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Ultrasonography as a method of diagnosis and treatment monitoring in dermatology

Diagnosis of skin diseases is most often possible on the basis of anamnesis and dermatological clinical examination consisting mainly in observing the pathological changes. It is possible to estimate the kind and extent of the lesion, whereas its depth can be estimated only indirectly. The third factor, that is the depth of skin pathological changes, is estimated through observation and palpation (touching, light pressing). Detailed analysis of the eminence degree of the lesion done this way is a subjective assessment of the examiner. The lack of objective methods in diagnosing and treatment monitoring of many dermatoses has led to searching for pictorial methods. The past few years have brought considerable advancement in these methods, including ultrasonography (8). Ultrasound examination as a non-invasive, simple and easy method of diagnosis and treatment monitoring, has found its application in dermatological examination and monitoring of cryosurgery procedures. Estimation of the size of the freezing zone and the course of the healing process allows to monitor the treatment effectiveness (9).

The aim of the study is to present the applicability of an ultrasonic scanner with 9 MHz ultrasound applicator in diagnosing many dermatological diseases as well as in monitoring a popular method of treating dermatoses, cryosurgery.

MATERIAL AND METHODS

The "Desmin H" ultrasonic scanner, by Echoson, was used for the examinations. The scanner was equipped with a linear ultrasound applicator emitting and analysing the waves of 9 MHz frequency, with a producer declared tissue penetration depth of up to 30 mm. Additional tools: the "Cineloop" picture memory module and an auxiliary memory system, allow the transfer of pictures to the hard drive and their further processing. Chosen for the diagnostic examinations were: normal skin, naevi pigmentosi, common warts, plantar warts, mosaic warts, nail warts, flap warts, seborrheic warts, senile keratosis, keloid. The diagnoses were made on the bases of dermatological examination. Ultrasonography was also applied for monitoring of the healing process after the cryosurgery treatment.

RESULTS

In the obtained sonogram of normal skin, epidermis entry echo cannot be distinguished. The hyperechogenic epidermis merges with the dermis. In order to obtain the epidermis entry echo, the ultrasound scanner equipped with an over 20 MHz ultrasound applicator would have to be applied. The dermis is seen as a non-homogenous area, with a rather clear border passing into the subcutaneous tissue. The inhomogeneity of the obtained ultrasound image of the layer issues from the presence of the hyperechogenic collagen fibres and the hypoechogenic extracellular matrix. Under the dermis there is the hypoechogenic subcutaneous tissue containing irregular hyperechogenic bands that correspond to connective tissue septa (Fig. 1). As for the subcutaneous tissue, the only estimation can be made of the border between the subcutaneous tissue and the dermis.

Fig. 1. Ultrasonic image of normal skin. The dermis and subcutaneous tissue are marked with arrows

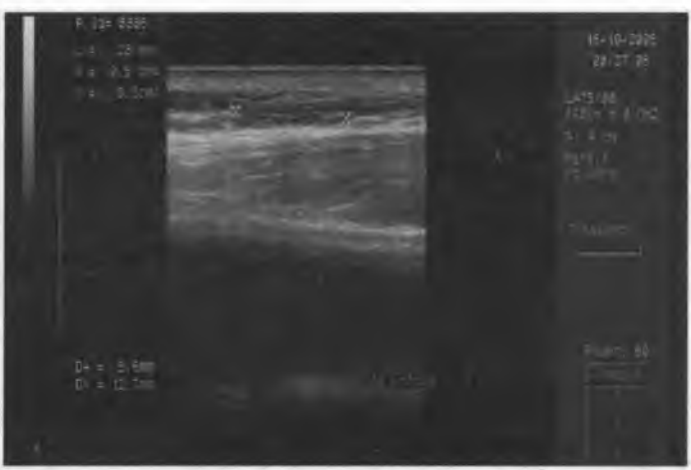

Fig. 2. Ultrasonic image of neavum pigmentosum with the lesion size marked

In the case of naevi pigmentosi it is merely possible to determine the size of the lesion, and only for naevi of over 1 mm (Fig. 2). It is impossible to determine the border between the normal tissue

and the naevus. The ultrasound scanner used makes it impossible to estimate whether the procedure of the naevus surgery has been thorough, as well as to differentiate between the lesions (naevus, dysplastic changes or melanoma).

The ultrasonic scanner applied, equipped with the 9 MHz ultrasound applicator, does not allow estimation of common and plantar warts of up to 1 mm. All the bigger warts, however, can be effectively monitored (Fig. 3). In the sonogram, common and plantar warts are visible as irregular hyperechogenic structures. In the layers below that area, the "acoustic shadow" can be seen, which is connected with strong suppressing of ultrasonic waves. In the case of seborrheic warts the echogenic structure is non-homogenous: hypoechogenic areas are interspersed with hyperechogenic bands (connective tissue bands). It is possible to determine the size of seborrheic warts by means of ultrasonic examination.

Fig. 3. Ultrasonic image of common wart with the lesion size marked

Fig. 4. Ultrasonic image of common wart seven days after the cryosurgery treatment. The arrows mark places of incomplete destruction of the pathological tissue

On the seventh day after the cryosurgery procedure of a common wart, a hyperechogenic area can be observed that corresponds to incomplete destruction of the lesion (Fig. 4). The incomplete healing effect is confirmed by dermatological examination. The obtained ultrasonic image of scar-forming after a common wart cryosurgery confirms the applicability of the method in treatment monitoring of some dermatoses. The resolution of the ultrasonic image obtained is too low to allow monitoring of shallow-placed lesions, with fuzzy edges, such as: mosaic warts, flap warts, senile keratosis, solar keratosis.

DISCUSSION

Ultrasonography is an acknowledged and commonly used method of visualizing the abdominal organs, thyroid, breasts, testicles, heart, and eyes. In the diagnostics of internal organs the frequencies used vary from 2 MHz to approximately 7.5 MHz. Obstetric and gynaecological ultrasonography uses frequencies from 2 MHz to 3.5 MHz, ultrasound cardiography – 3 MHz to 5 MHz, and blood vessels are monitored with the frequencies ranging from 5 MHz to 7.5 MHz (6). Attempts at ultrasound diagnosis of skin lesions have been made for many years now. There are numerous accounts on using ultrasound applicators of 20 MHz and higher frequencies (1, 10). Scanners of this type and high frequency ultrasonic applicators are difficult to obtain and expensive. The ultrasound image obtained depends on numerous physical phenomena, such as: reflection, refraction, dispersion, and deflection of the wave. The interactions between the wave and the tissue examined form the ultrasonographic image (7). Pathological processes occurring in the skin, resulting in higher collagen levels in the tissue, intensify the echogenics of the picture, whereas higher water levels reduce the echogenics (9). Echogenics corresponds to the picture density that is measured objectively with the number of pixels. Pixels are points of a defined density.

The obtained ultrasonographic image of the normal skin does not allow to distinguish the three skin layers. The epidermis entry echo merges with the dermis, forming one layer. In order to discriminate the epidermis it would be necessary to use ultrasound applicators of 20 MHz and higher frequencies (2, 3). Then, it would be possible to estimate surface lesions in the skin that are limited to the epidermis. The dermis is visible as a hyperechogenically non-homogenous layer with a rather clear border separating it from the subcutaneous tissue. The normal skin image obtained corresponds to the data in the references (4).

In the obtained ultrasonogram of a naevus pigmentosus it is merely possible to determine its size. It is impossible to clearly define the border between the naevus and the normal skin. Also, it is not possible to assess the effectiveness of the surgery, and therefore to establish further therapeutic procedure. In order to be able to exactly determine the border of the lesion and to effectively monitor the surgery procedure it is necessary to use ultrasound applicators of 32 MHz and higher frequencies (5).

The ultrasound image obtained from an ultrasonic scanner with the 9 MHz ultrasound applicator confirms the applicability of this method for estimating the size and depth in the skin of common, plantar and seborrheic warts. The limitations result from the size of the lesions. The resolution of the picture obtained is too low to allow examining of the smaller warts (up to 1 mm) (5). Such is the case of the shallow-placed, fuzzy-edged mosaic warts, flap warts, senile keratosis.

The aim of liquid nitrogen freezing therapy (cryosurgery) is to produce fibre reconstruction of the lesion treated. Fibrosis that occurs during scar-forming after the cryosurgery, as well as in the keloid, is visible in the ultrasonographic image as a hyperechogenic area. The results obtained are confirmed by data from the references (5, 9). It is possible to use the 9 MHz ultrasound applicator to monitor the scar-forming process and check the effectiveness of the cryosurgery procedure.

Ultrasound exmination makes it possible to recognise hyperechogenic and hypoechogenic structures, but it does not allow to identify what structures are visualised as hyper- or hypoechogenic. It is, however, a good method of determining the depth of pathological changes in the skin.

CONCLUSIONS

1. Ultrasound examination can be applied to determine the size of common and seborrheic warts. All the shallow-placed lesions, such as mosaic warts, flap warts, senile keratosis, cannot be visualised because of too low resolution of the picture obtained.

2. It is possible to use the ultrasonic scanner applied to estimate the scar-forming process, and therefore to monitor healing.

3. The ultrasonic scanner used, equipped with the 9 MHz linear ultrasound applicator, does not allow to visualize all three layers of the skin. It is not possible to identify the epidermis entry echo, whereas the dermis and the subcutaneous tissue can be monitored.

4. The 9 MHz linear ultrasound applicator used does not allow to determine the border between the lesion and the normal skin; it is also impossible to assess the effectiveness of the surgery. In the case of naevi pigmentosi it is possible to estimate their size.

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SUMMARY

Up till now clinical examination and histopathological examination have been the only methods for diagnosing skin diseases. For many years attempts have been made at ultrasonographic diagnosis of dermal lesions. The ultrasound image of the skin is created mostly by water and collagen; on the basis of these data, using the ultrasonic scanner, conclusions can be made about the processes of skin destruction and regeneration. This method allows to observe certain qualities of the normal skin as well as pathological changes in the skin, without biopsy. The aim of the study was to assess the usefulness of ultrasonography in examining the normal skin, lesions in the skin (neavi pigmentosi, common warts, plantar warts, mosaic warts, nail warts, flat warts, seborrheic warts, senile keratosis, keloid), as well as in monitoring the effectiveness of cryosurgery procedures. It has been confirmed that the ultrasonographic method is useful: for estimating pathological changes occurring in the skin, as well as the skin thickness; for estimating the size of: neavi pigmentosi, common warts, seborrheic warts; for estimating the scar forming process after cryosurgery procedures. Due to low resolution of the sonograms obtained with the use of the 9 MHz ultrasound applicator, it is impossible to monitor all shallow-placed lesions of up to 1 mm. Ultrasound examination is a quick and non-invasive method, allowing to diagnose certain skin diseases and potentially helpful in monitoring the treatment effectiveness.

Ultrasonografia jako metoda diagnostyczna i monitorująca leczenie w dermatologii

Dotychczas jedynymi metodami diagnostycznymi w chorobach skóry były badanie kliniczne i badanie histopatologiczne. Od wielu lat podejmowane są próby diagnostyki ultrasonograficznej zmian skórnych. Obraz ultrasonograficzny skóry tworzy głównie woda i kolagen. Opierając się na tych danych można przy użyciu ultrasonografu wnioskować o procesach niszczenia i odbudowy skóry. Metoda ta umożliwia obserwację pewnych cech skóry zdrowej oraz patologicznych zmian skórnych bez wykonywania biopsji. Celem pracy była ocena wartości badania ultrasonograficznego w badaniu skóry zdrowej, patologicznych zmian skórnych (znamiona barwnikowe, brodawki zwykłe, brodawki podeszwowe, brodawki mozaikowe, brodawki okołopaznokciowe, brodawki płaskie, brodawki łojotokowe, rogowacenie starcze, keloid), jak również w kontroli skuteczności zabiegów kriochirurgicznych. Potwierdzono przydatność metody ultrasonograficznej: do oceny patologicznych zmian zachodzących w skórze oraz jej grubości; do oceny wielkości znamion barwnikowych, brodawek zwykłych, brodawek podeszwowych, brodawek łojotokowych; do oceny procesu tworzenia się blizny po zabiegach kriochirurgicznych. Ze względu na zbyt małą rozdzielczość otrzymanego obrazu przy zastosowaniu głowicy 9 MHz niemożliwe jest obrazowanie wszystkich płytko położonych zmian o rozmiarach do 1 mm. Badanie USG jest szybką i bezinwazyjną metodą pozwalającą na diagnostykę niektórych schorzeń skóry, która może stać się pomocna w monitorowaniu efektów leczenia.