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Sonographic Comparison of Morphologic Characteristics Between Pilonidal Cysts and Hidradenitis Suppurativa

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Objectives—To compare the sonographic characteristics of pilonidal cysts and hidradenitis suppurativa.

Methods—A retrospective study of sonographic examinations was performed on 2 groups: 1 with pilonidal cysts and the other with hidradenitis suppurativa. The sonographic characteristics of the pilonidal cyst and hidradenitis suppurativa groups were analyzed, compared, and correlated, including an analysis of the histologic findings. For the pilonidal cyst group, the distribution, morphologic characteristics, location, shape, diameter, axis, vascularity, and scarring were also described. Statistical analyses included Spearman, Wilcoxon, Kruskall-Wallis, χ^2, and Fisher tests.

Results—The sonographic examinations of 84 patients were reviewed: 43 with pilonidal cysts and 41 with hidradenitis suppurativa. The comparison of the morphologic characteristics of the key lesions between the pilonidal cyst and hidradenitis suppurativa groups showed no statistically significant differences ($P < .05$). Both groups had similar dermal and hypodermal saclike and bandlike structures that communicated with the widened base of the hair follicles. Retained fragments of hair tracts within the lesions were sonographically detected in both pilonidal cysts (100%) and hidradenitis suppurativa (83%) and also found on histologic specimens; however, the density of hair tracts per structure was higher in pilonidal cysts. Sonographic signs of scarring were absent in 63% of pilonidal cysts. Only 2% of pilonidal cysts showed communicating bandlike structures.

Conclusions—Key lesions of pilonidal cysts and hidradenitis suppurativa have similar sonographic morphologic characteristics, which suggests that a pilonidal cyst may be a variant or localized form of hidradenitis suppurativa. The retained fragments of hair tracts frequently detected in both entities may be caused by ectopic production of hair and not by embedding. Common therapeutic strategies and research can be designed for both entities.

Key Words—dermatologic ultrasound; hair; hair ultrasound; hidradenitis; hidradenitis imaging; hidradenitis ultrasound; hidradenitis suppurativa; pilonidal cyst; pilonidal cyst imaging; pilonidal cyst ultrasound; skin ultrasound

Pilonidal cysts and hidradenitis suppurativa are related inflammatory conditions that have been included in what is called the "follicular occlusion tetrad" that draw together 4 pathologic conditions that seem to share plugging of the hair follicles in their

physiopathologic mechanisms. The remaining 2 entities of the tetrad are acne conglobate and dissecting cellulitis of the scalp.[1] Thus, both hidradenitis suppurativa and pilonidal cysts are commonly present in corporal regions with cutaneous folds that may be subject to high levels of mechanical stress, something that has been proposed as a potential trigger of hidradenitis suppurativa.[2]

A pilonidal cyst or sinus has been reported as a common suppurative condition that affects young adults in the intergluteal region through the supposed embedding of hair tracts into a damaged epithelium, which secondarily has inflammation and infection.[3,4] On the other hand, hidradenitis suppurativa is a chronic inflammatory disease of presumably follicular origin, which is more commonly detected in young people, that produces recurrent draining lesions mostly in the axillary and groin regions; however, it has been also reported to affect the inframammary, intermammary, buttock, and intergluteal regions.[5,6]

To date, pilonidal cysts and hidradenitis suppurativa are clinically considered and managed as different entities. For example, pilonidal cysts tend to be surgically treated, and hidradenitis suppurativa cases are medically managed in the early or intermediate stages of severity; however, in the late severe stages, hidradenitis suppurativa may be managed surgically.

Despite the fact that dermatologists frequently manage hidradenitis suppurativa cases, patients with pilonidal cysts and hidradenitis suppurativa may be seen and treated by a wide range of medical specialists. These include general surgeons, emergency physicians, plastic surgeons, coloproctologists, gynecologists, family physicians, and dermatologists, among others.

A closer link between pilonidal cysts and hidradenitis suppurativa has been suggested by a histological study of pilonidal cysts from 27 patients that showed similar features as those reported in hidradenitis suppurativa. Thus, in that study, it was proposed that a pilonidal cyst could be a unilocalized type of hidradenitis suppurativa.[7] Common histologic characteristics between pilonidal cysts and hidradenitis suppurativa in that study included the presence of follicular hyperplasia, hyperkeratosis, and interfollicular epidermal hyperplasia with involvement of the terminal hair follicles and inflammatory mixed infiltrates.[7] Nevertheless, histologic examinations in hidradenitis suppurativa may be limited because of its usual large extent and multizone type of involvement.

Since both pilonidal cysts and hidradenitis suppurativa present with alterations of the hair,[7] knowledge of the normal sonographic morphologic characteristics of the hair follicles and tracts, which already have been reported in the literature,[8,9] might be relevant for a better understanding of the alterations in the diseases that constitute the follicular occlusion tetrad, such as pilonidal cysts and hidradenitis suppurativa.[1]

Furthermore, sonography has been proved useful for supporting the diagnosis of both pilonidal cysts[10] and hidradenitis suppurativa[11–18] and allows sonographic staging of hidradenitis suppurativa.[13,15,18] The sonographic criteria for diagnosing hidradenitis suppurativa include abnormalities in the thickness and echogenicity of the dermis, the presence of dermal pseudocysts, as well as dermal and/or hypodermal fluid collections and fistulous tracts connected to the base of widened hair follicles, which commonly contain fragments of hair tracts. The sonographic staging of hidradenitis suppurativa is based on the description and counting of key subclinical lesions such as pseudocysts, fluid collections, and fistulous tracts.[13,15,17,18]

Application of the recommended protocol for studying dermatologic lesions, which includes grayscale and color Doppler scans[19] in these cases, allows one to determine the morphologic characteristics, severity, and activity of these conditions at the same time. Thus, the presence of increased blood flow surrounding the key lesions in hidradenitis suppurativa or in the periphery of a pilonidal cyst is usually suggestive of inflammation and activity of the disease per se.[13–15]

Importantly, the knowledge of these sonographic subclinical alterations allows more accurate staging of hidradenitis suppurativa because there are anatomic abnormalities that cannot be deducted by a physical examination. This factor may be of paramount importance because the management of hidradenitis suppurativa usually varies according to the stage of severity. Moreover, the use of the sonographic staging of hidradenitis suppurativa has been reported to modify management in 82% of adults[13] and 95% in children[18] because the clinical examination tends to underestimate the disease.

In contrast with a histologic examination, sonography allows the study of multiple corporal regions at the same time noninvasively.[20] This factor could be relevant in diseases that tend to involve multiple regions at the same time, such as hidradenitis suppurativa, and may obviate the performance of serial biopsies or underestimation of the severity of hidradenitis suppurativa.

Surprisingly, there are few reports in the literature on the use of sonography in pilonidal cysts, and to date, no sonographic-histologic correlations or "in-depth" sonographic studies of the morphologic characteristics of pilonidal cysts have been reported. Furthermore, a deeper analysis of the sonographic morphologic characteristics of pilonidal cysts and hidradenitis suppurativa would be important for a better insight into the pathophysiologic mechanisms of these entities, and to our knowledge, these have not been previously described.

The finding of similarities between these conditions may indicate closer monitoring and study of patients with pilonidal cysts, and if these patients correspond to a variant or localized form of hidradenitis suppurativa, perhaps common therapeutic guidelines could be designed. The aim of this study was to compare the sonographic characteristics of pilonidal cysts and hidradenitis suppurativa.

Materials and Methods

A retrospective study of the sonographic examinations of patients with pilonidal cysts and hidradenitis suppurativa was performed. All patients underwent the sonographic protocol published for studying dermatologic lesions,[19] which included grayscale and color Doppler imaging in all cases. The Institutional Review Board approved the study and waived the need for signed informed consent from the patients. The study was performed according to the Helsinki principles of medical ethics.

The inclusion criteria were as follows: (1) patients who were clinically evaluated by a dermatologist and then sequentially referred for sonographic examinations to rule out the diagnosis of a pilonidal cyst or hidradenitis suppurativa from June 2015 to June 2016; (2) color Doppler sonographic examinations with positive diagnostic criteria for a pilonidal cyst[10] or hidradenitis suppurativa[13]; (3) patients with pilonidal cysts who had surgical confirmation after the sonographic examinations; and (4) patients with hidradenitis suppurativa who were clinically staged (Hurley classification[21]) before the ultrasound examination and then, sonographically scored (SOS-HS; sonographic scoring of hidradenitis suppurativa[13]). The exclusion criteria were as follows: (1) history of surgery or procedures in the affected region(s) before the ultrasound examinations that might have distorted the interpretation of the sonographic features; (2) patients taking biologic medications; and (3) other concomitant systemic or regional cutaneous disease.

Ultrasound Equipment, Protocol, and Operator

The equipment consisted of a multichannel ultrasound machine (LOGIQ E9 XD Clear; GE Healthcare, Milwaukee, WI; linear and compact linear transducers; upper-range frequencies, 16 and 18 MHz). The sonographic protocol included grayscale imaging (at least 2 perpendicular axes of each lesion), color or power Doppler imaging, and spectral curve analysis. The configuration was automatically provided by the machine (setting: musculoskeletal, superficial, skin), which included the use of the upper range of frequencies as well as the lowest wall filter and pulse repetition frequency for avoiding the generation of noise. The same operator, a radiologist who has worked on dermatologic sonography for the last 16 years, performed all color Doppler examinations.

Sonographic Parameters

For the hidradenitis suppurativa and pilonidal cyst groups, the following sonographic parameters were analyzed:

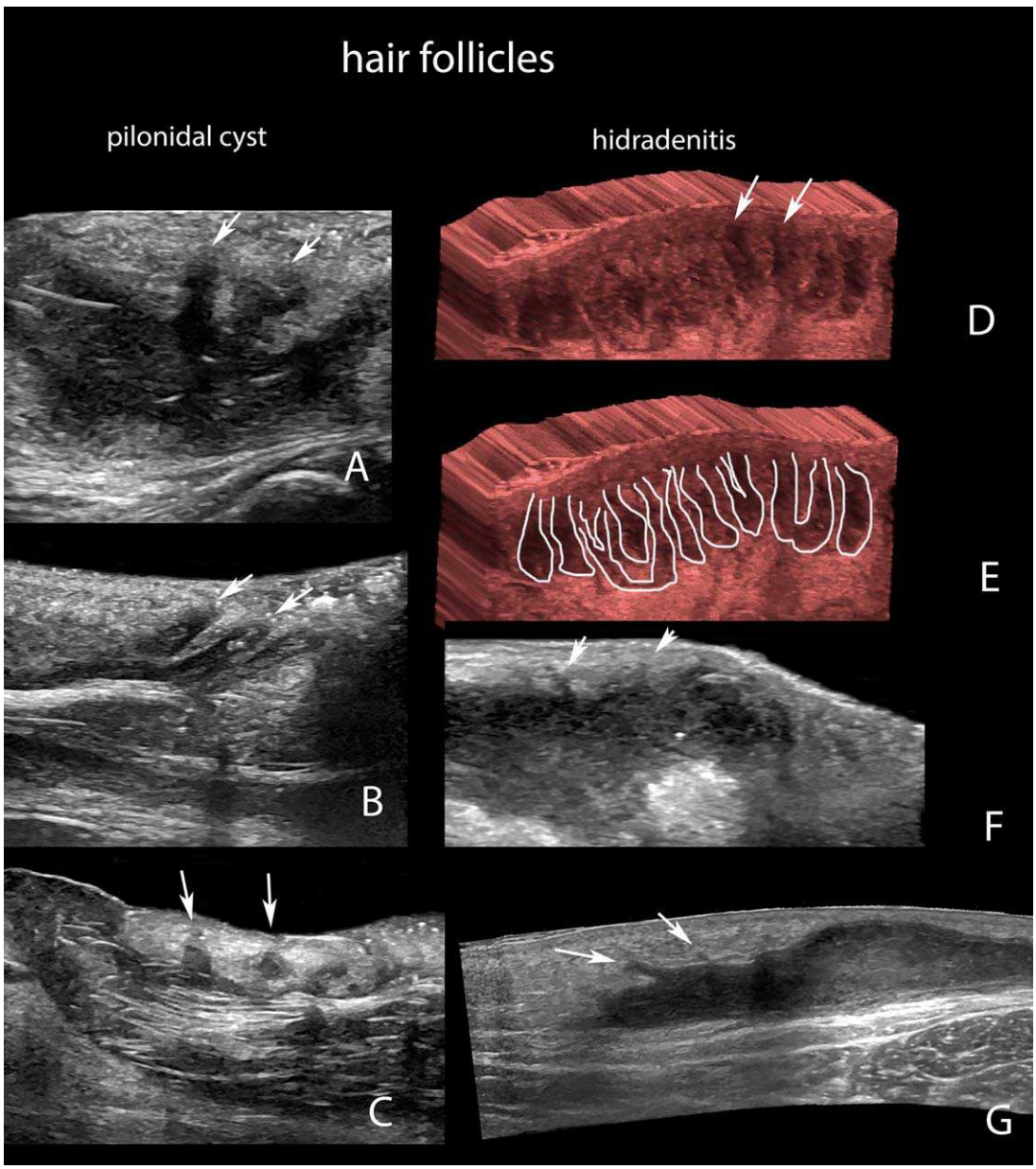
1. Layers involved, including dermis and hypodermis;
2. Morphologic characteristics—for the purposes of this study, the terms "saclike" and "bandlike" structures were defined, considering the previous definitions for key sonographic lesions of hidradenitis suppurative[13,15,18]:
   a. Saclike—a dermal and/or hypodermal anechoic or hypoechoic sacular collections connected to the base of widened hair follicles (ie, fluid collection);
   b. Bandlike—a dermal and/or hypodermal anechoic or hypoechoic tract connected to the base of widened hair follicles (ie, fistulous tract);
3. Retained fragments of hair tracts—monolaminar or bilaminar hyperechoic structures within saclike or bandlike structures.[13,15,17,18] This feature was reported as present or absent;
4. Hypodermal edema—increased echogenicity of the hypodermis underlying the sonographic lesions, which was categorized as present or absent; and
5. Hypervascularity—presence of vessels in the periphery or within saclike or bandlike structures, which was categorized as present or absent on color Doppler imaging.

For the pilonidal cyst group only:

1. Longest diameter and thickness (centimeters);
2. Affected side of the intergluteal region;

3. Axis—longitudinal, oblique, or transverse and angle of the pilonidal cyst (degrees);
4. Clinical orientation of the cutaneous lesion in relation to the sonographic lesion—cephalad, caudal, lateral, or on top;
5. Communication between multiple saclike or bandlike structures—present or absent;
6. Scarring presence, which was graded as reported for hidradenitis suppurativa fistulous tracts[22]:
   a. Grade 0, absent;

Figure 1. Sonography of hair follicles in hidradenitis suppurativa and pilonidal cysts (longitudinal views; **D** and **E**, 3-dimensional reconstructions). Hair follicle dilatation and communication (arrows) with saclike and bandlike structures are shown in pilonidal cysts (**A–C**) and hidradenitis (**D–G**; **E** with hair follicles outlined).



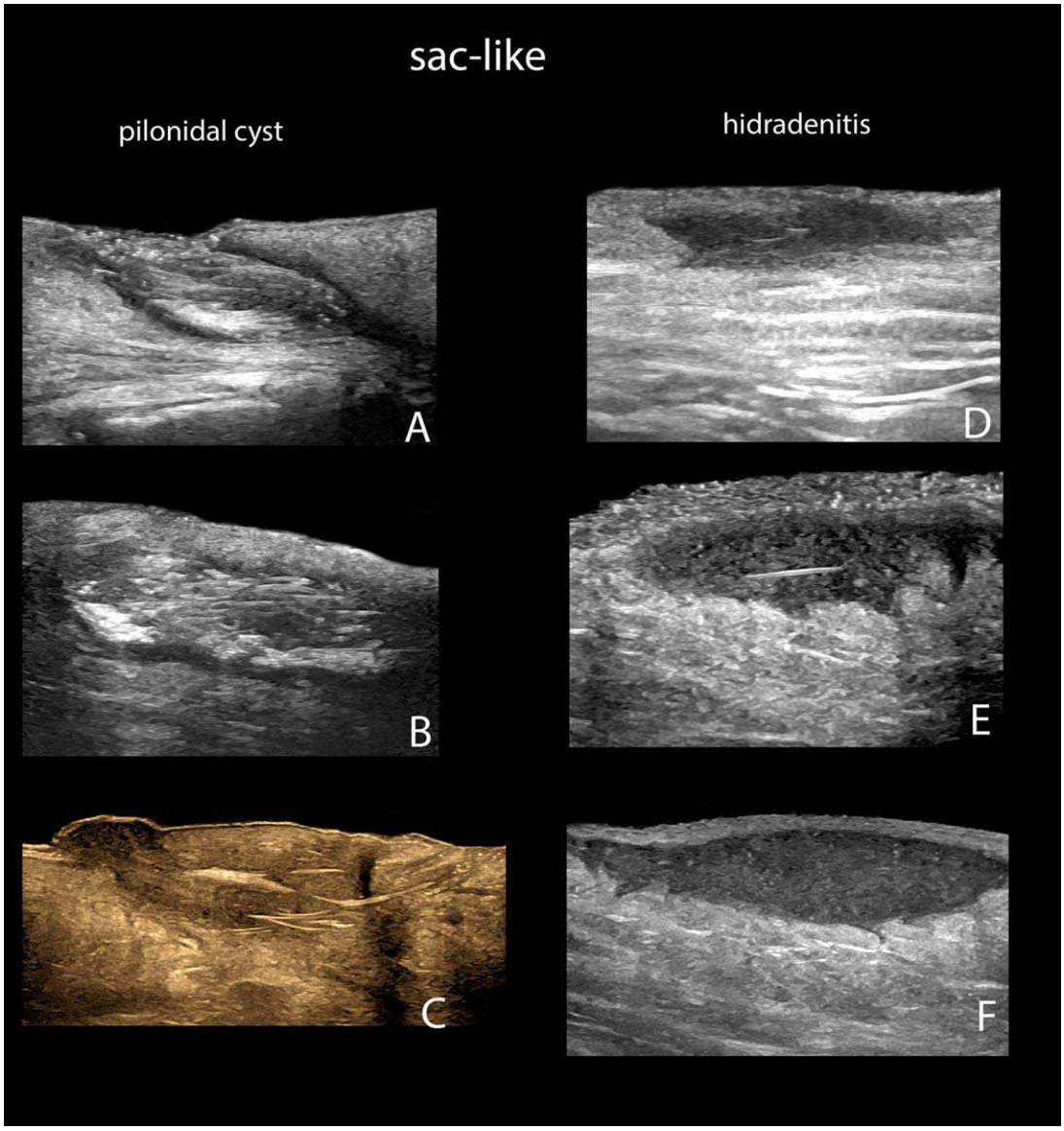
b. Grade 1, hypoechoic band with a laminar pattern in the periphery of the lesion;
c. Grade 2, hypoechoic band with a laminar pattern invading the lumen of the structure and provoking a halo sign (transverse view);
7. Vascularity—thickness (millimeters) and maximum peak systolic velocity (centimeters per second) of the regional vessels; and
8. Dermal alterations—decreased echogenicity, present or absent.

Figure 2. Sonography of hair tracts in hidradenitis suppurativa and pilonidal cysts (longitudinal views). Hair tracts (arrows) within saclike and bandlike structures are shown in pilonidal cysts (**A–C**) and hidradenitis (**D–F**).

Sonographic-Histologic Correlation

In 5 hidradenitis suppurativa cases clinically classified as Hurley grade 3 and sonographic stage 3 that underwent surgery (wide excision) after the sonographic examinations, an analysis of the histologic samples was performed, and these data were correlated with the database of histologic samples of pilonidal cysts and sonographic findings. In the case of a sonographically positive and histologically negative presence of retained fragments of hair tracts within the hidradenitis suppurativa lesions, a sonographic marking of the nonprocessed macroscopic samples suspected of containing hair tracts was performed. These samples were sonographically studied immersed in a disposable plastic container filled with saline and then returned to the Department of Pathology in 100-mL marked disposable plastic cups with formalin.

Figure 3. Sonographic saclike morphologic characteristics in hidradenitis suppurativa and pilonidal cysts (longitudinal views). Saclike morphologic characteristics are shown in pilonidal cysts (**A–C**) and hidradenitis (**D–F**).



Statistical Evaluation

The statistical analyses included Spearman, Wilcoxon, Kruskall-Wallis, χ^2, and Fisher tests. Stata version 12.1 software (StataCorp, College Station, TX) was used, and significance was set at $P < .05$.

Results

A retrospective study of the color Doppler sonographic examinations of 84 patients who met the criteria was performed. The pilonidal cyst group was composed of 43 cases, and the hidradenitis suppurativa group included 41 cases.

Main Results for Pilonidal Cyst and Hidradenitis Suppurativa Groups

Pilonidal cysts were more frequent in young men ($\leq$25 years) and sonographically involved the dermis and hypodermis and appeared as saclike or bandlike structures that communicated with the base of widened hair follicles. Multiple fragments of hair tracts were detected in all cases within these structures. Pilonidal cysts showed hypervascularity in the periphery and signs of underlying hypodermal edema in all patients. Sonographic signs suggestive of scarring were absent in more than half of pilonidal cysts. The frequency of communicating bandlike structures in pilonidal cysts was low.

The hidradenitis suppurativa group was mainly composed of young women ($\leq$30 years) and sonographically showed dermal and hypodermal saclike and bandlike structures that communicated with the base of widened hair follicles. Retained fragments of hair tracts were detected in most cases; however, the density of hairs (ie, the number of hair tracts in each structure) was lower than in pilonidal cysts. Signs of hypervascularity and hypodermal edema were present in all cases.

In the statistical analyses, the comparison between pilonidal cysts and hidradenitis suppurativa showed no statistically significant differences in the characteristics of the key lesions in the groups; however, pilonidal cysts

Figure 4. Sonographic bandlike morphologic characteristics in hidradenitis suppurativa and pilonidal cysts (longitudinal views). Bandlike morphologic characteristics are shown in pilonidal cysts (**A–C**) and hidradenitis (**D–F**).

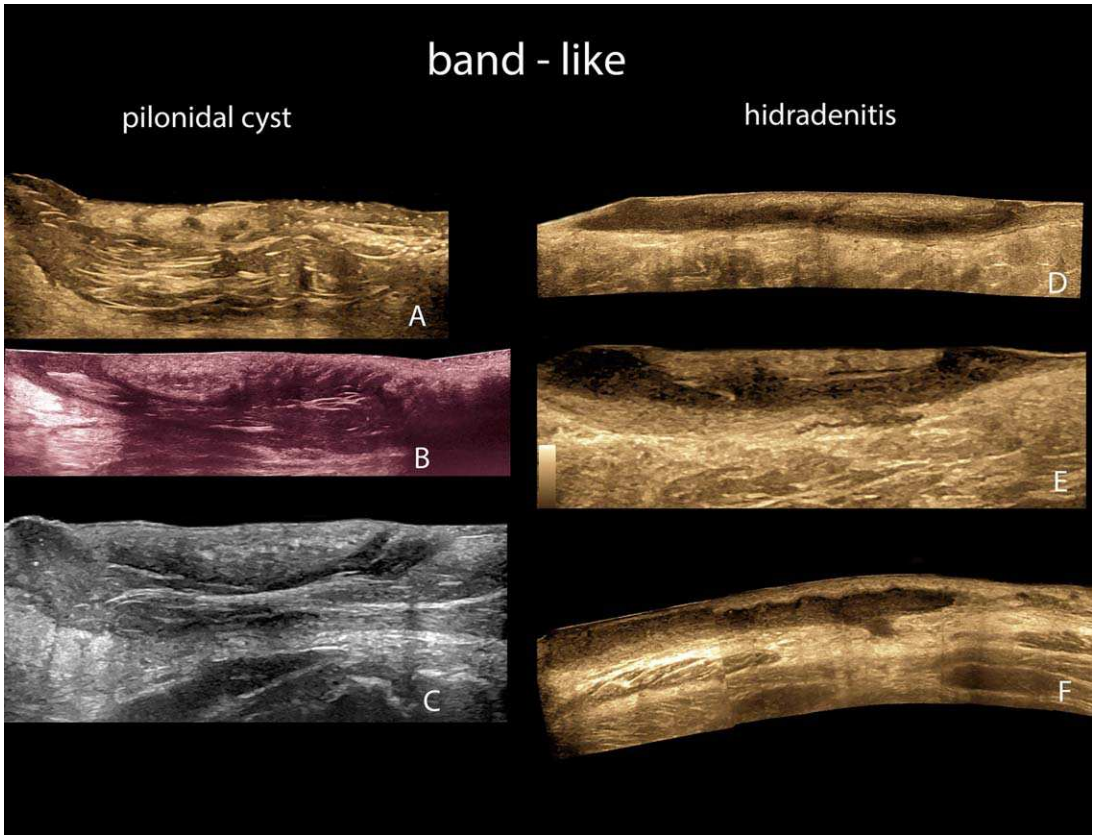
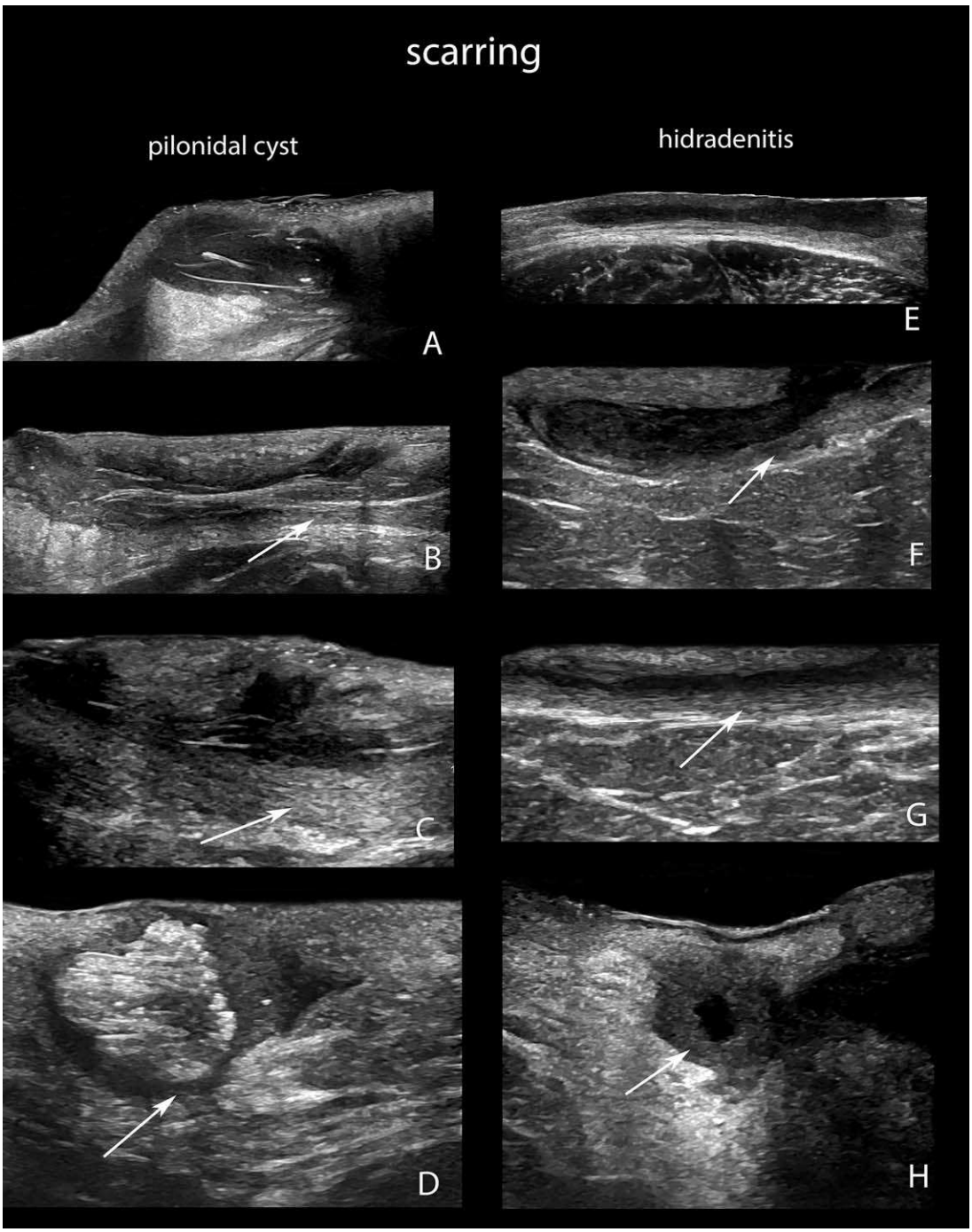


Figure 5. Scarring in hidradenitis suppurativa and pilonidal cysts (**A–C** and **E–G**, longitudinal views; **D** and **H**, transverse views; arrows indicate hypoechoic laminar tissue). Pilonidal cysts (**A–D**) and hidradenitis (**E–H**) are shown. **A** and **E**, No scarring. **B** and **F**, Grade 1 scarring. **C** and **G**, Grade 2 scarring. **D** and **H**, Halo sign in grade 2 scarring.



were significantly more frequent in men; a slightly higher but still young age was significant for hidradenitis suppurative; and pilonidal cysts presented a single location in all cases. Both conditions showed similar morphologic characteristics of the lesions (saclike and bandlike) and the presence of retained fragments of hair tracts within the structures (Figures 1–6, Tables 1–3, and Videos 1–5). The agreement between Hurley and sonographic staging of hidradenitis suppurativa was statistically acceptable ($\kappa = 0.3422$; $P < .05$).

Statistical Analysis of Detailed Features in Pilonidal Cysts

In pilonidal cysts, the following statistical comparisons, correlations, and associations were nonsignificant (Tables 4–8):

Figure 6. Color Doppler sonography of vascularity in hidradenitis suppurativa and pilonidal cysts (longitudinal views). Vascularity in pilonidal cysts (**A–C**) and hidradenitis (**D–F**) is shown. Variable degrees of internal and peripheral blood flow are shown (in colors).

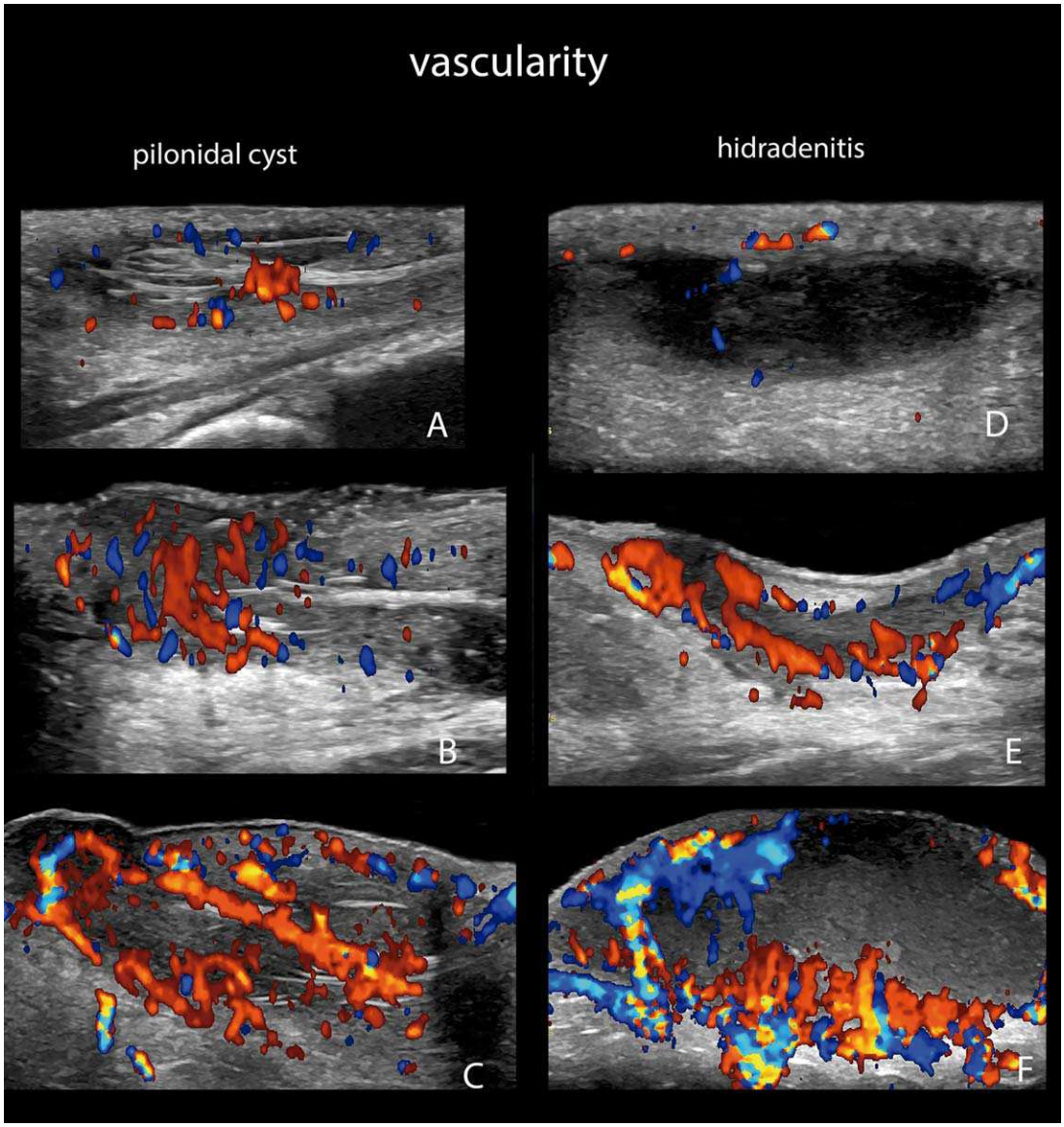


Table 1. Main Sonographic Characteristics of the Pilonidal Cyst Group

Characteristic	Value
Sex, n (%)	
Male	29 (67)
Female	14 (33)
Total	43 (100)
Age, y	
Mean ± SD, y	20 ± 7
Range, y	15–52
Layers involved, n (%)	
Dermis and hypodermis	43 (100)
Longest diameter, cm	
Mean ± SD	3 ± 1
Range	0.9–6.9
Thickness, cm	
Mean ± SD	0.7 ± 0.3
Range	0.4–1.9
Intergluteal location, n (%)	
Right	9 (21)
Middle	14 (33)
Left	20 (47)
Morphologic characteristics, n (%)	
Saclike	22 (51)
Bandlike	21 (49)
Communication with widened hair follicles	43 (100)
Retained hair tracts, n (%)	
Yes	43 (100)
Major axis, n (%)	
Longitudinal	21 (49)
Oblique	20 (47)
Transverse	2 (2)
Angle in relation to midline, n (%)	
0°	21 (49)
20°	1 (2)
30°	6 (14)
45°	15 (35)
Hypodermal edema, n (%)	
Yes	40 (93)
No	3 (7)
Hypervascularity, n (%)	
Yes	42 (98)
No	1 (2)
Vessel thickness, cm	
Mean ± SD	0.9 ± 0.4
Range	0.7–1.6
Scarring, n (%)	
0	27 (63)
1	10 (23)
2	6 (14)
Dermal alterations of echogenicity and thickness, n (%)	
Yes	43 (100)
Communicating bandlike structures, n (%)	
Yes	1 (2)
No	42 (98)
Special morphologic characteristics, n (%)	
Bilobulated	1 (2)

1. Age and sex versus sonographic length, thickness, and scarring;
2. Sonographic scarring and major axis;
3. Color Doppler sonographic vascularity versus clinical location of the cutaneous lesion and sonographic scarring;
4. Clinical location of the cutaneous lesion versus sonographic scarring; and
5. Sonographic scarring and angle of the cyst.

Table 2. Main Sonographic Characteristics of the Hidradenitis Suppurativa Group

Characteristic	Value
Sex, n (%)	
Male	8 (20)
Female	33 (80)
Total	41 (100)
Age, y	
Mean ± SD	28 ± 11
Range	15–59
Layers involved, n (%)	
Dermis and hypodermis	41 (100)
Location, n (%)	
Axillary	24 (59)
Groin	5 (12)
Axillary and groin	6 (15)
Thoracic-mammary	3 (7)
Axillary and intergluteal	1 (2)
Groin and intergluteal	1 (2)
Retroauricular	1 (2)
Hurley staging, n (%)	
1	23 (56)
2	9 (22)
3	9 (22)
Sonographic staging, n (%)	
1	18 (44)
2	7 (17)
3	16 (39)
Morphologic characteristics, n (%)	
Saclike	30 (73)
Bandlike	16 (39)
Saclike and/or bandlike	41 (100)
Dermal alterations of echogenicity and thickness, n (%)	
Yes	41 (100)
Communication with widened hair follicles, n (%)	
Yes	41 (100)
Retained hair tract fragments, n (%)	
Yes	34 (83)
Hypodermal edema, n (%)	
Yes	41 (100)
Hypervascularity, n (%)	
Yes	41 (100)

Histologic Analysis

On histologic analysis, the relevant features were as follows: Hidradenitis suppurativa cases showed saclike and bandlike structures as well as fragments of hair tracts, dilatation and plugging of hair follicles, dense inflammatory infiltrates, and granulation tissue and vessels. Pilonidal cyst cases also presented trapped fragments of hair tracts (Figures 7 and 8).

Discussion

This color Doppler sonographic study showed significantly similar anatomic appearances between the key lesions of pilonidal cysts and hidradenitis suppurativa. These features include the presence of saclike and bandlike structures that contain fragments of hair tracts and are connected to the base of dilated hair follicles. These

Table 3. Association[a] and Comparison[b] Between Sonographic Findings in the Pilonidal Cyst and Hidradenitis Suppurativa Groups

Characteristic	Scale	Pilonidal Cyst	Hidradenitis	*P*
Sex, n (%)[a]	Male	29 (67)	8 (20)	<.01[c]
Mean age ± SD, y[b]	y	22 ± 7	28 ± 11	.0008[c]
Saclike, n (%)[a]	Yes	12 (52)	30 (73)	.032[c]
Bandlike, n (%)[a]	Yes	20 (47)	17 (41)	.641
Saclike and bandlike, n (%)[a]	Yes	0 (0)	9 (22)	.001[c]
Trapped hair tracts, n (%)[a]	Yes	43 (100)	34 (83)	.0023[c]
Hypodermal edema, n (%)[a]	Yes	40 (93)	41 (100)	.13
Increased vascularity, n (%)[a]	Yes	42 (98)	41 (100)	.512

[a]χ^2 and Fisher tests.
[b]Wilcoxon test.
[c]Significant, $P < .05$

Table 4. Pilonidal Cysts: Correlation[a] and Comparison[b] Between Age and Sex Versus Sonographic Length, Thickness, and Scarring

	Age[a]	
Characteristic	***r***	***P***
Length ≥ 3 cm	0.163	.4687
Thickness ≥ 0.7 cm	−0.2174	.1614

	Sex[b]		
	Male	**Female**	***P***
Length, ≥ 3 cm	3.6 (3.2–4.05)	3.85 (3.3–4.9)	.4156
Thickness, ≥ 0.7 cm	0.7 (0.58–1.05)	0.8 (0.6–1.00)	.9406
Scarring	0 (1–25)	0 (0–1)	.4876

Data are presented as p50 (p25-p75) where applicable.
r, rho.
[a]Spearman test.
[b]Wilcoxon test.

Table 5. Pilonidal Cysts: Comparison Between Sonographic Scarring and Major Axis[a]

	Major Axis			
Characteristic	**Longitudinal**	**Oblique**	**Transverse**	***P***
Scarring	0 (0–1)	0 (0–2)	0 (0–0)	.59835

Data are presented as p50 (p25-p75).
[a]Kruskall-Wallis test.

findings might support and perhaps prove by themselves a follicular origin for both entities, which so far has not been possible to demonstrate because of the limitations of clinical examinations and the lack of multiregional data in histologic analyses.

The described characteristics match reported clinical findings on the sex distribution, such as pilonidal cysts being more common in male patients and hidradenitis suppurativa more frequent in female patients, as well as the sonographic appearances of the main anatomic alterations reported in both entities.[5,11–13,15,18] These findings also reinforce a previous histologic hypothesis that pilonidal cysts might be a localized form of hidradenitis suppurativa.[7] The only acceptable agreement found between the clinical (Hurley) and sonographic staging was not surprising and similar to a previous report because of the underestimation of severity by the Hurley clinical scoring.[13]

Interestingly, the intrinsic characteristics of pilonidal cysts, such as axis, length, thickness, and degree of scarring, seem not to influence each other. To our knowledge, these characteristics have not been previously analyzed and may be related to the etiology of these entities. The low presence of scarring (37%) and communicating bandlike structures in pilonidal cysts may mean that these commonly "single-location" entities are more rapidly diagnosed than hidradenitis suppurativa; therefore, there is no time for the development of prominent scarring and communicating fistulous tracts in comparison with hidradenitis suppurativa. In fact, hidradenitis suppurativa presents a delay in the diagnosis that some series describes as up to 7 years[23] and in our experience may be up to 10 years.

Physiopathologically, it has been hypothesized in the literature that the origin of pilonidal cysts may be related to the abnormal penetration of hair tracts through dilated follicular ostia in an already damaged epithelium, which can be encouraged by friction or rubbing in hairy patients.[3,4] However, to date, this "embedding" mechanism for explaining the presence of hair tracts within the lesions of pilonidal cysts has not been scientifically proved. Moreover, considering the sonographic observations in pilonidal cyst and hidradenitis suppurativa lesions, it would seem difficult for these thick nests of hair tracts to abnormally penetrate the surface of the skin into the dermal and hypodermal lesions. This embedding process would imply the simultaneous passing of multiple long fragments of hair tracts through considerably small (millimetric or submillimetric) follicular ostia, which seems unlikely to us.

These retained fragments of hair tracts may act as foreign bodies or potent chronic irritants that promote the continuation of the inflammatory process in the

Table 6. Pilonidal Cysts: Association[a] and Comparison[b] Between Color Doppler Sonographic Vascularity Versus Clinical Location of the Cutaneous Lesion[a] and Sonographic Scarring[b]

	Increased Vascularity		
Characteristic	**Yes**	**No**	***P***
Location, n (%)[a]			.937
Cephalad	23 (54.76)	1 (100)	
On top	14 (33.33)	0 (0)	
Lateral	2 (4.76)	0 (0)	
Bilateral	2 (4.76)	0 (0)	
Caudal	1 (2.38)	0 (0)	
Scarring[b]	0 (0–1)	0 (0–0)	.4529

Data are presented as p50 (p25-p75) where applicable.
[a]Fisher test.
[b]Wilcoxon test.

Table 8. Pilonidal Cysts: Correlation Between Sonographic Scarring and Angle of the Cyst[a]

	Scarring	
Characteristic	***r***	***P***
Angle	0.0468	.7659

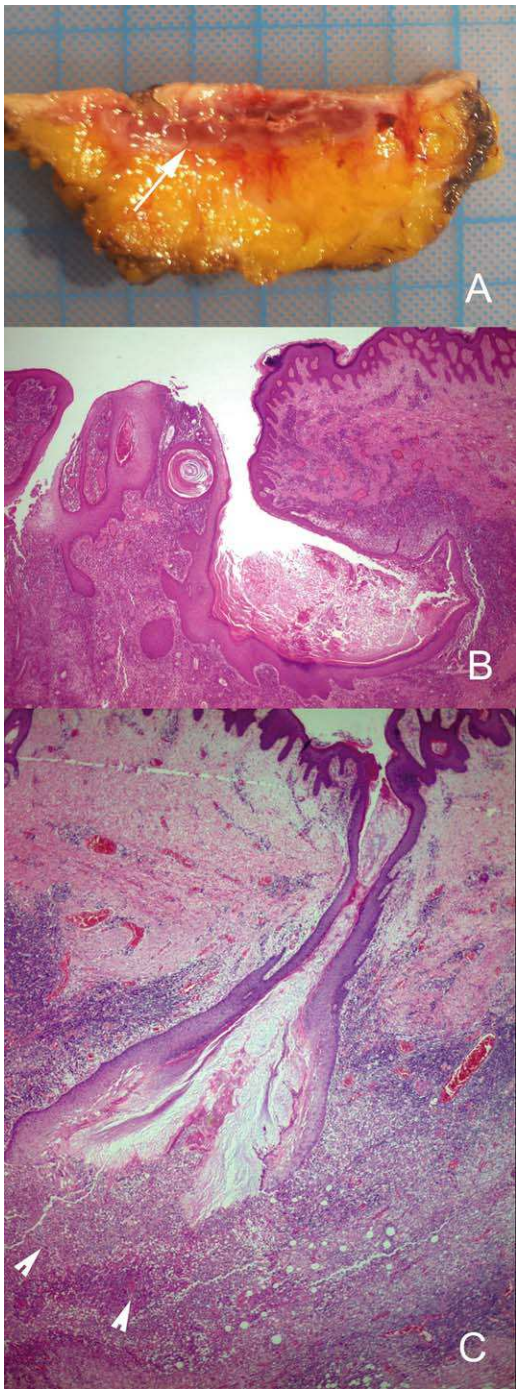
r, rho.
[a]Spearman test.

Table 7. Pilonidal Cysts: Comparison Between Clinical Location of the Cutaneous Lesion Versus Sonographic Scarring[a]

	Location					
Characteristic	**Bilateral**	**Caudal**	**Cephalad**	**Lateral**	**On Top**	***P***
Scarring	1 (0–2)	2 (2–2)	0 (0–1)	0 (0–0)	0 (0–0.25)	.1703

Data are presented as p50 (p25-p75).
[a]Kruskall-Wallis test.

Figure 7. Histologic specimens of hidradenitis suppurativa. (**B** and **C**, hematoxylin-eosin, original magnification × 40). **A**, Macroscopic view of a bandlike (fistulous) tract (arrow) running in the same axis of the cutaneous layers in a specimen. **B**, Follicular infundibular ectasia with hyperkeratosis, acanthosis, irregularities, papillomatosis, plugging, and dense dermal infiltrates. **C**, Follicular infundibular ectasia with rupture of the bottom (arrowhead) of a hair follicle and mixed inflammatory infiltrates.



dermis and hypodermis. Certainly, friction or rubbing mechanisms may help the development of inflammation in the cutaneous layers. Additionally, areas with a higher density of hair tracts may potentially indicate more targets for the development of abnormal processes. Hence, by correlating the sonographic findings in pilonidal cyst and hidradenitis suppurativa groups, we hypothesize that these trapped fragments of hair tracts may be primarily generated within the saclike and bandlike structures in both conditions as ectopic sites of production of hair and keratin debris.

Interestingly, the review of in-depth reports on the physiologic mechanisms of the production of the hair show that hair follicles contain a number of stem cells that are necessary for generating and developing the final mature hair structure. To reach its follicular fate, these stem cells are activated through complex signaling processes such as Wnt-β-catenin and the sonic hedgehog homologue,[24–28] which include the presence of vitamin D receptors.[29] Nevertheless, it has been described that the differentiation of these adult stem cells may occur in the absence of a predefined stem cell niche and could depend on the antagonism between Wnt and sonic hedgehog homologue signaling pathways.[24]

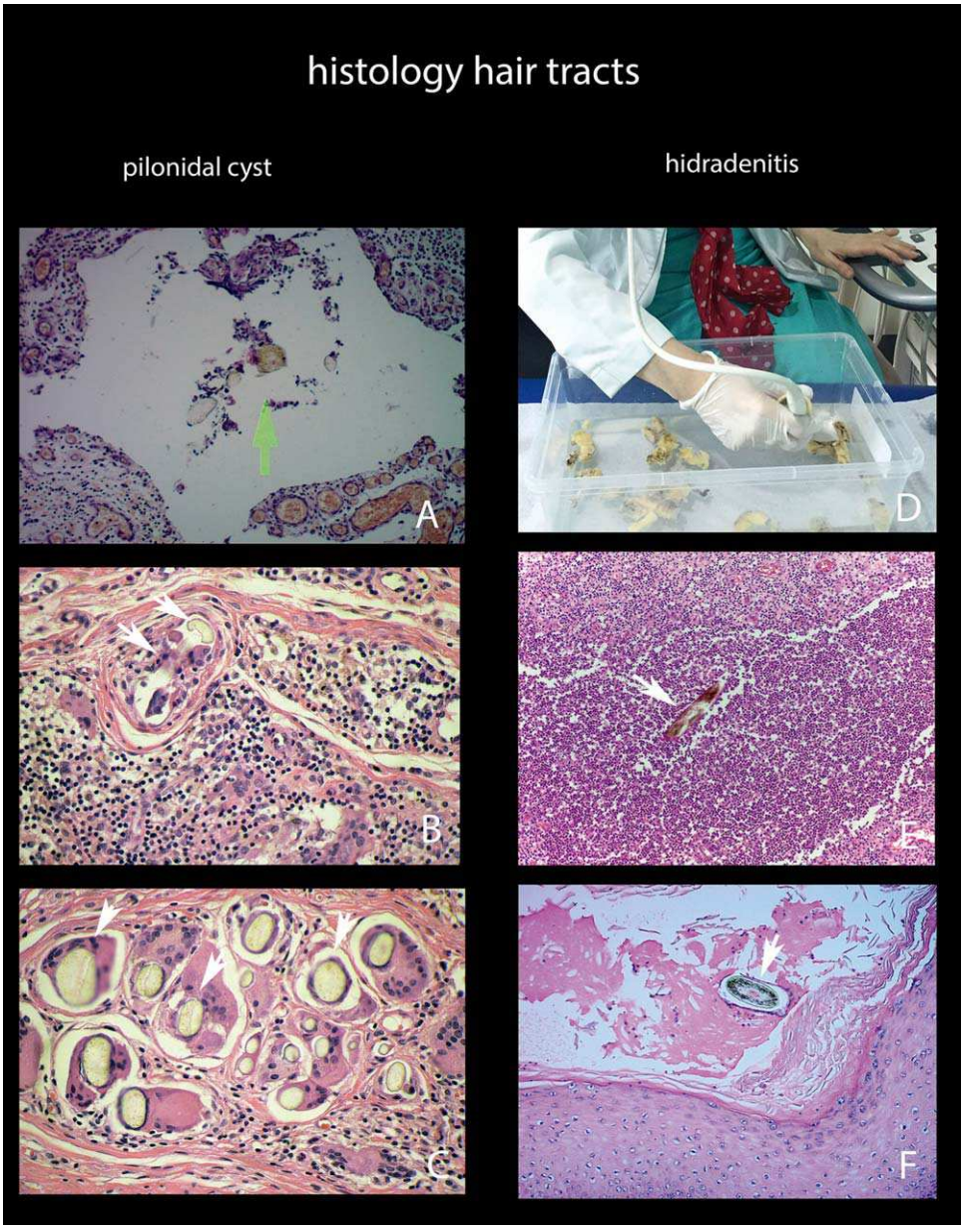
In addition, it has been suggested that overexpression of localized Wnt converts dermal adipose cells into a distinct fibroblast subtype, which leads to fibrosis and disrupted hair follicle cycling.[27] Moreover, collagen VI has been reported to be abundantly expressed in the skin, strongly deposited in hair follicles, and critically produced in a nonregulated way by skin wounding.[28] Experimentally, the lack of collagen VI can delay hair cycling and growth under physiologic conditions; however, it seems to promote the development of wound-induced abnormal hair regrowth without affecting skin healing.[28] Another participant in this process seems to be the vitamin D receptor that interacts with the transforming growth factor signaling pathway to promote the normal inflammatory response to cutaneous injury.[29]

Therefore, the follicular occlusion reported in pilonidal cysts and hidradenitis suppurativa may not be the primary event. Instead, the plugging of the hair follicles would be a secondary event generated as a consequence of deregulation of the signaling mechanisms and processes in charge of the development and functioning of the hair, which include the abnormal differentiation of stem cells, the ectopic production of keratin and hair tract fragments, as well as anomalous healing and

inflammatory processes. The same processes may also be unregulated in other related diseases reported as part of the follicular tetrad, such as dissecting cellulitis of the scalp and acne conglobate.[1] Nevertheless, further research on the sonographic link between these entities may be needed.

The connection between pilonidal cysts and hidradenitis suppurativa may be additionally supported by

Figure 8. Histologic specimens of hair tracts in hidradenitis suppurativa and pilonidal cysts. Pilonidal cysts (**A–C**) and hidradenitis (**D–F**) are shown (hematoxylin-eosin, original magnifications: **A, E**, and **F**, × 100; **B** and **C**, × 40). **A**, Fragments of hair tracts in the center (arrow), granulation tissue, lymphoplasmacytic infiltrates, and dilated capillary vessels are shown. **B**, Hair fragment (arrows) surrounded by a foreign body–type reaction in a pilonidal cyst. **C**, Multiple hair fragments (arrows) within the cytoplasm of multinucleated giant calls. **D**, Sonographic search for hair tracts in hidradenitis suppurativa specimens. **E**, Fragment of a hair tract (arrow) surrounded by leukocytes and fibrinous material. **F**, Hair tract fragment (arrow) associated with a cystic-like structure with squamous epithelia and keratinous debris.



reports of ectopic sites of pilonidal cysts, which include the genital region, scalp, abdominal wall, groin, and axilla.[30] Perhaps these cases might actually correspond to hidradenitis suppurativa.

The development of ectopic sites of hair growth that include the complete hair follicle with the bulb and tract have been also reported in the nail bed, something different from the finding of subungual fragments of hair tracts in some occupations such as hairdressing.[31,32]

Furthermore, it has been described that hair follicles, experimentally transplanted to the injured spine of mice, produced long hair tracts from the spinal cord.[33] This finding may mean that the presence of chronic trauma can promote the growth of longer hair tracts. The latter facts also reinforce the hypothesis that hair tracts may not need a specific niche for development, just the presence of epidermally derived stem cells, activation of the appropriate signaling pathways, and the presence of certain receptors.

Perhaps the unregulated nature of the local physiopathologic processes of hair formation and the presence of chronic injury conditions in the same region might explain the common sonographic presence of hair tracts and keratinous debris within the saclike and bandlike structures in pilonidal cysts and hidradenitis suppurativa, as well as the presence of fibrotic scarring. Mechanical stress or injury produced by friction or rubbing, high-humidity conditions, and the presence of a high density of hairs in certain corporal regions may activate, stimulate, and perpetuate the production of these abnormalities.

The sonographic finding of saclike and bandlike morphologic characteristics in these conditions may be due to different subtypes of unbalanced mechanisms. Of these, the generation of a bandlike structure may be associated with deeper deregulation in the collagen pathways or overexpression of Wnt signaling, leading to a greater presence of fibrosis or abnormal fibrotic scarring. The sonographic characteristics and classification of fistulous tracts into different types according to the degree of scarring have already been reported in hidradenitis suppurativa.[22]

The limitations to this work were the same as those currently described for dermatologic sonography. These include lesions that measure 0.1 mm or less,[34] something that is not relevant for the usually large size of pilonidal cysts and hidradenitis suppurativa. The low number of cases may also be mentioned as a limitation. However, to our knowledge, this sonographic comparison of pilonidal cyst and hidradenitis suppurativa lesions, which included morphologic, physiopathologic, statistical, and histologic analyses, has not been previously reported. Another limitation may have been that this study considered the experience of a single observer who both performed the sonographic examinations and interpreted the data. Nevertheless, at the same time, this factor may have provided consistency to this study because it provided a standardized protocol performed by a trained observer under real-world conditions and was supported by clinical, surgical, and histologic data.

The anatomic proof of the similarities between hidradenitis suppurativa and pilonidal cysts may potentially affect their management, the research field, and clinical trials related to these conditions. Thus, common therapeutic strategies might be applied for these cases. An initial example of a common therapeutic strategy is the recently reported successful use of resorcinol for treating a pilonidal cyst, something that has been also used for managing hidradenitis suppurativa.[35]

In conclusion, color Doppler sonography provides significant anatomic evidence of similar morphologic features between the key lesions of hidradenitis suppurativa and pilonidal cysts, which suggests that pilonidal cysts may be a variant or localized form of hidradenitis suppurativa. Perhaps the fragments of hair tracts frequently detected in the sonographic lesions of both entities may be caused by the ectopic production of hair, in addition to other abnormal processes, and are unlikely to occur by a mechanism involving the embedding of hair tracts. Common therapeutic strategies and research may be designed for both entities.

References

1. Vasanth V, Chandrashekar BS. Follicular occlusion tetrad. *Indian Dermatol Online J* 2014; 5:491–493.
2. Boer J, Nazary M, Riis PT. The role of mechanical stress in hidradenitis suppurativa. *Dermatol Clin* 2016; 34:37–43.
3. Kueper J, Evers T, Wietelmann K, et al. Sinus pilonidalis in patients of German military hospitals: a review. *GMS Interdiscip Plast Reconstr Surg DGPW* 2015;4:Doc02.
4. Velasco AL, Dunlap WW. Pilonidal disease and hidradenitis. *Surg Clin North Am* 2009; 89:689–701.
5. Jemec GB. Clinical practice: hidradenitis suppurativa. *N Engl J Med* 2012; 366:158–164.

6. Scheinfeld N. An atlas of the morphological manifestations of hidradenitis suppurativa. *Dermatol Online J* 2014; 20:22373.
7. von Laffert M, Stadie V, Ulrich J, Marsch WC, Wohlrab J. Morphology of pilonidal sinus disease: some evidence of its being a unilocalized type of hidradenitis suppurativa. *Dermatology* 2011; 223:349–355.
8. Wortsman X, Wortsman J, Matsuoka L, et al. Sonography in pathologies of scalp and hair. *Br J Radiol* 2012; 85:647–655.
9. Wortsman X, Guerrero R, Wortsman J. Hair morphology in androgenetic alopecia: sonographic and electron microscopic studies. *J Ultrasound Med* 2014; 33:1265–1272.
10. Mentes O, Oysul A, Harlak A, Zeybek N, Kozak O, Tufan T. Ultrasonography accurately evaluates the dimension and shape of the pilonidal sinus. *Clinics (Sao Paulo)* 2009; 64:189–192.
11. Wortsman X, Jemec GBE. High frequency ultrasound for the assessment of hidradenitis suppurativa. *Dermatol Surg* 2007; 33:1–3.
12. Kelekis NL, Efstathopoulos E, Balanika A, et al. Ultrasound aids in diagnosis and severity assessment of hidradenitis suppurativa. *Br J Dermatol* 2010; 162:1400–1402.
13. Wortsman X, Moreno C, Soto R, Arellano J, Pezo C, Wortsman J. Ultrasound in-depth characterization and staging of hidradenitis suppurativa. *Dermatol Surg* 2013; 39:1835–1842.
14. Martorell A, Segura Palacios JM. Ultrasound examination of hidradenitis suppurative [in Spanish]. *Actas Dermosifiliogr* 2015; 106(suppl 1):49–59.
15. Wortsman X. Imaging of hidradenitis suppurativa. *Dermatol Clin* 2016; 34:59–68.
16. Martorell A, García-Martínez FJ, Jiménez-Gallo D, et al. An update on hidradenitis suppurativa (part I): epidemiology, clinical aspects, and definition of disease severity. *Actas Dermosifiliogr* 2015; 106:703–715.
17. Wortsman X, Wortsman J. Ultrasound detection of retained hair tracts in hidradenitis suppurativa. *Dermatol Surg* 2015; 41:867–869.
18. Wortsman X, Rodriguez C, Lobos C, Eguiguren G, Molina MT. Ultrasound diagnosis and staging in pediatric hidradenitis suppurativa. *Pediatr Dermatol* 2016; 33:e260–e264.
19. Wortsman X, Alfageme F, Roustan G, et al. Guidelines for performing dermatologic ultrasound examinations by the DERMUS group. *J Ultrasound Med* 2016; 35:577–580.
20. Wortsman X. Common applications of dermatologic sonography. *J Ultrasound Med* 2012; 31:97–111.
21. Hurley HJ. Axillary hyperhidrosis, apocrine bromhidrosis, hidradenitis suppurativa and familial bening pemphigus: surgical approach. In: Roenigk RK, Roenigk HH (eds). *Dermatologic Surgery*. New York, NY: Marcel Dekker; 1989:729–739.
22. Wortsman X, Castro A, Figueroa A. Color Doppler ultrasound assessment of morphology and types of fistulous tracts in hidradenitis suppurativa. *J Am Acad Dermatol* 2016; 75:760–767.
23. Saunte DM, Boer J, Stratigos A, et al. Diagnostic delay in hidradenitis suppurativa is a global problem. *Br J Dermatol* 2015; 173: 1546–1549.
24. Strzyz P. Adult stem cells: hair stem cells born without a home. *Nat Rev Mol Cell Biol* 2016; 17:133.
25. Xiong Y, Liu Y, Song Z, Hao F, Yang X. Identification of Wnt/β-catenin signaling pathway in dermal papilla cells of human scalp hair follicles: TCF4 regulates the proliferation and secretory activity of dermal papilla cell. *J Dermatol* 2014; 41:84–91.
26. Huntzicker EG, Oro AE. Controlling hair follicle signaling pathways through polyubiquitination. *J Invest Dermatol* 2008; 128: 1081–1087.
27. Jahoda CA, Gilmore AC. What lies beneath: Wnt/β-catenin signaling and cell fate in the lower dermis. *J Invest Dermatol* 2016; 136:1084–1087.
28. Chen P, Cescon M, Bonaldo P. Lack of collagen VI promotes wound-induced hair growth. *J Invest Dermatol* 2015; 135:2358–2367.
29. Luderer HF, Nazarian RM, Zhu ED, Demay MB. Ligand-dependent actions of the vitamin D receptor are required for activation of TGF-β signaling during the inflammatory response to cutaneous injury. *Endocrinology* 2013; 154:16–24.
30. Sion-Vardy N, Osyntsov L, Cagnano E, Osyntsov A, Vardy D, Benharroch D. Unexpected location of pilonidal sinuses. *Clin Exp Dermatol* 2009; 34:e599–e601.
31. de Vasconcelos P, Goyri-O'Neill J, Soares-Almeida L, Ferreira J, Filipe P. Subungual ectopic hair studied by scanning electron microscopy. *J Eur Acad Dermatol Venereol* 2016; 30:472–473.
32. Emeksiz MC, Uzar Kocak M. Subungual ectopic hair (onycotrychia). *J Eur Acad Dermatol Venereol* 2014; 28:1263–1264.
33. Cao W, Li L, Mii S, Amoh Y, Liu F, Hoffman RM. Long-term extensive ectopic hair growth on the spinal cord of mice from transplanted whisker follicles. *PLoS One* 2015; 10:e0133475.
34. Wortsman X, Wortsman J. Clinical usefulness of variable-frequency ultrasound in localized lesions of the skin. *J Am Acad Dermatol* 2010; 62:247–256.
35. Encabo B, Pascual JC, Romero D, Ruiz de Apodaca RF, Selva J, Jemec GBE. Pilonidal sinus: clinical and ultrasonographic response to topical 15% resorcinol. *Br J Dermatol* 2016; 175:1103–1104.