High Frequency Ultrasonography of the Skin and Its Role as an Auxillary Tool in Diagnosis of Benign and Malignant Cutaneous Tumors – A Comparison of Two Clinical Cases

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ABSTRACT The number of dermatologic entities that can be studied by ultrasound examination (US) of the skin is increasing. Conventional US and high frequency US (HFUS) are considered useful additional tools in improving the diagnosis and management of common benign and malignant skin tumors. US may help in positive and differential diagnosis of primary melanocytic neoplasms and of locoregional spread in melanoma patients. US preoperative evaluation of primary melanoma thickness correlates with histologically estimated melanoma thickness, and can help determine surgical margins and indications for sentinel lymph node biopsy. It is also useful during follow-up after surgical treatment for early detection of recurrence or metastases. In this case report, we present two cases of skin lesions clinically suspicious for malignancy. The first lesion was a round nodule 3 mm in diameter, resembling a blue nevus. In HFUS it was well delimited, hypoechoic, and well vascularized. The second lesion presented as an elevated, well-circumscribed nodule, 5-6 mm in diameter, inhomogeneous in color. HFUS depicted a poorly delimited, irregular, hypoechoic lesion crossing the dermoepidermal junction. At the first exam it was not vascularized, but 6 months later a number of vascular flow signals within the lesion were found. In histopathological examination the lesions were finally diagnosed as, respectively: benign cavernous hemangioma and melanoma. In both presented cases HFUS proved to be useful in a differential diagnosis of suspicious skin lesions. Noninvasive and easy to perform, HFUS is a valuable diagnostic method in dermatology.

KEY WORDS: ultrasonography, skin tumors, melanoma, cavernous hemangioma

INTRODUCTION

Since its invention, ultrasonography (US) has become a standard diagnostic procedure and the most frequently used imaging method in medicine (1,2). The number of dermatologic entities to which US of

the skin can be applied is increasing. In recent years US has become a reliable adjunctive tool in a diagnosis and also in assessment of the activity and severity of some cutaneous diseases (3).

US has several advantages among other imaging procedures: it is noninvasive, it does not require exposure to radiation, contrast injection, or confining the patient in a tight space (3). The examination can be easily repeated at any time. Unlike magnetic resonance imagining (MRI) and computed tomography (CT), it can clearly visualize even small (less than 3 mm) lesions of the skin. Cutaneous US provides important, real time anatomic information that may be useful for decisions on extending diagnostic procedure and treatment (3). US shows a 3-dimensional picture of the size and outline of skin lesions, their location, relation to surrounding structures, vascularization, quality (whether the lesion is solid, cystic, or both) and the inner structure (homo- and heterogeneous, hypo- and hiperechoic) (2,5). However, the information provided by US depends heavily on examiners experience and skills and also on the frequency of US.

According to frequency, US can be divided into conventional US (frequencies less than 20 MHz) and high frequency US (HFUS) (frequencies from 20 up to 50 MHz). The former (7,5-15 MHz US) is useful in evaluation of subcutaneous palpable lesions and lymph nodes (1,5). It is widely used in dermatologic oncology, for both pre-operative staging and follow-up of melanoma patients (2,4). The optimal frequencies for visualization of the upper layers of the skin are 15MHz or higher, because the definition of the skin layers is better at higher frequencies (1,3).The higher frequency is, the better the resolution that can be obtained and smaller objects that can be depicted. However, increase of frequency results in decrease of the depth of US penetration (5).

US allows the assessment of vascularization of the skin lesions by the use of color Doppler ultrasonography (CDS), which can be very helpful in evaluation of primary skin tumors and inflammatory skin diseases and in discrimination between inflammatory and metastatic lymph nodes (2,5).

Most common applications of cutaneous US are benign afflictions such as epidermal cysts, pilonidal cysts, vascular lesions, and malignant tumors e.g. melanoma and nonmelanoma skin cancers or skin metastases (1-5). US can depict satellite, in transit, and nodal metastases (3). Further indications for cutaneous HFUS include inflammatory skin diseases such as circumscript scleroderma, progressive systemic sclerosis, psoriasis, lichen planus, and other conditions e.g. the assessment of wound healing, scars, lymphedema of the limbs, and allergologic conditions (1,2,4). Finally, HFUS is considered useful for cosmetic purposes e.g. localizing implants, evaluation of actinic skin damage, and treatment control for keloids and haemangiomas (1).

We present two clinical cases as examples of the usefulness of cutaneous US in diagnosis of malignant and benign skin tumors and during the follow-up period for early detection of recurrence. Ultrasonographic evaluations were performed using the ultrasonic Philips IU22 device equipped with a 18 MHz and 15 MHz transducer and Ultrasonix device with a 40 MHz transducer.

CASE REPORTS

Case 1: A 57-year-old male patient was admitted with a history of a growing skin lesion on the forehead that he had first noticed 3 months before. At the time of admission to our Institution the patient's lesion presented as a small, round, smooth, black tumor, measuring approximately 3 mm in diameter, clinically resembling a blue nevus (Figure 1).

The HFUS examination was performed. The first exam during the patients first visit showed a well delimited, hypoechoic dermoepidermal lesion, 1.2

Figure 1. Clinical presentation. **A.** Case 1: round, smooth, black tumor, measuring approximately 3 mm in diameter, clinically resembling a blue nevus. **B.** Case 2: an elevated, well-circumscribed nodule, 5-6 mm in diameter, inhomogeneous in color, composed of different shades of brown, black, and grey. Two brown pigmented macules 2-3 mm in diameter are present on the margin of the lesion.

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mm in thickness, crossing the dermoepidermal junction (Figure 2). CDS showed numerous vascular flow signals within and around the lesion. During follow-up one month later, a well delimited, hypoechoic, 2.5×1.3 mm lesion was depicted. Vascularization evaluated by CDS was similar to previous exam (Figure 2). In videodermoscopy a homogenous pattern with an irregular diffuse area of black or gray pigment and absence of a pigment network were seen, with a diffuse blue-whitish area. Irregular linear and dotted vessels were also shown.

Because of the patient's age and the growing character of the lesion, it was eligible for surgical excision, which was performed nearly two months after the patient's first visit. Surgical margins were 0.1 cm. Pathological examination revealed a circumscribed aggregate of large vascular channels in the dermis filled with organized thrombi leading to papillary fronds. The diagnosis of cavernous hemangioma was established. No further treatment was required.

Case 2: A 23 year-old male patient was admitted to our Dermatological Department due to a history of a skin lesion localized on the left parietal area. Three months before he had noticed the appearance of a pigmented nodule within a raised, flesh-colored skin lesion present for some years, that he had thought to be a consequence of an injury during shaving. Physical examination revealed an elevated, well-circumscribed nodule that was 5-6 mm in diameter. The color of the lesion was inhomogeneous, composed of different shades of brown, black, and grey. Two brown pigmented macules, 2-3 mm in diameter, were present on the margin of the lesion (Figure 1).

HFUS was performed. The first examination revealed a spindle-shaped, hypoechogenic, poorly delimited lesion invading the dermoepidermal junction with features of infiltration of the upper skin layers and compression of the lower skin layers and fatty tissue. CDS visualized a single signal of vascular flow in the fatty tissue below the lesion, which was not suspicious since such single vessels were visible in the normal skin. The dimensions of the lesion were: 8.1 mm horizontally and 1.2 mm axially (Figure 3). Videodermoscopy showed a homogenous pattern with a diffuse irregular area of dark-brown/gray-black pigmentation and an absence of a pigment network, with a diffuse blue-whitish area. Additionally, irregular, unevenly distributed black, brown, and gray dots and globules were present, occurring predominantly at the periphery. Vascular pattern was polymorphous. A slight serohemorrhagic exsudation was also centrally depicted. The patient did not agree to surgical excision of the lesion.

The second exam, performed 6 months later, visualized the lesion within the dermis, which was nonhomogeneously hypoechoic, poorly delimited, irregular, and crossing the dermoepidermal junction. Tumor thickness evaluated with HFUS was about 3mm. CDS showed numerous vascular flow signals within the lesion (Figure 4). Excisional biopsy was performed. Pathological examination revealed atrophic epidermis with single scattered intraepidermal melanocytic

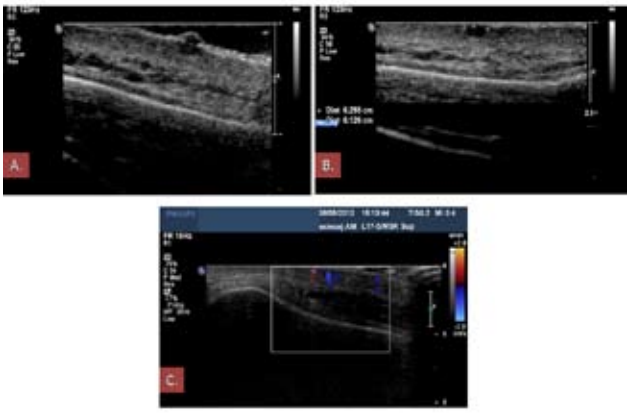

Figure 2. Case 1. US examinations. **A.** The well-delimited dermoepidermal lesion of reduced echogenicity, penetrating the dermoepidermal junction. **B.** Second US examination – the well-delimited hypoechoic lesion, 2.5x1.2mm in size. **C.** Color Doppler scan showing numerous vascular flow signals within and around the lesion.

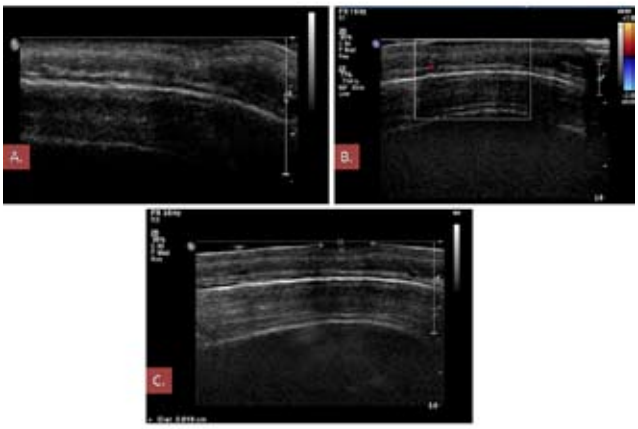

Figure 3. Case 2. US examinations. **A.** the hypoechogenic lesion crossing the dermoepidermal border, poorly-delimited, infiltration of the upper dermal layers with compression of the lower dermal layers and fatty tissue – mass effect – the expansively growing lesion. **B.** Color Doppler scan visualizing a single signal of vascular flow in the fatty tissue below the lesion. **C.** The lesion about 8.1x1.2 mm in size.

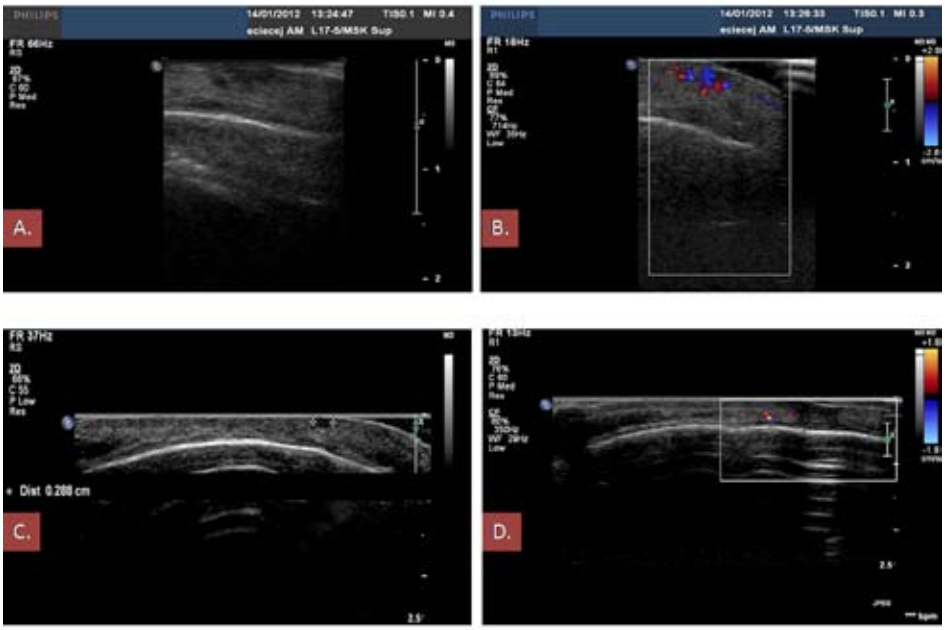

Figure 4. Case 2. US examinations. **A.** The lesion within the dermis of non-homogeneously decreased echogenicity crossing the dermoepidermal junction, poorly delimited and irregular. **B.** Color Doppler scan showing numerous vascular flow signals within the lesion. **C.** Recurrence, 2.8 mm in size. **D.** Color Doppler scan – vascular flow signals within the dermis around the focus.

proliferation and nested atypical melanocytic proliferations in the upper dermis surrounded by a fibrous desmoplastic stroma with features of regression and inflammatory infiltrate (at least Clark level III). Histologically measured thickness of the tumor was 3 mm (T3) – the same as in HFUS.

Five months after surgical removal of the lesion, a follow-up HFUS examination was conducted. It depicted the focus within the dermis of non-homogeneously decreased echogenicity, irregular and poorly delimited, 2.8 mm in size. In CDS many vascular flow signals were visualized within the dermis around the focus – a recurrence of melanoma was diagnosed (Figure 4). It was treated with surgical re-excision and adjuvant radiotherapy.

DISCUSSION

HFUS is a valuable, noninvasive method for evaluation of skin lesions. Many reports have been published concerning its usefulness in estimation of primary skin melanocytic lesions and locoregional spread of malignant skin tumors (staging phase). US enables preoperative measurement of the depth of infiltration and vascularization of the tumor, which might be suggestive for invasive tumors with high metastatic potential.

For melanoma, the depth of infiltration can be reliably measured by cutaneous HFUS in thick lesions (>2 mm). In thinner lesions the correlation between thickness measured using a linear 14-MHz frequency ultrasound sensor and histologically estimated melanoma thickness according to Breslow is less clear, most likely due to inflammatory infiltration, which cannot be distinguished from tumor tissue in US (6). This results in overestimation of tumor thickness in US at 20 MHz (2,11). Cutaneous HFUS with a 12-15 MHz linear probe can reliably differentiate primary melanomas thicker than 1 mm from those thinner than 1 mm (6), so it can be helpful in both choosing appropriate surgical margins (9) and reducing the need of further re-excision (10). In the study in which 50 MHz US were used, measurement was highly reliable for invasive melanoma, even in the presence of lymphocytic infiltration (11). Several studies have shown that the use of higher frequencies (50-100 MHz) reduces the overestimation of tumor thickness in melanocytic skin lesions (11,12). However, at 100 MHz the penetration depth is limited to 1.5 mm. The angiogenesis evaluated with CDS is considered a prognostic factor and could be used to identify melanomas with a high metastatic potential. Thus, the follow-up strategy among patients with vascularized primary melanomas should be particularly attentive (13).

In recent years some new promising noninvasive diagnostic methods have been introduced into dermatology. They include reflectance confocal microscopy which is considered to be useful in differential diagnosis of skin melanocytic lesions and non-linear

laser multiphoton imaging of the skin. These new methods are currently under evaluation, and many clinical studies are being conducted, in melanoma patients as well (14-16).

CONCLUSION

Both presented cases were equivocal clinically and in US. The first one clinically presented as a slowly growing, blue-nevus like lesion that proved to be a benign cavernous hemangioma. In US, it was well circumscribed with abundant blood supply. In the second case, US was applied repeatedly and depicted a constantly growing, invasive lesion with increasing vascularization. The thickness evaluated with US corresponded with histological measurements. When used in postinterventional monitoring it helped in early detection of melanoma recurrence, and thus enabled quick reexcision.

In both presented cases, US turned out to be a helpful tool in diagnosis, in management decisions, and during the follow-up period.

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REFERENCES:

1. Jasaitiene D, Valiukeviciene S, Linkeviciute G, Raisutis R, Jasiuniene E, Kazys R. Principles of high-frequency ultrasonography for investigation of skin pathology. J Eur Acad Dermatol Venereol 2011;25:375-82.
2. Schmid-Wendtner MH, Dill-Müller D. Ultrasound Technology in Dermatology. Semin Cutan Med Surg 2008;27:44-51.
3. Wortsman X. Common Applications of Dermatological Ultrasonography. J Ultrasound Med 2012;31:97-111.
4. Dill-Müller D, Maschke J. Ultrasonography in dermatology. J Dtsch Dermatol Ges 2007;5:689-707.
5. Schmid-Wendtner MH. Ultrasound scanning in dermatology. Arch Dermatol 2005;141:217-24.
6. Kaikaris V, Samsanavičius D, Maslauskas K, Rimdeika R, Valiukevičiene S, Makstiene J, *et al.* Measurement of melanoma thickness comparison of two methods: ultrasound versus morphology. J Plast Reconstr Aesthet Surg 2011;64:796-802.
7. Samimi M, Perrinaud A, Naouri M, Maruani E, Vaillant L, Machet L. High-resolution ultrasonography assists the differential diagnosis of blue naevi and cutaneous metastases of melanoma. Br J Dermatol 2010;163:550-6.
8. Music MM, Hertl K, Kadivec M, Pavlović MD, Hocevar M. Pre-operative ultrasound with a 12-15 MHz linear probe reliably differentiates between melanoma thicker and thinner than 1 mm. J Eur Acad Dermatol Venereol 2010;24:1105-8.
9. Hayashi K, Koga H, Uhara H, Saida T. High-frequency 30-MHz sonography in preoperative assessment of tumor thickness of primary melanoma: usefulness in determination of surgical margin and indication for sentinel lymph node biopsy. Int J Clin Oncol 2009;14:426-30.
10. Machet L, Belot V, Naouri M, Boka M, Mourtada Y, Giraudeau B, *et al.* Preoperative measurement of thickness of cutaneous melanoma using high-resolution 20 MHz ultrasound imaging: A monocenter prospective study and systematic review of the literature. Ultrasound Med Biol 2009;35:1411-20.
11. Guitera P, Li LX, Crotty K, Fitzgerald P, Mellenbergh R, Pellacani G, *et al.* Melanoma histological Breslow thickness predicted by 75-MHz ultrasonography. Br J Dermatol 2008;159:364-9.
12. Gambichler T, Moussa G, Bahrenberg K, M. Vogt, H. Ermert, D. Weyhe, *et al.* Preoperative ultrasonic assessment of thin melanocytic skin lesions using a 100-MHz ultrasound transducer: a comparative study. Dermatol Surg 2007;33:818-24.
13. Lassau N, Lamuraglia M, Koscielny S, Spatz, A, Roche, A, Leclere, J, *et al.* Prognostic value of angiogenesis evaluated with high-frequency and Colour Doppler sonography for preoperative assesment of primary cutaneous melanomas: Correlation with recurrence after a 5 year follow-up period. Cancer Imaging 2006;6:24-9.
14. De Giorgi V, Massi D, Sestini S, Cicchi R, Pavone FS, Lotti T. Combined non-linear laser imaging (two-photon excitation fluorescence microscopy, fluorescence lifetime imaging microscopy, multispectral multiphoton microscopy) in cutaneous tumours: first experiences. J Eur Acad Dermatol Venereol 2009;23:314-6.
15. Carrera C, Puig S, Malvehy J. In vivo confocal reflectance microscopy in melanoma. Dermatol Ther 2012;25:410-22.
16. Debarbieux S, Depaepe L, Poulalhon N, Balme B, Dalle S, Thomas L. Reflectance confocal microscopy accurately discriminates between benign and malignant melanocytic lesions exhibiting a 'dermoscopic island'. J Eur Acad Dermatol Venereol 2013;27:e159-65.