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Relationship between High-Resolution Ultrasonographic and Pathological Appearances in Epidermal Cyst: An Image Representation of the Plantar Type

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Abstract

As the high-resolution multifrequency transducers and multichannel color Doppler machines have been developed, the image representation in dermatologic ultrasound has been rapidly growing in recently years. Epidermal cyst is the common benign intradermal or subcutaneous tumors presenting over the body including hairless skin. In this review, the author provides an update on the characteristic Ultrasonography (US) features and compares US imaging to pathological appearances in epidermal cyst. Given the characteristic pathological appearances, the traumatic epidermal cyst on the sole may tend to appear as a concentric ring pattern owing to the effect of high-resolution US. As a concentric ring pattern or onion-ring appearance on gray-scale US accurately reflects pathological features, it may be important for the dermatologist that the tumor representing concentric ring sign on gray-scale US is considered as an epidermal cyst especially at the unusual sites.

Keywords: Dermatologic ultrasound; Plantar epidermal cyst; Concentric ring sign; High-resolution ultrasonography; Human papillomavirus-associated epidermal cyst

Introduction

The imaging in dermatologic ultrasound has been rapidly growing in recently years [1,2]. The international working group, called Dermatologic Ultrasound (DERMUS) [2] recommended a 15 MHz as the minimum frequency for performing dermatologic examinations. Epidermal cyst is regarded as level 1 content of the training program in dermatologic ultrasound by DERMUS. The author has previously described the usefulness of comprehensive high-resolution ultrasound imaging and Real-Time Tissue Elastography along with enhanced MRI and elasticity features of peripheral rim in epidermal cyst [3,4]. Epidermal cyst most commonly occurs on the head and neck. Ultrasonography (US) studies for epidermal cyst of the sole at an unusual site [5-7] have been reported in a dermatological field. In this review, the author provides an update on the characteristic US features and describes the relationship between ultrasonographic and pathological appearances in epidermal cyst.

Dermatological Ultrasound

The guidelines [1] and an assessment training program [2] have been provided by DERMUS. A 15 MHz is the minimum frequency recommended for performing dermatologic examination. The contents for level 1 including the basic ultrasound knowledge, normal dermatologic ultrasound anatomy, and common pathologic condition were proposed by DERMUS [2]. Epidermal cyst is also considered as level 1 content of the training program in dermatologic ultrasound by DERMUS [2]. The author usually performs US examinations for dermatologic lesions with a high-resolution, broad-band (5MHz-18MHz) linear transducer (Nobulus Hitachi, Ltd. Tokyo, Japan) and also provided several studies in dermatologic area [3,4, 8-18].

Skin Anatomy and Elasticity in Dermatological Ultrasound

The author previously showed the images of skin anatomy and elasticity on gray-scale US and Real-Time Tissue Elastography (RTE) in dermatology [16,17]. The report by Mandava et al. [19] suggested that normal skin is composed of three

layers including the epidermis (thickness 0.06 mm to 0.6 mm), dermis (thickness 1 mm to 4 mm), and subcutaneous tissue (thickness 5 mm to 20 mm). The epidermis represents a hyperechoic line in nonglabrous skin, while it appears as bilaminar hyperechoic and parallel lines in glabrous skin. The dermis represents a hyperechoic band, showing less bright than the epidermis, whereas subcutaneous fat layer appears as a hypoechoic with hyperechoic fibrous septa in between [20]. The smooth distinction between the deep dermis and the superficial dermis or the subepidermal low-echogenicity band has been described [21,22]. The superficial fascia covering the muscular tissues appears as a hyperechoic regular line at deeply location [19]. With respect to the normal skin elasticity, the author previously showed that the dermis represents blue color reflecting low elasticity, while the subcutaneous fat tissue shows red color, representing high elasticity on RTE [17]. The study by Yang et al. described that the skin site, sex, and age affected the skin elastic modules values estimated by real-time Share Wave Elastography (SWE) in healthy individuals [23]. It has been also mentioned that skin elasticity was higher in men than in women at each site and raised in subjects aged 20 to 50 years than in the other age group at the finger [23].

Epidermal Cyst

Epidermal cyst is a common slow-growing dermal or subcutaneous epithelial cyst, which contains keratin and is lined by the epidermis [3,24]. The lesion includes the retention of keratinous debris and cholesterol or sebaceous materials [25]. Epidermal cyst usually occurs in the hair-bearing skin such as head, neck, trunk, and back region. While the unusable sites are palm, sole, fingers, breast, oral cavity, and external genitiate regions. The rare transformations of epidermal cyst into squamous cell carcinoma have been reported [26]. It is important to distinguish an epidermal cyst from other benign superficial soft tissue tumors such as ganglion, pilomatrixoma, lipoma, steatocystoma, dermatofibroma, and intradermal nevus. The cosmetic outcomes of the cases with the inflamed or ruptured cysts are less favorable. It is significant to decide the accurate preoperative diagnosis because the different treatment for ruptured and unruptured types are performed [3,27].

A Different Pathogenesis in Hair Follicle and Hairless Skin

A different pathogenesis was suggested in the occurrence in hair follicles and in hairless skin. The progressive cystic ectasia of the infundibular portion of hair follicles has been known as a result in epidermal cyst of the common benign subcutaneous lesion [3,28]. While the implantation of epidermal fragments into dermis as a result of a penetrating or traumatic injury had been thought to be the main cause of palmoplantar epidermal cyst in hairless skin such as planter and palmer regions [7]. Shimizu et al. [29] compared the clinicopathologic features of epidermal cyst on the sole with those of traditional types and trichilemmal cysts. Most of the epidermal cysts on the sole showed the presence of parakeratosis and lack of a granular layer at least the upper portion of the cyst walls, indicating that most cases of the epidermal cyst on the sole are considered as a true traumatic epidermal cyst. Another etiology due to the Human Papillomavirus (HPV) including HPV57 and HPV 60 has been reported [30]. The report by Egawa et al. [31] suggested that certain palmoplantar epidermoid cysts might develop following metaplasia of the epithelium of eccrine ducts in response to HPV 60 infection. The study provided that the imaging features of HPV-associated plantar epidermoid cysts on MR and US represented linear arrangement of several adjacent globular cysts [7].

Relationship between Ultrasonographic and Pathological Appearances

Pseudotestis and Nonpseudotestis Patterns

It has been reported that US features on gray-scale are classified into two types, i.e., pseudotesis and nonpseudotestis patterns [25] and the classification of 5 patterns of another study have been also described in epidermal cyst [24]. Pseudotestis pattern on gray-scale US is mostly accompanied with filiform anechoic areas and echogenic reflectors in epidermal cyst. Pathologically, filiform anechoic areas are consistent with packed keratin lamellae, whereas echogenic reflectors are consistent with cholesterol, sebaceous foci, or calcifications [25]. Nonpseudotestis pattern is depicted as heterogeneously echoic or lobulated

nodules or represented a concentric ring or target signs [25]. The nonpseudotestis pattern tends to show a high frequency of rupture than the pseudotestis pattern without a statistical significance. The author provides the high-resolution US images and describes the relationship between ultrasonographic and pathological features in epidermal cyst. Gray-scale US appearance shows pseudotestis pattern with filiform anechoic areas and echogenic reflectors of epidermal cyst on the right mandibular location in a 41-year-old man (Figure 1). Pathological findings showed that the filiform anechoic areas were consistent with packed keratin lamellae and echogenic reflectors corresponded to cholesterol and/or sebaceous foci.

Figure 1: Pseudotestis pattern of epidermal cyst on the right mandibular location in a 41-year-old man. Pseudotestis pattern with filiform anechoic areas, echogenic reflectors, and hypoechoic rim was depicted on gray-scale US.

Concentric Ring Sign

An onion-ring appearance with alternating concentric hyperechoic and hypoechoic rings has been reported in epidermal cysts of the testis, breast, and soft tissue regions [32-35]. The study by Manning et al. [34] suggested that testicular epidermoid cysts show concentric rings of alternating echogenicity pattern in 62% on gray-scale US. Chen et al. [35] have described that US features in testicular epidermal cyst represent mostly lamellated, heterogeneous internal ecotecture, with hypoechoic and hyperechoic concentric rings, namely onion-ring appearance. Previous studies indicated that the relation between the concentric ring pattern on US and the alternating layers of compact laminated keratin and the squamous cells in pathology was observed [25,32,33,36,37]. Considering the characteristic pathological appearances, the traumatic epidermal cyst without HPV infection on the sole may tend to appear as a concentric ring sign by means of high-resolution US. Epidermal cyst on the sole in a 16-year-old female was demonstrated in Figure 2. US features on gray-scale showed an ovoid nodule with a laminated, concentric ring pattern or onion-ring appearance (Figure 2). Histological examination showed cystic lesion with a stratified squamous epithelial lining and compact keratin lamellae (Figure 3a and 3b).

Figure 2: Epidermal cyst on the sole in a 16-year-old female. US features on gray-scale showed an ovoid nodule with a laminated, concentric ring pattern.

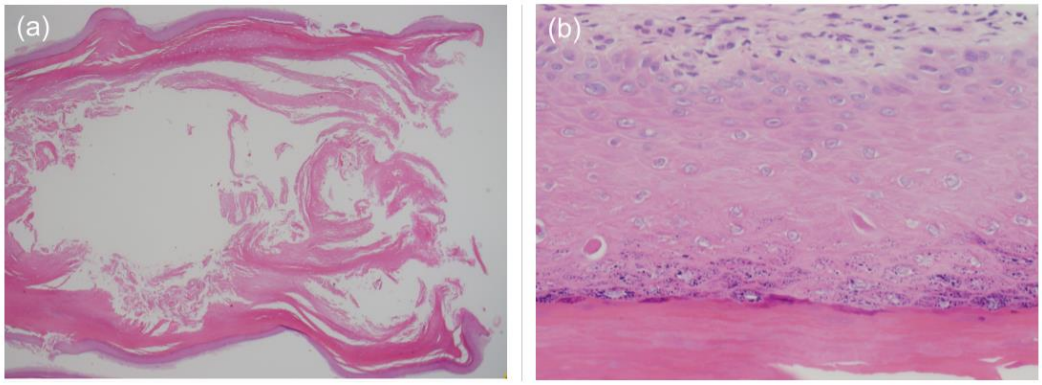

Figure 3: (a) Histological examination showed cystic lesion with a stratified squamous epithelial lining and compact keratin lamellae (hematoxylin-eosin, original magnification × 10). (b) A stratified squamous epithelial lining and compact keratin lamellae were observed in the high-power field (hematoxylin-eosin, original magnification × 400).

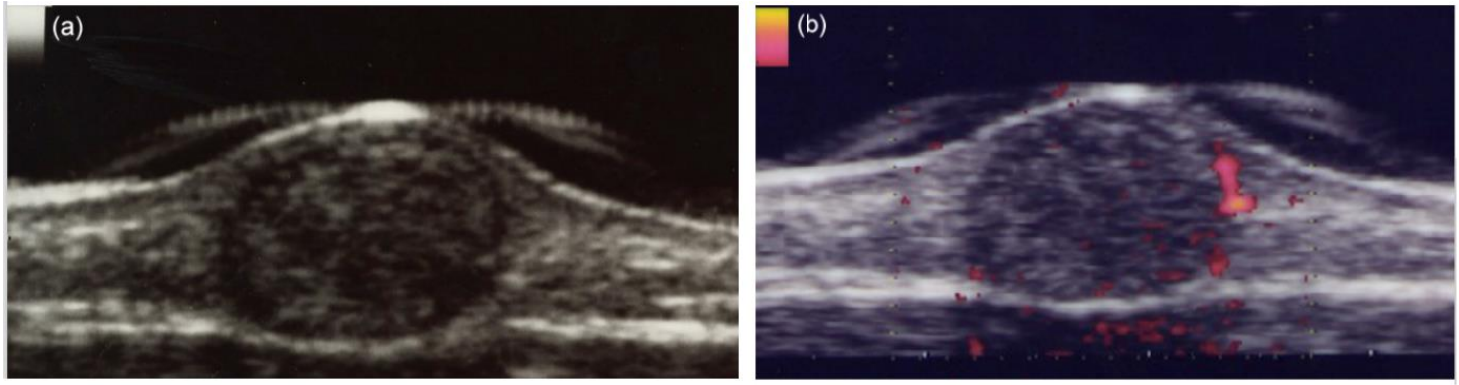

Figure 4: (a) Epidermal cyst on the right upper extremity in a 70s female. A heterogeneous, hypoechoic nodule with dermal attachment and peripheral rim was shown on gray-scale US. (b) Power Doppler US partially showed blood flow signal in periphery.

Dermal Attachment, Focal Dermal Protrusion, Submarine Sign

According to the Huang's report, dermal attachment is defined as close apposition or mild bulging of the lesion to the overlying dermis without any intervening subcutaneous fat. Whereas focal dermal protrusion is defined as prominent focal bulging of the lesion protruding into the dermis [25]. They suggested that these signs may be useful for differentiation from other superficial soft tissue tumors [25]. Recently, Lee et al. [38] suggested that epidermal cyst may have a clinically punctum showing the follicular infundibulum of the terminal hair from the cyst origin. They defined that the focal projection of the hypoechoic portion towards the epidermis as the submarine signs. It is suggested that the submarine sign may be related to punctum [38]. Well, it is clinically important to differentiate trichilemmal cyst from epidermal cyst. Trichilemmal cysts frequently occur in the scalp with dense hair follicle. He et al. [39] described that US features in trichilemmal cysts show well-defined, hypoechoic lesion with calcification and posterior sound enhancement. The connecting tract namely punctum is clinically absent in trichilemmal cyst.

Rim or Halo Appearance

The author previously described real-time tissue elastography in epidermal cyst along with enhanced MRI and elasticity features of peripheral rim [4]. The rim or halo sign was depicted as a sharply defined hypoechoic or hyperechoic pattern surrounding the epidermal cyst on gray-sale US. The study by Kim et al. [40] reported that peripheral low echoic rim; consistent with the capsule was detected in 67% on gray-scale US [40]. The report by Yuan et al. has highlighted a higher frequency of the

absence of a halo or rim in the ruptured cysts than in unruptured cysts with statistical significance [41]. It has been also suggested that the walls of cyst consisted of keratinizing stratified squamous epithelium might be represented as the hypoechoic halo of ruptured and unruptured epidermal cysts [41,42]. Epidermal cyst on the right upper extremity of a 70s female showed a heterogeneously, hypoechoic nodule with dermal attachment and peripheral rim on gray-scale US (Figure 4a). Power Doppler US partially showed blood flow signal in periphery (Figure 4b).

Conclusion

1. It is putative that concentric ring pattern or onion ring appearance on gray-scale ultrasonography accurately reflects pathological features in epidermal cyst.
2. Given the characteristic pathological appearances, the traumatic epidermal cyst on the sole may tend to appear as a concentric ring pattern by using high-resolution ultrasonography.
3. As a close relationship between high-resolution ultrasonographic and pathological features was recognized, it may be important for the dermatologist to consider the tumor representing concentric ring sign on gray-scale ultrasonography as an epidermal cyst especially at the unusual sites.

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References

1. Wortsman X, Alfageme F, Roustan G, Arias-Santiago S, Martorell A, Catalono A, et al. Guidelines for performing dermatologic ultrasound examinations by the DERMUS group. J Ultrasound Med. 2016;35(3):577-80.
2. Wortsman X, Alfageme F, Roustan G, Arias-Santiago S, Martorell A, Catalono A, et al. Proposal for an assessment training program in dermatologic ultrasound by the DERMUS group. J Ultrasound Med. 2016;35(11):2305-9.
3. Fujioka K. Usefulness of comprehensive high-resolution ultrasound imaging in dermatologic field: epidermal cyst. Biomed J Sci & Tec Res. 2018;12(1).
4. Fujioka K. Real- time Tissue elastography in epidermal cyst: along with enhanced MRI and elasticity features of peripheral rim. Biomed J Sci & Tec Res. 2019;16(5):12310-4.
5. Arandes-Marcocci J, Mele-Ninot G, Quintana-Codina M, Iglesias-Sancho M, Redonnet MS. Palmoplantar epidermoid cysts: two cases and brief review of the literature. Dermatol Online J. 2019; 25(10):13030.
6. Lee KM, Park JH, Min KH, Kim EK. Epidermal cyst on the sole. Arch Plast Surg. 2013;40(4):475-6.
7. Sato Y, Nozaki T, Matsusako M, Eto H, Matsui M, Suzuki K, et al. Human papillomavirus-associated plantar epidermoid cysts: MR and US imaging appearance. Skeletal Radiol. 2014;43(2):257-61.
8. Fujioka K, Fujioka A, Eto H, Suzuki K, Sanuki E, Tanaka Y, et al. Nodular fascitis in the thigh followed up using ultrasonography. J Med Ultrason. 2006;33(1):49-53.
9. Fujioka K, Fujioka A, Oishi M, Eto H, Tajima S, Nakayama T. Ultrasonography findings of intradermal nodular fasciitis: a rare case report and review of the literature. Clin Exp Dermatol. 2017;42(30):335-6.
10. Fujioka K, Fujioka A, Tajima S, Oishi M, Hayashi K, Eto H, et al. Characteristic power Doppler sonographic imaging of nodular fasciitis from a dermatological perspective: another case and review of three cases. J Clin Case Rep. 2018;8(9):1165.
11. Fujioka K, Fujioka A, Oishi M, Hayashi K, Nakayama T. High-resolution ultrasound imaging for angioleiomyoma: a painful and vascularized superficial tumor. Biomed J Sci & Tec Res. 2018;9(5):7383-6.

12. Fujioka K. Presentations of clinical, ultrasonographic and pathological features of nodular fasciitis from an established cytogenetic viewpoint: review of the case series. J Carcinog Mutagen. 2018;9(4)1000326.
13. Fujioka K. Painful cutaneous and subcutaneous tumors accompanied with vascularized appearance using high-resolution ultrasound in dermatology: the acronym "ENGLAND" or "LEND AN EGG". Biomed J Sci & Tec Res. 2019;12(4):9449-53.
14. Fujioka K. A comparison between superficial and deep-seated lipomas on high-resolution ultrasonography: with RTE and MRI appearances. Biomed J Sci & Tec Res. 2019;19(2):14220-5.
15. Fujioka K. Characteristic appearances of nodular fasciitis on high-resolution ultrasonography: with vasculature status from a lesion-located perspective. Biomed J Sci & Tec Res. 2019;20(4):15266-72.
16. Fujioka K. Fujioka A, Oishi M, Okada M. A new application in dermatological ultrasound. Biomed J Sci & Tec Res. 2019;22(5):16948-52.
17. Fujioka K. Fujioka A, Okada M. Utility of high-resolution ultrasonography by using acoustic coupler in dermatology. Biomed J Sci & Tec Res. 2019;23(5):17696-701.
18. Fujioka K. Fujioka A, Okada M. High-resolution ultrasonographic appearances in superficial fibromatoses: palmar and plantar diseases. Biomed J Sci & Tec Res. 2020;27(2):20548-54.
19. Mandava A, Ravuri PR, Konathan R. High-resolution ultrasound imaging of cutaneous lesions. Indian J Radiol Imaging. 2013;23(3):269-77.
20. Wortsman X. Common applications of dermatologic sonography. J Ultrasound Med. 2012:31(1):97-111.
21. Scotto di Santolo M, Saqnelli M, Mancini M, Scalvenzi M, Delfino M, Schonauer F, et al. High-resolution color-Doppler ultrasound for the study of skin growths. Arch Dermatol Res. 2015;307(7):559-66.
22. Wortsman X. Sonography of dermatologic emergencies. J Ultrasound Med. 2017;36(9):1905-14.
23. Yang Y, Wang L, Yan F, Xiang X, Tang Y, Zhang L, et al. Determination of normal skin elasticity by using real-time share wave elastography. J Ultraound Med. 2018;37(11):2507-16.
24. Lee HS, Joo KB, Song HT, Kim YS, Park DW, Park CK, et al. Relationship between sonographic and pathologic findings in epidermal inclusion cysts. J Clin Ultrasound. 2001;29(7):374-83.
25. Huang CC, Ko SF, Huang HY, Ng SH, Lee TY, Lee YW, et al. Epidermal cysts in the superficial soft tissue: sonographic features with an emphasis on the pseudotestis pattern. J Ultrasound Med. 2011;30(1):11-7.
26. Veenstra JJ, Choudhry S, Krajenta RJ, Eide MJ. Squamous cell carcinoma originating from cutaneous cysts: the henry ford experience and review of the literature. J Dermatolog Treat. 2016;27(1):95-8.
27. Park J, Chae IS, Kwon DR. Utility of sonoelastography in differentiating ruptured from unruptured epidermal cysts and implications for patient care. J Ultrasound Med. 2015;34(7):1175-81.
28. Kirkham N. Tumors and cysts of the epidermis. In: Elder DE, Elenitsas R, Johnson Jr BL, Murphy GF, editors. Lever's histopathology of the skin. 9th (edn.). Philadelphia: Lippincott Williams & Wikins, USA; 2005. p. 814-5.
29. Shimizu Y, Sakita K, Arai E, Tsuchida T, Ogawa F, Shinichi B, et al. Clinicopathologic features of epidermal cysts of the sole: comparison with traditional epidermal cysts and trichilemmal cysts. J Cutan Pathol. 2005;32(4):280-5.
30. Marquart JD, Trakimas CA, Sawchuk WS, Nuovo GJ, de Villiers EM, Turainsky GW. Human papillomavirus 57-induced extensive, recalcitrant cutaneous verrucae. J Am Acad Dermatol. 2006;55(5):907-8.
31. Egawa K, Egawa N, Honda Y. Human papillomavirus-associated planar epidermoid cyst related to epidermoid metaplasia of the eccrine duct epithelium: a combined histological, immunohistochemical, DNA-DNA in situ

hybridization and three-dimensional reconstruction analysis. Br J Dermatol. 2005;152(5):961-7.

32. Crystal P, Shaco-Levy R. Concentric rings within a breast mass on sonography: lamellated keratin in an epidermal inclusion cyst. AJR Am J Roentgenology. 2005;184(Suppl 183):S47-8.
33. Langer JE, Ramchandani P, Siegelman ES, Banner MP. Epidermoid cysts of the testicle: sonographic and MR imaging features. AJR Am J Roentgenol. 1999;173(5):1295-9.
34. Manning MA, Woodward PJ. Testicular epidermoid cysts: sonographic features with clinicopathologic correlation. J Ultrasound Med. 2010;29(5):831-7.
35. Chen ST, Chiou HJ, Pan CC, Shen SH, Chou YH, Tiu CM, et al. Epidermoid cyst of the testis: an atypical sonographic appearance. J Clin Ultrasound. 2016:44(7):448-51.
36. Stein MM, Stein MW, Cohen BC, Li M, Koenigsberg M. Unusal sonographic appearance of an epidermoid cyst of the testis. J Ultrasound Med. 1999;18(10):723-6.
37. Cho JH, Chang JC, Park BH, Lee JG, Son CH. Sonographic and MR imaging findings of testicular epidermoid cysts. AJR Am J Roentgenol. 2002;178(3):743-8.
38. Lee DH, Yoon CS, Lim BJ, Lee HS, Kim S, Choi AL, et al. Ultrasound feature-based diagnostic model focusing on the "submarine sign" for epidermal cysts among superficial soft tissue lesions. Korean J Radiol. 2019;20(10):1409-21.
39. He P, Cui LG, Wang JR, Zhao B, Chen W, Xu Y. Trichilemmal cyst: clinical and sonographic features. J Ultrasound Med. 2019;38(1):91-6.
40. Kim HK, Kim SM, Lee SH, Racadio JM, Shin MJ. Subcutaneous epidermal inclusion cysts: ultrasound (US) and MR imaging findings. Skeletal Radiol. 2011;40(11):1415-9.
41. Yuan WH, Hsu HC, Lai YC, Chou YH, Li AF. Differences in sonographic features of ruptured and unruptured epidermal cysts. J Ultrasound Med. 2012;31(2):265-72.
42. Jin W, Ryu KN, Kim GY, Kim HC, Lee JH, Park SJ. Sonographic findings of ruptured epidermal inclusion cysts in superficial soft tissue: emphasis on shapes, pericystic changes, and pericystic vascularity. J Ultrasound Med. 2008;27(2):171-6.