessary. Furthermore, to the best of our knowledge, specific US criteria for diagnosing bilateral retronychia and studies that considered the anatomic differences between digits have not been reported. The aim of this study was to assess the main US characteristics of retronychia and propose US diagnostic criteria that could be valid for different digits unilaterally and bilaterally.

Materials and Methods

We performed a case-control study with a retrospective interpretation of the images from color Doppler US examinations of all cases with a US diagnosis of retronychia that were evaluated between June 2014 and September 2016. These images were compared with a group of healthy nails.

The patients were included in the study if they met the following eligibility criteria: (1) clinical and US diagnosis of retronychia, which was clinically and/or surgically confirmed by a subsequent dermatologic evaluation; and (2) clinical and US images obtained the same day. Exclusion criteria were as follows: (1) patients without dermatologic evaluations; and (2) other concomitant systemic or local dermatologic disease.

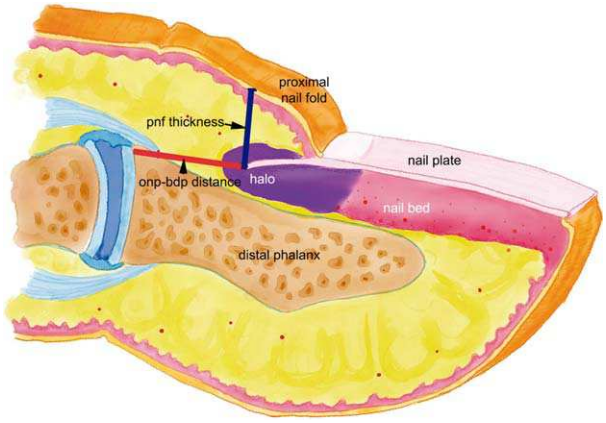
Ultrasonographic Diagnostic Criteria and Evaluation

In all retronychia cases that met the eligibility criteria (43 nails with retronychia and 37 contralateral healthy nails in these cases) and healthy controls (130 nails from 11 participants) the following US diagnostic criteria were defined and evaluated (total, 210 nails): criterion 1, presence of a hypoechoic halo or band surrounding the origin (ie, proximal edge) of the nail plate; criterion 2, distance between the origin of the nail plate and the base of the distal phalanx (millimeters); and criterion 3, thickness of the proximal nail fold (millimeters) (Figure 1).

Additional US features such as echogenicity and hypervascularity (color Doppler and B-flow echoangiography) as well as concomitant alterations of the morphologic characteristics of the nail bed and proximal nail fold were also described.

All US parameters were evaluated in the affected and contralateral digits in all patients as well as in all fingernails of both hands in 11 healthy participants and both big toes in 10 of them. The US equipment was a LOGIQ E9 XD Clear system with high, linear, and compact linear variable-frequency transducers working in an upper range between 15 and 18 MHz (GE Healthcare, Waukesha, WI). The same settings were used in all cases and followed the recommendations of guidelines for performing dermatologic US studies and the reported techniques for examining the nail on US, which included

Figure 1. Retronychia: illustration that shows the US diagnostic criteria for diagnosing retronychia. Criterion 1, hypoechoic halo sign (purple region); criterion 2 (red line), distance between the origin of the nail plate and the base of the distal phalanx (onp-bdp); and criterion 3 (blue line), thickness of the proximal nail fold (pnf).



grayscale and color Doppler evaluations in at least 2 perpendicular axes.[8,19]

All US examinations were performed by the same operator, a senior radiologist with greater than 15 years of experience in soft tissue and superficial structure US. The Institutional Review Board (Clinica Servet) approved the study and waived the need for signed consent from the patients and healthy participants. All clinical and US evaluations followed the Helsinki principles of medical ethics on human subjects.

Control Group

The healthy control group was composed of healthy participants with normal nails (all fingernails from 11 participants and both big toes in 10 of them; n = 130 normal nails) and 37 contralateral healthy nails in cases with unilateral retronychia.

Statistical Analyses

Descriptive and statistical analyses included the Student *t* test, Mann-Whitney *U* test, Fisher exact test, Kruskal-Wallis test, and Dunn post hoc test. Sensitivity and specificity with a 95% confidence interval (CI) were calculated for each US diagnostic criterion. $P < .05$ was considered statistically significant. The software used was Stata version 12 (StataCorp, College Station, TX).

Results

Retronychia Case Analysis

A total of 43 retronychias were evaluated in 37 patients. Unilateral cases constituted 84% (n = 31) and bilateral 16% (n = 6). Seventy percent (n = 26) were female and 30% (n = 11) male, for a female-to-male ratio of 2.4:1. The mean age ± SD was 34.8 ± 18.5 years, with no significant difference in age according to sex ($P = .102$).

The 3 most frequently affected digits in decreasing order were the left big toe (40%), right big toe (28%), and right thumb (12%), with no significant differences in the affected digit according to sex (Table 1). One hundred percent of retronychia cases had a hypoechoic halo surrounding the origin of the nail plate (criterion 1 positive). Considering all digits, the mean distance between the origin of the nail plate and the base of the distal phalanx was 4.3 ± 1.7 mm, and the mean thickness of the proximal nail fold was 2.5 ± 0.7 mm.

Additional US findings were as follows: 72% of nail plates showed proximal nail fold hypervascularity

Table 1. Distribution of the Locations of Retronychia per Digit

Digit	%	n
Left big toe	40	17
Right big toe	28	12
Right index finger	12	5
Right thumb	5	2
Right middle finger	5	2
Left thumb	2	1
Left middle finger	2	1
Left ring finger	2	1
Right ring finger	2	1
Left little finger	2	1

Figure 2. Retronychia: US sign (criterion 1). Ultrasonography (grayscale, longitudinal view, left hallux) shows a hypoechoic band (halo; asterisks) surrounding the origin of the nail plate. Note the partial disruption of the proximal part of the ventral plate (arrow), hypoechogenicity, and thickening of the nail bed.

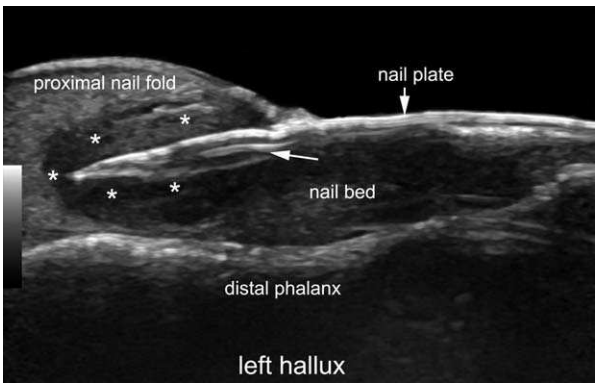
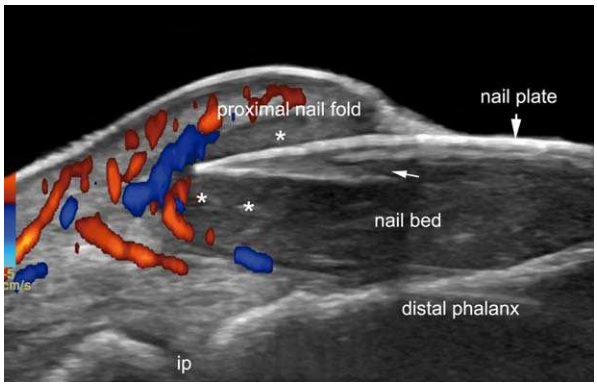
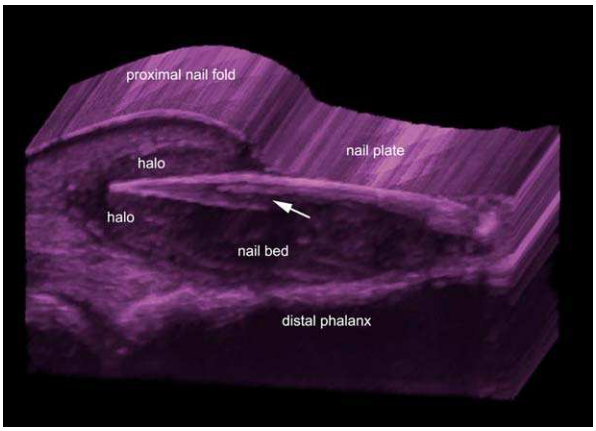


Figure 3. Retronychia: US inflammation signs. Color Doppler US (longitudinal view, left hallux) shows hypervascularity (in colors) at the proximal nail fold and nail bed. The hypoechoic halo sign (asterisks), disruption of the proximal part of the ventral plate (horizontal arrow), and thickening and decreased echogenicity of the nail bed are also shown; ip indicates interphalangeal joint.



suggestive of inflammation; 56% showed hypoechogenicity of the nail bed, compatible with chronic inflammatory changes; and in 67% of the latter cases, the US alterations involved the matrix region (Figures 2–8 and Videos 1 and 2). Concomitant onychomadesis (ie, fragmentation of the nail plate) was present in 40% of the cases; 86% of big toes showed areas of disruption that affected the proximal part of the ventral plate without interruption of the dorsal plate; onychocryptosis was present in 14%; malalignment of the nail was present in 9%; and pincer nails were present in 2%.

Figure 4. Retronychia: 3-dimensional US reconstruction. Note the halo sign and the thickening of the proximal nail fold. Partial disruption of the proximal part of the nail plate (arrow) and thickening and decreased echogenicity of the nail bed are also shown.



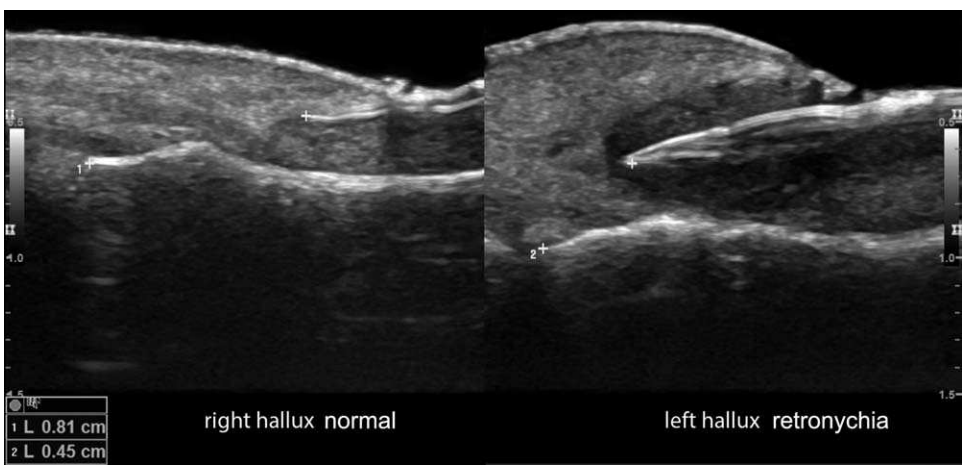
Healthy Control Group Analysis

The mean age of the healthy control group was 31 ± 6.3 years, with 27% female and 73% male participants. The control group did not have a hypoechoic halo surrounding the origin of the nail plate, and there were no significant differences in the comparisons of the distance between the origin of the nail plate and the base of the distal phalanx between contralateral fingernails and big toes (Table 2).

When analyzing the distance between the origin of the nail plate and the base of the distal phalanx per digit, it was greater in the thumbs and big toes (mean, 5.3 ± 0.8 mm) in comparison with the second, third, fourth, and fifth fingernails (mean, 3.8 ± 0.5 mm; $P < .001$). No significant differences were found in the distances between the origin of the nail plate and the base of the distal phalanx according to sex ($P = .742$).

The thickness of the proximal nail fold showed no significant differences in fingernails and big toes ($P = .921$). The mean thickness of the proximal nail fold was 1.8 ± 0.4 mm (n = 130) for all digits (Table 3). When analyzing the thickness of the proximal nail fold according to sex, a significantly thinner proximal nail fold ($P < .001$) was detected in female participants (female [n = 36], 1.6 ± 0.2 mm; male [n = 94], 1.9 ± 0.4 mm).

Figure 5. Retronychia: US measurement of the distance between the origin of the nail plate and the base of the distal phalanx (criterion 2) in big toes. Ultrasonography (grayscale, longitudinal views, side-by-side comparison between the right [normal; 8.1 mm] and left [retronychia; 4.5 mm] big toes) shows decreased distance in the retronychia. There is also a halo sign (criterion 1) and thickening of the proximal nail fold (criterion 3) on the retronychia side.



Distance Between the Origin of the Nail Plate and the Base of the Distal Phalanx in Retronychia Versus Healthy Group Nails

The analysis of the distance between the origin of the nail plate and the base of the distal phalanx showed significant differences in the thumbs and big toes, with mean values of 4.5 ± 1.9 mm (n = 32) in the retronychia group and 5.7 ± 1.3 mm (n = 64) in the healthy group ($P < .001$). On the other hand, there were no differences in this distance between the retronychia group (3.8 ± 0.2 mm [n = 11]) and healthy group (3.9 ± 0.5 mm [n = 99]) for the second, third, fourth, and fifth fingernails ($P = .756$).

Figure 6. Retronychia: US measurement of the distance between the origin of the nail plate and the base of the distal phalanx (criterion 2) in the middle fingers. Ultrasonography (grayscale, longitudinal views, side-by-side comparison between the right [normal; 4.2 mm] and left [retronychia; 3.0 mm] middle fingers) shows a decreased distance in retronychia. Note the halo sign (criterion 1) and the thickening of the proximal nail fold (criterion 3) on the retronychia side.

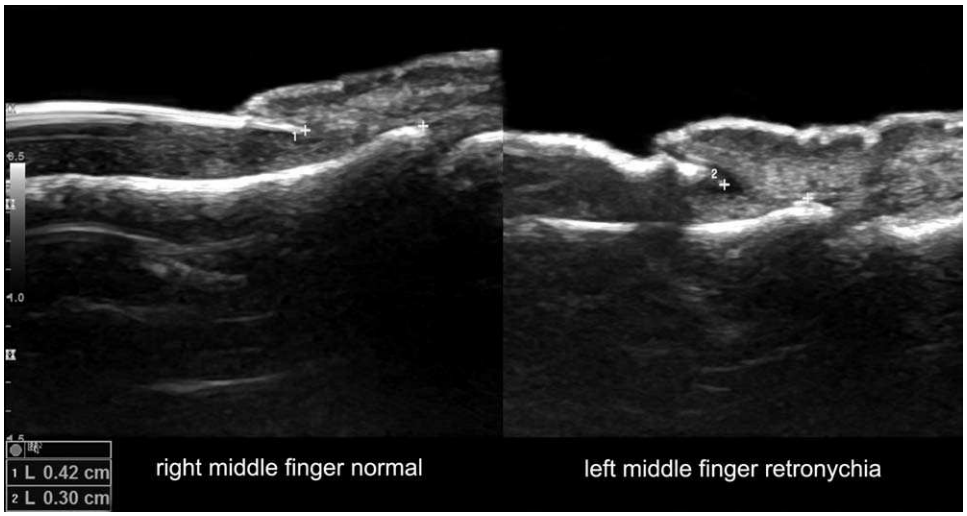
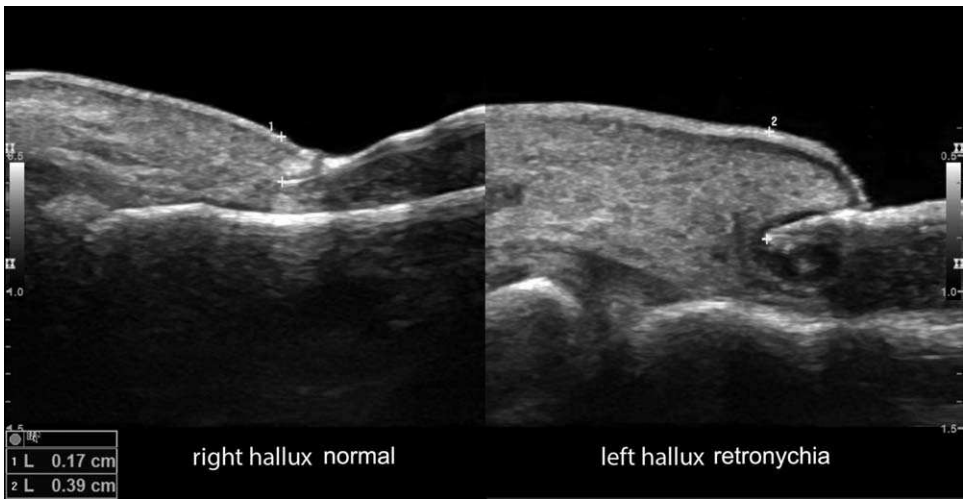


Figure 7. Retronychia: US measurement of the thickness of the proximal nail fold (criterion 3). Ultrasonography (grayscale, longitudinal views, side-by-side comparison between the right [normal; 1.7 mm] and left [retronychia; 3.9 mm] big toes) shows increased thickness of the proximal nail fold in retronychia. Note the decreased echogenicity of the proximal nail fold and nail bed as well as the halo sign and increased thickness of the abnormal nail bed. Partial disruption of the proximal part of the ventral plate is shown on the retronychia side.



Thickness of the Proximal Nail Fold in Retronychia Versus Healthy Group Nails

Significant differences ($P < .001$) were found in the comparison of the thickness of the proximal nail fold of the fingernails and big toes between retronychia and healthy group nails (retronychia, 2.5 ± 0.7 mm [n = 43]; healthy nails, 1.8 ± 0.5 mm [n=163]).

Specific and Significant Statistical Analyses of US Diagnostic Criteria for Diagnosing Retronychia

Sensitivity and Specificity of Criterion 1

The presence of criterion 1 (hypoechoic halo) had sensitivity of 100% (95% CI, 92%–100%) and specificity of 100% (95% CI, 95%–100%; area under the receiver operating characteristic curve [AUROC], 1.00; 95% CI, 0.966–1.00) for diagnosing retronychia in all fingernails and big toes.

Cutoff Points, Sensitivity, and Specificity of Criteria 2 and 3 for Diagnosing Unilateral Retronychia

When considering the distance between the origin of the nail plate and the base of the distal phalanx (criterion 2) in all the affected fingernails and big toes, a difference of 0.5 mm or greater between the nail affected with retronychia and the healthy contralateral nail in the same patient was found, with sensitivity of 82% (95% CI, 60%–95%) and specificity of 71% (95% CI, 48%–89%; AUROC, 0.871; 95% CI, 0.720–0.947) for diagnosing retronychia in the thumbs and big toes and sensitivity of 82% (95% CI, 48%–98%) and specificity of 91% (95% CI, 78%–98%; AUROC, 0.886; 95% CI, 0.777–0.958) for the second, third, fourth, and fifth fingernails.

A significant difference was found in the comparison of the thickness of the proximal nail fold (criterion 3) in retronychia nails and healthy contralateral nails of

Figure 8. Retronychia: US comparison of vascularity between normal and abnormal sides. Color Doppler US (longitudinal views, side-by-side comparison between the right [normal] and left [retronychia] big toes) shows is increased vascularity (in colors) in the proximal nail fold and nail bed on the affected side. Note the halo sign (criterion 1) and the increased thickness of the proximal nail fold (criterion 3) on the retronychia side.

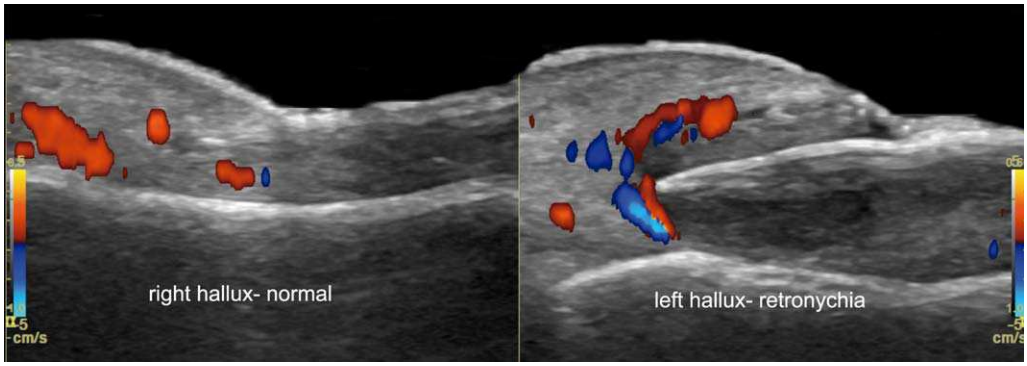


Table 2. Distance Between the Origin of the Nail Plate and the Base of the Distal Phalanx in Healthy Participants[a]

Digit	Left, mm	Right, mm
Big toe	5.1 ± 1.3	5.1 ± 0.9
Thumb	5.6 ± 0.5	5.5 ± 0.5
Index finger	3.7 ± 0.3	3.6 ± 0.4
Middle finger	3.7 ± 0.5	3.6 ± 0.5
Ring finger	3.9 ± 0.5	3.7 ± 0.5
Little finger	4.1 ± 0.6	4.0 ± 0.7

Data are presented as mean ± SD.
[a]Distance in similar nails that were affected by retronychia.

Table 3. Thickness of the Proximal Nail Fold in Healthy Participants[a]

Digit	Left, mm	Right, mm
Big toe	2.0 ± 0.8	2.0 ± 0.7
Thumb	1.8 ± 0.3	1.7 ± 0.3
Index finger	1.8 ± 0.4	1.8 ± 0.3
Middle finger	1.7 ± 0.2	1.8 ± 0.3
Ring finger	1.6 ± 0.3	1.7 ± 0.3
Little finger	1.7 ± 0.3	1.7 ± 0.3

Data are presented as mean ± SD.
[a]Thickness in similar nails that were affected by retronychia.

the same patient. A difference of 0.3 mm or greater showed sensitivity of 79% (95% CI, 61%–91%) and specificity of 82% (95% CI, 70%–90%; AUROC, 0.871; 95% CI, 0.783–0.927) for diagnosing retronychia in all fingernails and big toes.

When both criteria were combined, distance between the origin of the nail plate and the base of the distal phalanx (criterion 2) of 0.5 mm or greater and thickness of the proximal nail fold (criterion 3) of 0.3 mm or greater (cutoff points 1 and 2, respectively), sensitivity of 59% (95% CI, 36%–80%) and specificity of 86% (95% CI, 64%–97%; AUROC, 0.724; 95% CI, 0.563–0.846) were calculated for diagnosing retronychia in the thumbs and big toes, and sensitivity of 64% (95% CI, 31%–89%) and specificity of 98% (95% CI, 88%–99%; AUROC, 0.806; 95% CI, 0.670–0.895) were calculated for the second, third, fourth, and fifth fingernails.

Cutoff Points for Criterion 2 for Diagnosing Bilateral Retronychia

A cutoff point for the distance between the origin of the nail plate and the base of the distal phalanx distance (criterion 2) of 5.1 mm or less in the big toes or thumbs showed sensitivity of 63% (95% CI, 44%–79%) and specificity of 74% (95% CI, 64%–86%; AUROC, 0.681; 95% CI, 0.556–0.779) for diagnosing retronychia.

The simultaneous presence of a hypoecho halo (criterion 1) and a decreased distance between the origin of the nail plate and the base of the distal phalanx distance (criterion 2) of 5.1 mm or less affecting thumbs or big toes showed sensitivity of 63% (95% CI, 44%–79%) and specificity of 100% (95% CI, 94%–100%; AUROC, 0.812; 95% CI, 0.719–0.884) for diagnosing retronychia.

Cutoff Points for Criterion 3 for Diagnosing Bilateral Retronychia According to Sex

There were significant differences in the cutoff points for the thickness of the proximal nail fold according to sex. A proximal nail fold thickness of 2.2 mm or greater in male participants showed sensitivity of 75% (95% CI, 43%–95%) and specificity of 82% (95% CI, 73%–89%; AUROC, 0.784; 95% CI, 0.692–0.857) for diagnosing retronychia, and a proximal nail fold thickness of 1.9 mm or greater in female participants showed sensitivity of 75% (95% CI, 55%–88%) and specificity of 94.4% (95% CI, 81%–99%; AUROC, 0.843; 95% CI, 0.725–0.915).

The presence of a hypoechoic halo and a proximal nail fold thickness of 2.2 mm or greater in male participants showed sensitivity of 75% (95% CI, 43%–95%) and specificity of 100% (95% CI, 97%–100%; AUROC, 0.875; 95% CI, 0.747–1.00), and a hypoechoic halo and a proximal nail fold thickness of 1.9 mm or greater in female participants showed sensitivity of 74% (95% CI, 55%–88%) and specificity of 100% (95% CI, 94%–100%; AUROC, 0.973; 95% CI, 0.793–0.949) for diagnosing retronychia.

Summary of Main Results for US Diagnostic Criteria

The concomitant presence of positive US diagnostic criteria 1, 2, and 3 was highly significant for diagnosing retronychia in cases with unilateral involvement, and the presence of 2 or more criteria in the same patient (one of them criterion 1) could significantly support the diagnosis of retronychia in cases with bilateral involvement. A summary of the main US criteria for diagnosing retronychia is provided in Table 4.

Discussion

Three US diagnostic criteria for retronychia were defined and analyzed according to digit and sex, which included a study of more than 200 nails as well as unilateral and bilateral afflictions. The most affected digits in this US study (big toes and index finger) were similar to the ones described in clinical reports,[1–4,11] which provide an idea of the real-world conditions of this research.

Importantly, the US signs can be noninvasive windows for observing the pathophysiologic alterations produced in the nail unit in the presence of retronychia in vivo. Thus, the hypoechoic halo surrounding the origin of the nail plate (criterion 1) is compatible with inflammatory, granulation, and scarring tissue that affects the matrix region. This tissue seems to be an important factor for generation of the backward and upward displacement of the nail plate. Furthermore, the presence of inflammation at the proximal nail fold and nail bed also

Table 4. Main US Criteria for Diagnosing Retronychia

Presence of a hypoechoic halo surrounding the origin of the nail plate (constant).
Distance between the origin of the nail plate and the base of the distal phalanx of ≤5.1 mm in big toes and thumbs and/or a difference of ≥0.5 mm of this distance between the affected nail (with decreased distance) and the contralateral healthy nail.
Proximal nail fold thickness of ≥2.2 mm for male or ≥1.9 mm for female patients and/or proximal nail fold ≥0.3 mm thicker in comparison with the contralateral healthy nail.

may be confirmed by the US finding of regional hypervascularity on color Doppler imaging.

In our experience, the hypoechoic halo sign alone can be observed in other inflammatory conditions such as nail psoriasis; however, in psoriasis, the halo tends to be much thinner. In addition, in nail psoriasis, there are other concomitant US signs, such as hypoechogenicity and increased thickness of the nail bed, loss of definition of the ventral plate, hyperechoic deposits in the ventral plate, loss of definition of both plates, and wavy and thickened plates. All of these signs differ greatly from the US findings for retronychia.[6,8,20] However, a psoriatic nail can develop retronychia, particularly in late or severe stages; therefore, we must be aware to recognize these entities on US.

Nevertheless, despite the fact that the hypoechoic halo sign was always present in our retronychia cases and was 100% sensitive and specific when comparing retronychia with healthy controls, the use of this sign alone for diagnosing retronychia should be taken with caution. We suggest adding at least 1 of the other 2 US diagnostic criteria for diagnosing retronychia.

Onychomadesis (ie, full thickness fragmentation of the nail plate including dorsal and ventral plate) was present in only 40% of cases, which may mean that the presence of a limited space or a space conflict between new and old fragments of the nail plate cannot necessarily be the primary cause or the only cause of retronychia. Moreover, the origin of the backward and upward displacement of the nail plate could be, per se, the presence of inflammatory, granulation, and scarring tissue (halo sign). Furthermore, in this retronychia group, there were no US signs of 1 or more hidden nail plate fragments trapped in the proximal nail fold and pushing the visible segment of the nail plate. On the other hand, in retronychia, partial or patchy sites of disruption of the proximal part of the ventral nail plate without involvement of the dorsal plate may be detected. This disruption can be an early sign of affliction of the regions of the matrix in charge of the production of this part of the nail plate, which seem to be the proximal and intermediate parts of the matrix.[21] However, further research may be needed to find out whether these early disruption sites in the proximal part of the ventral plate are due only to single or isolated episodes of stoppage of the germinal process or whether they imply the presence of specific immunomediated inflammatory factors released in the nail unit.

The decrease of the distance between the origin of the nail plate and the base of the distal phalanx (criterion 2) can be a sensitive parameter for detecting retronychia, particularly in unilateral cases. Nevertheless, in cases with severe upward displacement of the proximal nail plate (eg, due to the excessive presence of inflammatory or granulation tissue), this distance may "artificially" not be substantially affected. In these cases, this measurement can be replaced by the distance between the origin of the nail plate and the distal part of the middle or proximal phalanx.

A limitation to this study was the impossibility of measuring differences of 0.1 mm or less. Another limitation may have been that all of the US examinations were performed and interpreted by a single observer, which at the same time may have provided consistency to this study because of the presence of a trained operator working under real-world and standardized conditions. Last, the development of objective US criteria for diagnosing retronychia may facilitate surgical planning and monitoring of these challenging cases as well as motivate further research on this perhaps underestimated condition.

In conclusion, US can support the diagnosis of retronychia in unilateral and bilateral cases. The simultaneous presence of 3 major US diagnostic criteria is noteworthy for assessing unilateral retronychia. Additionally, for diagnosing bilateral retronychia, the presence of at least 2 criteria, 1 of them being the presence of a hypoechoic halo surrounding the origin of the nail plate (criterion 1), can be useful.

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