Mammary Hidradenitis Suppurativa Lesions – A Suggestion for Phenotyping

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ABSTRACT

Background: Hidradenitis suppurativa (HS) is an under-diagnosed chronic inflammatory skin disease of the pilosebaceous unit of apocrine gland-rich parts of the body. The mammary area is the fourth most HS-affected area and, as typical lesions include non-fluctuating nodules, abscesses, and tunnels/sinus tracts, mammary HS is often mistaken for other mammary "boils", such as sub-areolar and granulomatous non-lactating breast abscesses. Our objective was to present a spectrum of mammary HS lesions, explore a possible classification, and expose mammary HS as a possible differential diagnosis to non-lactational breast abscesses.

Methods: A cross-sectional study on current and newly-referred patients treated for HS affecting the mammary area. Anamnestic information, subjective outcome measures, and lesion counts including anatomical location were collected. Patients with similar morphologies were grouped, and characteristics for the groups were investigated.

Limitations: We were not aware of the number of morphologies we would find, and as a result the study did not have sufficient power to show significant differences after correction for multiple testing.

Results: We found three morphologically different subtypes of mammary HS; the Sternal, the Frictional, and the Nodule types. These groups differed in anatomical lesion characteristics and other patient characteristics. Furthermore, we found a fourth Mixed type – a combination of the other three.

Conclusion: Differential diagnosis between mammary HS and sub-areolar or granulomatous non-fluctuating non-lactating breast abscess is most easily performed by assessing the precise anatomical location of the lesion and determining if the mammary lesion is the only lesion present or if similar lesions exist in other HS-specific areas.

KEY WORDS: hidradenitis suppurativa, mammary lesion, morphology, non-lactating breast abscess, phenotypes, sub-types

INTRODUCTION

Hidradenitis suppurativa (HS) is a chronic inflammatory skin disease of the pilosebaceous unit that affect 1-2% of the population across different cultures (1-4). The disease is characterized by recurrent inflamed non-fluctuating nodular lesions of the intertriginous skin areas, where they may progress via abscess formation to sinus tracts (tunnels) and scaring (5,6). The diagnostic criteria for HS are at least

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two episodes of typical lesions (nodules, abscesses, tunnels/sinus tract, etc.) at a classic body-site (the axillae, groin, genitals, perineal and perianal region, buttocks, infra- and inter-mammary folds) within a six-month-period (7). Records show that the mammary area is the area fourth most affected by HS (6).

Breast abscesses constitute a relevant differential diagnosis to mammary HS lesions and vice versa. Traditional breast abscesses primarily affect women of reproductive age, the most common type being lactational, and often result from a case of mastitis (8). At later ages, this type is less common and its counterpart, the non-lactating breast abscess (NLBA) with an altogether different pathogenesis, increases in frequency (8,9). NLBA is subdivided into sub-areolar (lactiferous duct obstruction) abscesses, granulomatous abscesses which, like HS, have a high rate of reoccurrence after surgical removal, and abscesses caused by an infectious agent such as bacteria or fungi (8-10). NLBA is often referred to as smoker's boils due to the high (70%) prevalence in those who also smoke 10 or more cigarettes a day (9). Amongst other risk factors for NLBA are obesity, diabetes, and African descent (11,12), all of which are also associated with increased risk of HS (13-15). Furthermore, sub-areolar abscesses tend to reoccur and form fistulas (9,) and as many as 57 % of NLBA may in fact reoccur, with tobacco smoking predisposing for reoccurrence (11). It has therefore been suggested that NLBA and HS are associated and that they may both originate from an occlusion of the pilosebaceous unit (16,17).

The primary treatment for breast abscesses are incision and drainage in combination with antibiotics such as e.g. flucloxacillin 250-500 mg f.t.d. (8), whereas treatment of HS primarily focuses on antibiotics with anti-inflammatory properties or acute triamcinolone injections, with only fluctuating abscesses and not nodules being given surgical drainage (18). This shows a divergent practice in treatment, for while incision and drainage should always be conducted at

Figure 1. Mammary hidradenitis suppurativa morphologies. Legend: Mild (a, c, e, g & g) and severe (b, d, f & h & i) versions of our morphologies: Nodule (a & b), Sternal (c & d), Friction (e & f), Mixed type: Nodule + Sternal (g), Nodule + Friction (h), and all three types (i).

the place of maximum fluctuation, for breast abscesses one should not wait for fluctuation to manifest before draining a potential abscess as necrosis can be considerable before leading to fluctuation (19). Incision is therefore often carried out at a stage where ultrasound shows a solid lesion (19).

As some patients with HS may present mammary fistula that can be adequately treated without surgery (16), it has become of some importance to adequately distinguish between mammary HS lesions and more traditional breast abscesses. Our aim was therefore to present a spectrum of how HS lesions of the mammary area may present and explore a possible classification.

PATIENTS AND METHODS

Descriptive stage

This cross-sectional study was conducted at the Department of Dermatology, Zealand University Hospital, Roskilde, Denmark during consultations in the outpatient clinic. We reviewed the records of current and newly referred patients treated by Dr. Saunte between October 2018 and March 2020 who presented with mammary HS symptoms. Information extracted included genetic predisposition, age, age at HS onset, BMI, smoking status, Hurley stage, co-morbidities, number of sinus tracts, number of nodules, lesions located at areas with belly-friction (abdominal folds and waste-band), DLQI, pain, HS severity (both measured by the patient on a numerical rating scale from 0-10), employment status, and whether they were currently receiving biologic treatment. The mammary lesion type was recorded and was later used to form the different mammary HS morphologies; The Sternal, the Frictional, and the Nodule types (Figure 1).

All patients recieved information about the study and its aproval by the Danish Data Protection Agency before subsequently providing verbal consent for the chart review.

Analytical stage

In the analytical part of the study, the frequencies of the different lesions were compared, as were the morphological groups in regards to the variables described in the section above. Since we were not aware of the number of groups we would find, the study did not have sufficient power to show significant differences after correction for multiple testing. Despite this, we do provide statistical data on the differences between groups.

Statistics

Nonparametric data were reported as frequency distribution and percentages, continuous data as means and standard deviation (SD) or medians, and interquartile range (IQR) based on normality. Comparisons were performed with Fisher's exact test or Chi-square test as appropriate. Differences between groups were calculated with ANOVA, Mann-Whitney U-tests, or Kruskal-Wallis analysis of variance, likewise depending on normality. Significance was set to P=0.05, and all analyses were adjusted for multiple testing using the Bonferroni method were applicable.

All statistics were performed in R 3.31 (GNU, General Public License).

Data and materials approval

Data from Danish registries are protected by the Danish Act on Processing of Personal Data and can only be accessed following application. This study has been approved by the Danish Data Protection Agency (REG-204-2017).

RESULTS

Descriptive stage

Based on clinical observations, we noticed that patients with HS who had involvement of the mammary area tended to show one of three separate morphologies. The Nodule type consists of classic HS lesions (6) that are often characterized in this anatomical area by deep-seated nodules and/or boils in the lower quadrants of the breasts, some located near the areola, but most located more than 1 cm away (Figure 1, a and b); these lesions may later perforate the skin, causing suppuration. The Sternal type is defined by fine narrow cord-like scarring at the intermammary area above the sternum (pilonidal cyst-like) (20) (Figure 1, c and d), and the Frictional type by nodules at places exposed to pressure from bra straps and areas of friction (21) (Figure 1, e and f). In addition, some patients presented more than one morphology and were identified as having a Mixed type (Figure 1, g, h and i).

Analytical stage

We included 51 patients in this cohort (Table 1). Of those, 62.7% (32/51) presented characteristics of just one type of lesions, the Nodule type (41.2%, 21/51) being by far the most prevalent as compared with the Frictional (17.6%, 9/51) and Sternal types (3.9%, 2/51). The Mixed group comprised 37.3% (19/51) of the cohort; this included three patients who had all three morphologies. In the Mixed group, 78.9 % (15/19) had the combination of the Nodule and the Frictional type, showing that the Frictional type occurred more often in combination with the Nodule type than by itself.

Table 1. Specifics on the four different morphological groups

Morphology		Nodule type	Sternal type	Frictional type	Mixed type	*P*-value
Total number with this morphology, n (% of all)		38 (74.5)	9 (17.6)	26 (51)		
Pt. with this morphology only, n (% of all)		21 (41.2)	2 (3.9)	9 (17.6)	19 (37.3)	
Basic descriptive variables						
HS family history, n (%)		13 (65) NA = 1	0 (0)	3 (33.3)	12 (63.2)	0.15
Age of onset, years (IQR)		17 (14; 22)	15.5 (15.3; 15.8)	18 (14; 26)	17 (13; 21)	0.82
Age, years (IQR)		46 (38; 53) †	19.5 (19.3; 19.8) †	43 (30; 51)	37 (24.5; 52)	**0.02**
BMI, (IQR)		34.4 (30.8; 38.7) NA = 1	26.5 (24.2; 28.9)	36.1 (35.9; 42.9)	35.2 (32; 40.9)	0.07
Since 18 years	BMI increase % increase	10 (6.6; 16) † 47.8 (27.9; 62.6) NA = 3	-1.9 (-2.9; -1) † -7.4 (-11.1; -3.7)	15.8 (9.6; 17.5) 36.5 (36; 66.7)	6.8 (4.6; 11.8) 26.5 (16.2; 51.3)	**0.04** 0.06
Smoker, (%)	Yes No Former	16 (76.2) 2 (9.5) 3 (14.3)	2 (100) 0 (0) 0 (0)	5 (55.6) 2 (22.2) 2 (22.2)	9 (47.4) 3 (15.8) 7 (36.8)	0.18
Subjective outcome measures and employment						
DLQI, (IQR)		7 (3.3; 12.8) † NA = 3	4 (4; 4)	11.5 (9.5; 13.2) NA = 1	14 (7.5; 19) † NA = 1	**0.02**
Pain, NRS, (IQR)		7 (4.5; 8) NA = 1	5 (2.5; 7.5)	6 (5; 7.3) NA = 1	8 (6; 9) NA = 2	0.58
HS severity, NRS, (IQR)		5 (2.8; 5.3) NA = 1	5 (5; 5)	6 (5; 7) NA = 1	7 (2; 8) NA = 2	0.43
Employment status, n (%) - unemployed - part time - retired - internship - sick leave - student - employed - compensation for loss of earnings		 1 (4.8) 2 (9.5) 7 (33.3) 0 (0) 2 (9.5) 0 (0) 8 (38.1) 1 (4.8)	 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 2 (100) 0 (0) 0 (0)	 3 (33.3) 1 (11.1) 1 (11.1) 0 (0) 0 (0) 0 (0) 4 (44.4) 0 (0)	 1 (5.3) 0 (0) 1 (5.3) 1 (5.3) 2 (10.5) 6 (31.6) 8 (42.1) 0 (0)	0.67
Total unemployment		3 (14.3)	0 (0)	3 (33.3)	3 (15.8)	0.55
Disease specific variables and treatment						
Hurley stage, n (%)	I II III	2 (9.5) 16 (76.2) 3 (14.3)	0 (0) 1 (100) 0 (0) NA = 1	0 (0) 7 (77.8) 2 (22.2)	1 (5.3) 14 (73.7) 4 (21.1)	0.79
Comorbidities, n (%)	Any - Hormonal - Neurological - Cardiac - Gastrointestinal - Skin - Joint - Other	18 (90) NA = 1 6 (30) 5 (25) 3 (15) 4 (20) 7 (35) 4 (20) 5 (25)	1 (50) 0 (0) 0 (0) 0 (0) 0 (0) 1 (50) 0 (0) 0 (0)	9 (100) 6 (66.7) 4 (44.4) 3 (33.3) 1 (11.1) 2 (22.2) 1 (11.1) 2 (22.2)	15 (78.9) 5 (26.3) 4 (21.1) 4 (21.1) 1 (5.3) 3 (15.8) 5 (26.3) 2 (10.5)	0.46 0.12 0.48 0.62 0.52 0.48 0.71 0.60
Sinus tracts, n (IQR)		0 (0; 0) NA = 4	0 (0; 0)	1 (0; 3)	1 (0; 1.5) NA = 4	0.17
Nodules, n (IQR)		2 (1; 3.3) † NA = 1	0 (0; 0) ‡, §	7 (4; 15) † ‡	6 (2.5; 17.3) § NA = 1	**0.004**
Belly friction, n		0 (0) †	0 (0)	3 (33.3)	8 (42.1) †	**0.004**
On biologic treatment, n		1 (5.9) NA = 4	0 (0) NA = 1	0 (0)	3 (15.8)	0.05

Combination types in Mixed Morphologies (% of all)			
Nodule and Sternal	Nodule and Friction	Sternal and Friction	All
2 (10.5)	12 (63.2)	2 (10.5)	3 (15.8)

Legend: Table of the differences between the four different groups divided into the following categories "Basic descriptive variables", "Subjective outcome measures and employment", and "Disease-specific variables and treatment".

N = number, HS = hidradenitis suppurativa, IQR = inter quartier range, BMI = body mass index, DLQI = dermatological life quality index, NRS = numerical rating scale, NA = not available. †, ‡ and § signifies which groups have statistical differences, albeit not significant after Benjamini-Hochberg correction for multiple testing.

Table 2. Patient-characteristics of each group

Nodule type	What we consider the classic type. Most frequent morphology. Mid-40s, smoker, overweight/obese, low-moderate disease activity. HS affects the daily activity but not as much as for other types. Likely has affected family members.
Sternal type	Rarest morphology. Young patient group – around 20 years (students). Lower BMI than the other groups (not obese). Very likely to smoke, do not necessarily have affected family members. Has fewer comorbidities (probably due to lower age). Has low disease activity outside the sternal area. The group with the lowest effect on daily activity. Considers their disease activity on par with other types (likely due to their younger age).
Frictional type	Common morphology. Most often seen in combination with the Nodule type. Latest age of onset. Start to mid-40s, overweight/obese, moderate-severe disease activity, has many sinus tracts. May experience HS lesions in the abdominal skinfolds/belt area. Large effect on daily activity. May have affected family members.
Mixed type	Most often a combination of the Nodule and Friction type. Is similar to those groups. Around 40 years of age, overweight/obese, smoker/former smoker, highest disease activity. Most likely to have HS lesions in the abdominal skinfolds/belt area. Largest effect on daily activities. Experience more pain and rates severity higher than those with a single morphology. Likely has affected family members. Group most likely to be treated with biologics.

Legend: Patient characteristics of each of the four groups.
HS = hidradenitis suppurativa, BMI = body mass index.

Basic descriptive variables

The likelihood of having a first-degree relative with HS was high for those with the Nodule (65.0%) and Mixed types (63.2%) and lower for those with the Frictional (33.3%) and Sternal type (0.0%) (*P*=0.15).

The age of onset was identical. The Nodule and Mixed groups had median ages of onset of 17 years, and the Sternal and Frictional group had onset ages of 15.5 and 18.0 years respectively (*P*=0.82). The lowest current age was that of the Sternal group (19.3 years), followed by the Mixed (37 years), Frictional (43 years), and lastly the Nodule group (46 years) (*P*=0.02). Though not significant after correction for multiple testing there was a statistical difference between the Nodule and Sternal group (*P*=0.03).

The lowest median BMIs were that of the Sternal group (26.5), followed by the Nodule (34.4), Mixed (35.2), and Frictional groups (36.1) (*P*=0.07). There was a difference between BMI development from the age of 18 to the time of the analysis for the Nodule and Sternal groups (BMI increase of 10 vs. -1.9). This difference was not statistically significant after correction for multiple testing. There was no difference in percentage change of BMI (*P*=0.06).

Active smoking was high for the Sternal (100.0%) and Nodule groups (76.2%) and lower for the Frictional (55.6%) and Mixed groups (47.4%) (*P*=0.18).

Subjective outcome measures and employment

The median DLQI was lowest for the Sternal group (4, IQR: 4-4), followed by the Nodule (7, IQR: 3.3-12.8), Frictional (11.5, IQR: 9.5-13.2), and Mixed groups (14, IQR: 7.5-19) (*P*=0.02). Though not significant after correction for multiple testing, there was a statistical difference between the Nodule and Mixed group (*P*=0.03). The median self-rated pain experienced was lowest for the Sternal (5, IQR: 2.5-7.5) and Frictional groups (6, IQR: 5-7.3), followed by the Nodule (7, IQR: 4.5-8) and Mixed group (8, IQR: 6-9) (*P*=0.58). The median HS severity was lowest for the Nodule (5, IQR: 2.8-5.3) and Sternal group (5, IQR: 5-5), followed by the frictional (6, IQR: 5-7) and Mixed groups (7, IQR: 2-8) (*P*=0.43).

Total unemployment was highest for the Frictional group (33.3%) followed by the Mixed (15.8%), Nodule (14.3%), and Sternal groups (0.0%), but these differences were not significant (*P*=0.55). There was also no difference when subdividing the employment types further (*P*=0.67) (Table 1).

Disease-specific variables and treatment

For all groups, the most common Hurley stage was stage II. The prevalence of Hurley stage II was highest for the Sternal group (100%) and similar for the Frictional (77.8%), Nodule (76.2%), and Mixed groups (73.7%) (*P*=0.79). There were only three cases of Hurley stage I; two cases in the Nodule group and one in the mixed group (combination of Nodule and Frictional type).

Nearly all members of the cohort reported some form of comorbidity, and as such the highest percentage of comorbidity was experienced by the Frictional group (100.0%), followed by the Nodule (90.0%), Mixed (78.9%), and Sternal groups (50.0%) (*P*=0.46).

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The highest median number of sinus tracts was found in the Frictional group (1, IQR: 0-3), followed by the Mixed (1, IQR: 0-1.5), Nodule (0, IQR 0-0), and Sternal groups (0, IQR: 0-0) (*P*=0.17). The highest median number of nodules was found in the Sternal group (7, IQR: 4-15), followed by the Mixed (6, IQR 2.5-17.3), Nodule (2, IQR: 1-3.3), and Frictional groups (0, IQR 0-0) (*P*=0.004). Though not significant after correction for multiple testing, there was a statistical difference between the Mixed and Sternal group, the Frictional and Nodule group, and the Sternal and Frictional group.

The rates of belly-friction were highest in the Mixed group (42.1%), followed by the Frictional (33.3%), Nodule, and Sternal groups (both 0.0%) (*P*=0.004). Though not significant after correction for multiple testing, there was a statistical difference between the Nodule and Mixed group.

Lastly, the rates of biologic treatment were highest for the Mixed group (15.8%), followed by the Nodule (5.9%), Sternal, Frictional and Full groups (all three 0.0%) (*P*=0.05) (Table 2).

DISCUSSION

HS is a distinct inflammatory skin disease that may affect the mammary areas and present as a differential diagnosis to NLBA. Due to the limited awareness of HS amongst physicians, diagnosing HS can be difficult, even more so when NLBA requires swift surgical treatment to avoid undue tissue damage. This sample suggests that subtyping of HS mammary lesions is possible, which may help in the differentiation between NLBA and HS.

Sub-areolar NLBA is defined as an abscess located one centimeter or closer to the areola. It is the most common type of NLBA (9) and is therefore the one most relevant to compare the HS morphologies with. In our study, we presented three different morphologies of mammary HS and showed that the most common was the Nodule type, and that the two other morphologies were more often found in combination with the Nodule type (Sternal 55.6%, (5/9) and Frictional 57.7%, (15/26)) than by themselves. While the Sternal type should be easy to differentiate from a NLBA, the Frictional and Nodule type are more problematic. The anatomical position further from the areola, potentially in places of friction such as from bra-straps etc., seems to be the best indicator that a target lesion is HS. Distinguishing a Nodule type HS lesion from a granulomatous breast abscess would be very difficult. Both are palpable, non-fluctuating, and may form sinus tracts/fistulas, which may suppurate. A diagnosis of a granulomatous breast abscess is often established after a pathologists describes a non-caseating granuloma confined within the breast lobules with no sign of infection or cancer (10). One distinguishing feature is that the Nodule type tends to favor the lower quadrants, whereas this area is the site of only 25% of granulomatous breast abscesses.

Furthermore, patients with different mammary HS morphologies had different patient-characteristics (Table 2). The Nodule group could be described as being in their mid-40s, often being smokers with a family history of HS and experiencing low to moderate disease activity. In many ways, these patients represent what we consider the typical patients with HS. The Sternal group was young, had the lowest age of onset, a lower BMI, and fewer comorbidities. This group had low disease activity outside the sternal area and correspondingly had the lowest effect on daily activity. These patients likely have a milder HS phenotype and are encountered primarily because such sternal lesions are less likely to be misdiagnosed as an infection. Alternatively, they may be a prodromal phenotype that later progresses to the more severe Mixed type. Their youth, earlier age at first symptom, and higher prevalence of smoking resemble that of another HS population with pilonidal sinus symptoms of the intergluteal cleft (22). The Frictional type was common, had the latest age of onset, the highest BMI, and a high number of sinus tracts. Patients in this group also reported lesions in other places of friction such as belt areas and abdominal skinfolds, indicating the possibility of external mechanical stress contributing to HS lesions though "Koebnerization" (21). The Mixed group consisted primarily of patients with a combination of the Nodule and Frictional type, and as such resembled these groups. This subtype had a large effect on daily life, and rated pain and severity as high.

Based on this information, we advise that HS should be considered a differential diagnosis for every case of non-fluctuating NLBA. The clinical presentation at sites of friction as well as at the lower quadrant further away from the areola can help the physician in making their diagnosis. Likewise, in cases of doubt, the presentation of multiple morphologies of mammary lesions or a history of similar lesions in other HS-specific areas will prove beneficial.

Ethics approval:

This study has been approved by the Danish Data Protection Agency (REG-204-2017).

Consent to participate:

Informed consent was obtained from all individual participants included in the study.

Consent for publication:

The patients in this study have given oral informed consent to publication of their case details and written informed consent for using their photographs.

Availability of data and materials:

All data for this study were originally collected at the Department of Dermatology, Zealand University Hospital, Roskilde, Denmark as part of consultations in the outpatient clinic. Data analyzed in this study are therefore protected by the Danish Act on Processing of Personal Data; data sharing for this study is therefore not possible.

Code availability:

The code used for analysis for this study is available upon request

Author contributions:

Concept and design: J Boer, GBE Jemec, and DM Saunte. Acquisition, analysis, or interpretation of data: All authors. Drafting of the manuscript: RK Andersen. Critical revision of the manuscript for important intellectual content: All authors. Statistical analysis: RK Andersen. Obtained funding: Not relevant. Administrative, technical, or material support: RK Andersen. Supervision: J Boer, DM Saunte, and GBE Jemec.

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R Kjærsgaard Andersen and J Boer reports no conflicts of interest.

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References:

1. Vinding GR, Miller IM, Zarchi K, Ibler KS, Ellervik C, Jemec GB. The prevalence of inverse recurrent suppuration: a population-based study of possible hidradenitis suppurativa. Br J Dermatol. 2014;170:884-9.
2. Ingram JR, Jenkins-Jones S, Knipe DW, Morgan CLI, Cannings-John P, Piguet V. Population-based Clinical Practice Research Datalink study using algorithm modelling to identify the true burden of hidradenitis suppurativa. Br J Dermatol. 2018;178:917-24.
3. Calao M, Wilson JL, Spelman L, Billot L, Rubel D, Watts AD, *et al*. Hidradenitis Suppurativa (HS) prevalence, demographics and management pathways in Australia: A population-based cross-sectional study. PloS one. 2018;13:e0200683.
4. Hagan PG, Kjærsgaard Andersen R, Seldam It, Gelder F, Zwijnenburg C, Boer J, *et al*. Hidradenitis suppurativa prevalence in Berekum, Ghana: A cross-sectional study and initial validation of a questionnaire in an African setting. JAAD Int. 2020;1:1-2.
5. Jemec GB. Clinical practice. Hidradenitis suppurativa. N Engl J Med. 2012;366:158-64.
6. Zouboulis CC, Del Marmol V, Mrowietz U, Prens EP, Tzellos T, Jemec GB. Hidradenitis suppurativa/Acne inversa: Criteria for diagnosis, severity assessment, classification and disease evaluation. Dermatology (Basel, Switzerland). 2015;231:184-90.
7. Zouboulis CC, Desai N, Emtestam L, Hunger RE, Ioannides D, Juhasz I, *et al*. European S1 guideline for the treatment of hidradenitis suppurativa/acne inversa. J Eur Acad Dermatol Venereol. 2015;29:619-44.
8. Boakes E, Woods A, Johnson N, Kadoglu N. Breast infection: A review of diagnosis and management practices. Eur J Breast Health. 2018;14:136-43.
9. Versluijs-Ossewaarde FN, Roumen RM, Goris RJ. Subareolar breast abscesses: characteristics and results of surgical treatment. Breast J. 2005;11:179-82.
10. Chirappapha P, Thaweepworadej P, Supsamutchai C, Biadul N, Lertsithichai P. Idiopathic granulomatous mastitis: A retrospective cohort study between 44 patients with different treatment modalities. Ann Med Surg (Lond). 2018;36:162-7.

11. Bharat A, Gao F, Aft RL, Gillanders WE, Eberlein TJ, Marganthaler JA. Predictors of primary breast abscesses and recurrence. World J Surg. 2009;33:2582-6.
12. Rizzo M, Gabram S, Staley C, Peng L, Frisch A, Jurado M. Management of breast abscesses in nonlactating women. Am Surg. 2010;76:292-5.
13. Garg A, Papagermanos V, Midura M, Strunk A. Incidence of hidradenitis suppurativa among tobacco smokers: a population-based retrospective analysis in the U.S.A. Br J Dermatol. 2018;178:709-14.
14. Tzellos T, Zouboulis CC, Gulliver W, Chen AD, Wolkenstein P, Jemec GB. Cardiovascular disease risk factors in patients with hidradenitis suppurativa: a systematic review and meta-analysis of observational studies. Br J Dermatol. 2015;173:1142-55.
15. Garg A, Lavian J, Lin G, Strunk A, Alloo A. Incidence of hidradenitis suppurativa in the United States: A sex- and age-adjusted population analysis. J Am Acad Dermatol. 2017;77:118-22.
16. Berná-Serna JD, Berná-Mestre JD. Mammary fistula could be included in the follicular occlusion tetrad. Eur J Dermatol. 2012;22:261-2.
17. Cosman BC, Al-Refaie WB. Mammillary fistula as a manifestation of acne inversa (hidradenitis suppurativa): report of two cases. J Am Coll Surg. 2002;194:829-33.
18. Saunte DML, Jemec GBE. Hidradenitis suppurativa: Advances in diagnosis and treatment. JAMA. 2017;318:2019-32.
19. Marchant DJ. Inflammation of the breast. Obstet Gynecol Clin North Am. 2002;29:89-102.
20. Gruber S, Windhofer C, Michlits W, Papp C. Hidradenitis suppurativa sternalis: surgical treatment of this "no-touch zone." a 10-year follow-up. Plast Reconstr Sur. 2008;122:81e-3e.
21. Boer J. Should hidradenitis suppurativa be included in dermatoses showing koebnerization? Is it friction or fiction? Dermatology (Basel, Switzerland). 2017;233:47-52.
22. Benhadou F, Van der Zee HH, Pascual JC, Rigopoulous D, Katoulis A, Liakou AI, *et al*. Pilonidal sinus disease: an intergluteal localization of hidradenitis suppurativa/acne inversa: a cross-sectional study among 2465 patients. Br J Dermatol. 2019;181:1198-1206. .