Review

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Diagnosis and characterization of cutaneous tumors using combined ultrasonographic procedures (conventional and high resolution ultrasonography)

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Abstract

High resolution ultrasonography, using 20 – 50 MHz transducers, is a novel diagnostic procedure for the investigation of the skin and its specific conditions. Conventional ultrasononography allows the identification of palpable pigmentary lesions without being able to establish the histologic type of the lesions. The method assesses the degree of tumoral penetration and the presence, type and intensity of circulation at that level. High resolution ultrasonography allows the identification of macular and nodular pigmentary lesions located up to 1.5 cm in depth. There is a correlation between the high resolution ultrasonographic aspect and the Breslow index used for melanoma stadialization. This correlation is limited in the presence of perilesional inflammatory infiltrate. The imaging examination is a valuable assessment method of the skin and its specific conditions. High frequency cutaneous ultrasonography has an important contribution in the screening of pigmentary lesions at risk.

Key words: ultrasonography, skin, pigmentary skin tumors

Rezumat

Ultrasonografia de înaltă rezoluţie, folosind transductoare cu frecvenţa de 20-50 MHz este o nouă procedură de diagnostic utilizată în evaluarea oragnului cutanat şi a patologiei asociate. Ultrasonografia convenţională permite identificarea leziunilor pigmentare palpabile fără a putea stabili tipul histologic al leziunii. Metoda evaluează gradul de penetraţie tumorală în profunzime şi prezentă, respectiv tipul şi amploarea circulaţiei la acest nivel. Ultrasonografia de înaltă rezoluţtie permite identificarea leziunilor pigmentare maculare şi nodulare cu localizare până la o profunzime de 1,5 cm. Există o corelaţie dintre aspectul ecografic cu rezoluţie înaltă şi indicele Breslow folosit în stadializarea melanomului. Această corelaţie prezintă eroare atunci când se constată existenţa unui infiltrat inflamator perilezional. Examinarea imagistică este o metodă valoroasă de apreciere non invazivă a tegumentului şi a patologiei asociate. Ecografia cutanată de înaltă frecvenţă are un aport valoros în screeningul leziunilor pigmentare cu risc.

Cuvinte cheie: ultrasonografie, tegument, tumori cutanate pigmentare

During the past years conventional and high resolution ultrasonography (US) has extended its utility in the field of clinic dermatology. The procedure involving ultrasound is a non invasive method allowing "in vivo" and "in real time" histologic assessment of the cutaneous structure as well as its specific conditions [1]. Several studies have proven the similarities between US and histological sections [2]. The inclusion of this method among the procedures used for the diagnosis of skin diseases is an attempt to replace as much as possible the invasive procedures, especially biopsy, with non invasive ones. The motivation for the extensive use of US derives from its ability to reveal in detail the skin components, up to 1.5 cm in depth, to assess the axial and lateral tumoral extension, the

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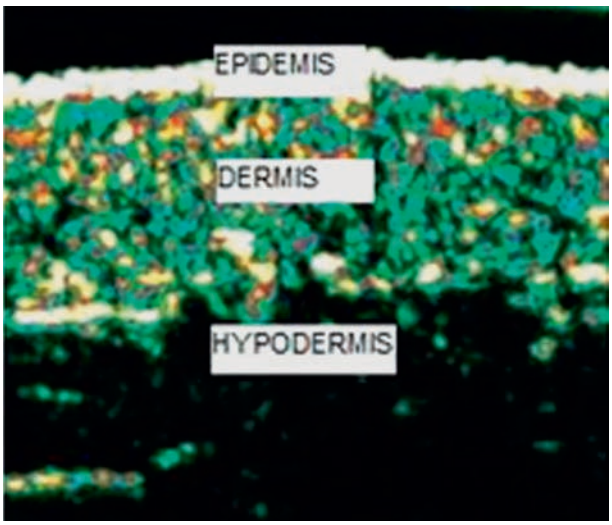

Fig 1. Normal skin (high frequency 20MHz B-mode ultrasonography). The epidermis or hyperechogenic entry line correlates with age, anatomical area, and associated therapy. The dermis or wide echogenic band is composed of different amplitude pixels which can be quantified by the Dermascan software and which are compared to a 0-250 scale. The hypodermis includes adipose panniculi separated by echogenic conjunctive vascular septa.

inflammatory and degenerative processes, as well as the eficiency of different topical and general therapies, thanks to the use of high frequency ultrasounds (fig 1) [3,4].

The main aim of this review is to highlight the contribution of conventional and high resolution US in the diagnosis of pigmentary tumoral lesions of the skin.

The use of conventional US has gained greatly in importance in clinic dermatology starting with the 70‘s [5]. It proved to be a valuable diagnostic method and to have several indications, such as: a. identification and description of visible and palpable structures, including malignant melanoma; b. preoperative and postoperative assessment of periferal lymph nodes in all patients with malignant skin tumors; c. monitoring of metastases, especially during chemotherapy.

The main applications of US in dermatology in the present times are conventional cutaneous US and examination with the high frequency transducer.

The conventional skin examination with the 7.5-13 MHz transducer offers an axial and lateral resolution of 0,2 mm and an ultrasonic depth of up to 7 cm. Therefore, B-mode US allows the identification and description of solid palpable structures and periferal lymph nodes with sizes as small as 2-3 mm. The Doppler or power Doppler examination is important for the identification of vascularisation, an important feature for the discrimination between benign or malignant tumors [6,7].

A very important application of the ultrasonographic examination is the detection and description of lymph nodes (table I) [6]. In normal conditions, the lymph nodes can not be distinguished from the neighbouring tissues because they have the same acoustic impedance as these. However, in pathologic situations, their acoustic impedance becomes different from that of normal skin, making them visible. The lymph nodes reacting to inflammatory conditions are oval in shape, with hypoechogenic perifery and hyperechogenic centres and are less than 3 mm in size. Tumoral lymph nodes have a diameter of over 1 cm, are hypoechogenic, either spherical or irregular in shape. This aspect must not be confused with that of collections occuring postoperatively (seroma, hematoma, abscess). Small hypoechogenic metastases in lymph nodes of under 3 mm, initially located in the marginal hypoechogenic area of reactive lymph nodes can not be distinguished using B-mode US. In these cases, the Doppler or Power Doppler examination for the assessment of vascularisation is necessary. Although in many cases the ultrasonographic method can provide some information on the nature of lymph nodes, the histopathologic examination can seldom be avoided.

The ultrasonographic skin examination with a high frequency transducer offers a 80 micrometer axial resolution, a 200 micrometer lateral resolution and a 1-1,5 cm depth [8,9]. According to the literature data and our experience, high frequency US is a non invasive instrument for skin examination having multiple applications both in the clinical and the research setting [10,11]. We mention some of the most important contributions of the method:

– the histologic skin evaluation and identification of each skin layer (epidermis, dermis, dermoepidermic and dermohypodermic junction, hypodermis). It is worth mentioning that the skin layer thickness is measured in “mm”, while the density of the dermis is measured in number of pixels of different amplitude.

– the assessment and description of pigmentary and non pigmentary tumoral structures: pigmented nevi, malignant melanomas, carcinomas, dermoid cysts, congenital nevi etc.

– the non invasive monitoring, both qualitative and quantitative, of the cutaneous alterations induced by senescence, as well as monitoring of chronic inflammatory conditions or the efficiency of various therapies [12].

An increased incidence of and mortality from skin cancers has been reported; however, the early detection and correct treatment can lead to up to 90% cure rate in low risk melanoma. The patients with cutaneous phototype 1 or 2, or those having nevocelullar nevi have a higher risk to develop a malignant melanoma.

Nevocelullar nevi are benign tumoral lesions of major importance because of their potential transformation into malignant melanoma; therefore, they become an important risk factor when present in high numbers. Congenital nevi can lead to melanomas in 10% of the cases. If the tumor is discovered in time, at sizes below 0.75 mm, the cure rate reaches almost 100%. It becomes obvious that US has imposed itself as a valuable and essential instrument, completing the clinical and dermatoscopic diagnosis.

Types pigmentary skin lesions and their ultrasonographic aspect

a. Thin malignant melanoma occurs in middle-aged subjects and can be located on any area of the skin. The lesions appears as a polychromatic pigmented macula with irregular contour, or as a slightly elevated plaque, and has a slow evolution (fig 2a). The dermatoscopic examination can reveal features aiding the diagnosis (fig 2b). The transition from the radial growth phase to the vertical growth phase begins with the development of an elevated nodule progressing in depth. The classical US can reveal the hypoechogenic elevated lesion "sitting on the skin surface". The high frequency US reveals the epidermic lesions, its regression areas and its degree of dermic penetration. The histological examination can accurately specify the diagnosis and the degree of dermic invasion (fig 2c).

b. Nodular malignant melanoma – is usually an exophytic structure with rapid growth rate, with suggestive clinical and dermatoscopic aspect – except in the achromic MM (fig 3a). Conventional US can assess the hypoechogenic, intensely vascularised tumor, but can not specify its histologic type (fig 3b) [13]. High frequency US quantifies the tumoral size and its degree of dermic penetration, correlating to the Clark histologic index (fig 3c).

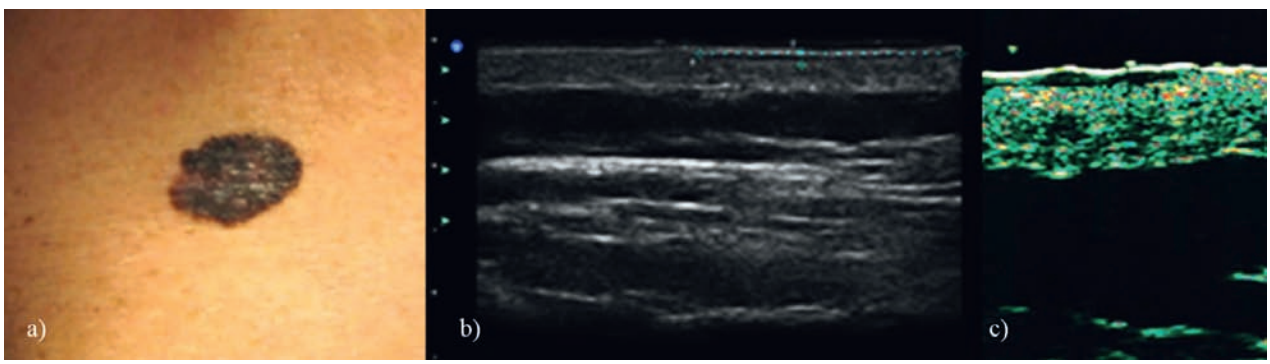

Fig 2. Thin malignant melanoma a) macroscopic aspect: polychromic maculopapular pigmentary lesion, with irregular contour and peripheral regression, located on the thorax; b) dermatoscopic aspect-thin malignant melanoma: polychromic pigmentary macula with a regression area; c) high frequency ultrasonography – irregular hypoechogenic band, with visible areas of vertical growth towards the superficial dermis, accompanied by inflammatory infiltrate (of hypoechogenic aspect) and superficial areas of tumoral regression accompanied by fibrosis (of hyperechogenic aspect). The histological examination confirms the diagnosis and the presence of safe margins.

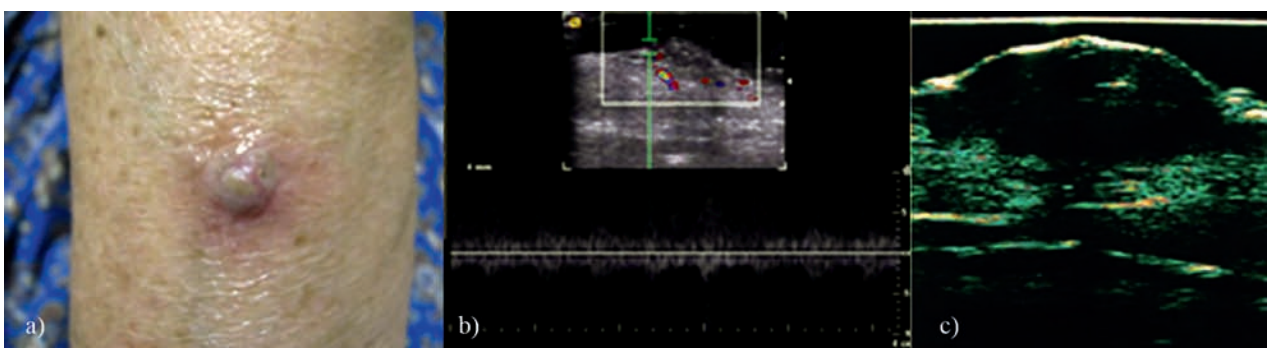

Fig 3. Nodular achromic melanoma located on the forearm a) macroscopic aspect (dermatoscopy has no relevance in achromic lesions); b) conventional ultrasonography: intensely vascularized tumor. There are no ultrasonographic markers to discriminate the tumoral type; c) dermascan aspect – hypoechogenic nodular tumor invading the profound dermis (Clark IV), accompanied by inflammatory infiltrate. The lesion was confirmed through histology (Clark IV).

c. Nevocellular nevi – are considered to be precancerous dermatoses. The junctional nevocellular nevi are pigmentary lesions having a high risk of malignant transformation. The nevic cells are located at the dermoepidermic junction. Dermatoscopy can identify some risk criteria, while high frequency US can assess the junctional location of the tumor, as well as its size, important features for the excision with safety margin of suspicious lesions. Compound nevocelullar nevi are macular-papular lesions involving the middle or profound dermis. Classic US determines the location within the dermis and the tumoral size, while high frequency US can evaluate the level of dermic invasion, correlating with the Clark histologic index in cases where the lesions are not accompanied by inflammatory edema. US assess the degree of cutaneous invasion, without specifying the tumoral type (fig 4, fig 5, fig 6).

d. Congenitali pigmentary nevi – are lesions having a major risk of transformation into MM. They are usually pigmented lesions with a smooth or papilomatous surface. US identifies the hypoechogenic structures penetrating the dermis and consequently, the pathologic examination confirms the malignant transformation. US is the optimal method for the monitoring of congenital nevi, which usually undergo malignant transformation during childhood.

The conventional ultrasonographic examination targets both tumoral structures as well as the neighbouring lymph stations. The assessment of regional adenopathies can be performed by placing the transducer along lymph vessels towards the lymphatic station. In the case of malignant melanomas of the limbs, the transducer is directed towards the armpit or inguinal region, while in the

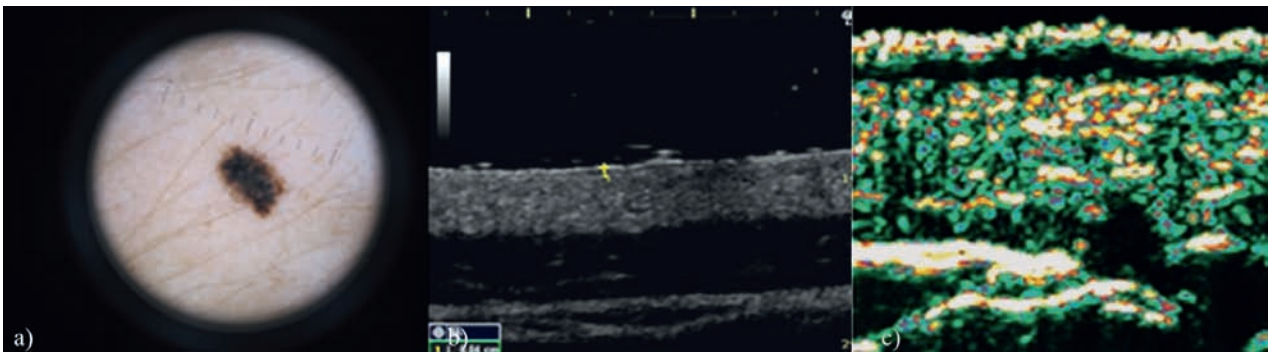

Fig 4. Junctional pigmented nevus: a) Pigmented lesion with irregular margins, dermatoscopic aspect; b) Superficial hypoechogenic band. Conventional ultrasonography does not complete the clinical and dermatoscopic diagnosis; c) Dermascan aspect – hypoechogenic band located at the junction, involving the papillary dermis.

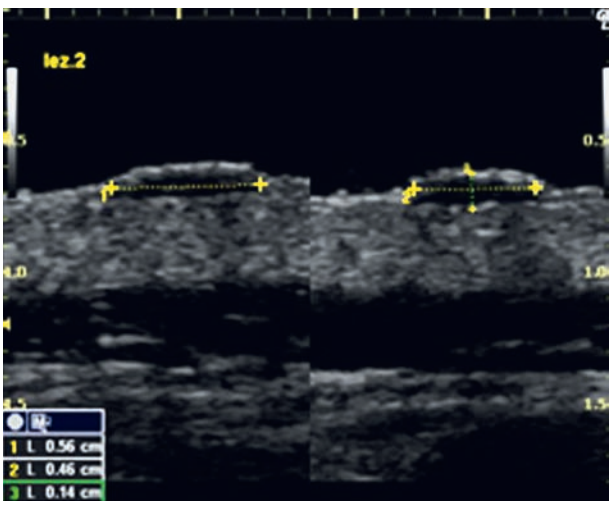

Fig 5. Compound pigmented nevi, conventional ultrasonography. Well defined, papular structure, "sitting on the epidermis".

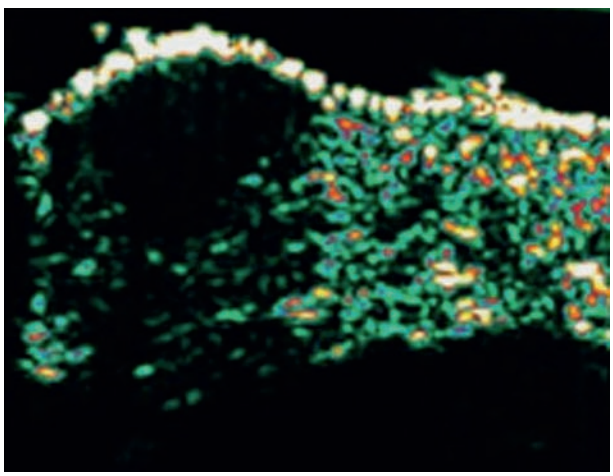

Fig 6. Compound pigmentary nevus, dermascan aspect. Tumor penetrating the papillary dermis and partially the middle dermis, accompanied by inflammatory infiltrate.

case of melanomas of the thorax, it is directed towards the laterocervical area, the parotid and the retroauricular space. Suspicious lymph nodes or skin lesions can be described according to the malignity or benignity criteria published in literature.

By means of US, the tumoral thickness can not be accurately predicted if it is accompanied by an important inflammatory process. According to literature data, no sonographic markers for the prediction of the histologic type of tumor have been described [5]. The size and thickness, measured in "mm", are elements essential for the surgical approach, excision margins, or the presence of sentinel lymph nodes. High frequency US is an important and useful instrument for preoperative assessment and postoperative monitoring of skin tumors, as well as for monitoring of pigmentary lesions at risk.

Optimising the ultrasonographic diagnosis requires modern techiques and devices. The sonographic method is constantly evolving in a number of directions, such as:

a. constrast-enchanced US. It is used in cases where the Doppler examination is not sufficient for the assessment of vascular features. For instance, reactive lymph nodes with very small, peripheral metastases can be examined by this procedure. The method allows the assessment of circulation in very small, 0.1-0.3 mm diameter vessels. It is not a routine technique, but can help prevent the surgical excision of small reactive lymph nodes. The use of new generation contrast agents (Sono Vue) provides an intense, homogeneous amplification of reactive nodules, as compared to neoplastic nodules, having perfusion defects or no vascular amplification [14,15].

b. ultrasound-guided fine-needle biopsy. This procedure completes the diagnosis of suspicious tumors identified clinically and ultrasonographically, especially in MM patients. The biopsy obtained is examined after previous dyeing. The sensitivity of the method is 95%, with an almost 1oo% specificity. It is a modern method that can help prevent surgical excision of suspected nodules [16].

c. high resolution US with 100 MHz transducer. It is used only in research centres in order to improve the image resolution. The ultrasound machine has an axial resolution of 11 micrometers, a lateral resolution of 30 micrometers and allows the visualisation to a depth of 2 mm [17,18].

Conclusions

The imaging techniques have imposed themselves as useful non invasive methods for skin examination and diagnostic tools for skin conditions. Cutaneous US can be used as a screening method of pigmentary lesions at risk. It allows the non invasive assessment of palpable tumoral lesions and provides valuable information concerning the therapeutic approach and postinterventional monitoring. The ultrasonographic diagnosis can be optimised through the use of other techniques: constrast-enhanced US, US-guided fine-needle biopsy and high resolution US.

Conflict of interest: absence of conflict of interest

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References

1. Schmid-Wendtner MH, Burgdorf W. Ultrasound scanning in dermatology. Arch Dermatol 2005; 141: 217-224.
2. Dragan L. Jovanovic DL, Katic V, Jovanovic B. Value of preoperative determination of skin tumor thickness with 20-MHz ultrasound. Arch Dermatol 2005;141:269-270
3. Lasagni C, Seidenari S. Echographic assessment of age dependant variations of skin thickness: a study on 162 subjects. Skin Res Technol 1995; 1: 81–85.
4. Tsukahara K, Takema Y, Moriwaki S, Fujimura T, Kitahara T, Imokava G. Age related alterations of echogenicity in Japanese skin. Dermatology 2000; 200: 303–307.
5. Braun Falco's Dermatology. 3rd Edition. Springer Medizin Verlag Heidelberg 2009: 50-56.
6. Solbiati L, Rizzato G, Belotti E. High resolution sonography of cervical lymph nodes in head and neck cancer: criteria for differentiation of reactive versus malignant lymph nodes. In: Proceedings of the 74th Meeting of the Radiologic Society of North America. Chicago III: Radiologic Society of North America. 1988: A113.
7. Schmid-Wendtner MH, Burgdhorf W. Ultrasound scanning in dermatology. Arch Dermatol 2005; 141: 217-224.
8. Rallan D, Harland CC. Ultrasound in dermatology – basic principles and applications. Clin Exp Dermatol 2003; 28: 632-638.
9. Cammarota T, Pinto F, Magliaro A, Sarno A. Current uses of diagnostic high-frequency US in dermatology. Eur J Radiol 1998; 27 Suppl 2: S215-223.
10. Jemec GB, Gniadecka M, Ulrich J. Ultrasound in dermatology. Part I. High frequency ultrasound. Eur J Dermatol 2000; 10: 492–497.
11. Szymańska E, Nowicki A, Mlosek K, et al. Skin imaging

with high frequency ultrasound — preliminary results. Eur J Ultrasound 2000; 12: 9–16.
12. Harland CC, Kale SG, Jackson P, Mortimer PS, Bamber JC. Differentiation of common benign pigmented skin lesions from melanoma by high-resolution ultrasound. Br J Dermatol 2000; 143: 281–289.
13. Andrei A, Badea R, Lupsor M, et al. Ultrasonographic features of cutaneous malignant melanoma – a preliminary study. Maedica J Clin Med 2006; 1: 13-22.
14. Crisan M, Cattani C, Badea R, et al. Modelling Cutaneous Senescence Process. Computational science and its applications. 2010: 6017: 215-224.
15. Blum A, Schlagenhauff B, Stroebel W, Breuninger H, Rassner G, Garbe C. Ultrasound examination of regional lymph nodes significantly improves early detection of locoregional metastases during the follow-up of patients with cutaneous melanoma: results of a prospective study of 1288 patients. Cancer 2000; 88: 2534-2539.
16. Blum A, Schmid-Wendtner MH, Mauss-Kiefer V, Eberle JY, Kuchelmeister C, Dill-Müller D. Ultrasound mapping of lymph node and subcutaneous metastases in patients with cutaneous melanoma: results of a prospective multicenter study. Dermatology 2006; 212: 47-52.
17. Voit C, Kron M, Schäfer G, et al. Ultrasound-guided fine needle aspiration cytology prior to sentinel lymph node biopsy in melanoma patients. Ann Surg Oncol 2006; 13: 1682-1689.
18. Turnbull DH, Starkoski BG, Harasiewicz KA, et al. A 40-100 MHz B-scan ultrasound backscatter microscope for skin imaging. Ultrasound Med Biol 1995; 21: 79-88.