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The Application Progress of Skin Imaging Technology in Psoriasis

Qinyi Wang*, Jin Gong#

Department of Dermatology, The First Affiliated Hospital of Yangtze University, Jingzhou, China
Email: 2022721085@yangtzeu.edu.cn

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Abstract

Skin imaging technologies such as dermoscopy, high-frequency ultrasound, reflective confocal microscopy and optical coherence tomography are developing rapidly in clinical application. Skin imaging technology can improve clinical diagnosis rate, and its non-invasiveness and repeatability make it occupy an irreplaceable position in clinical diagnosis. With the "booming development" of medical technology, skin imaging technology can improve clinical diagnosis rate. Researchers have made significant advances in assisting clinical diagnosis, prediction, and treatment of disease. This article reviews the application and progress of skin imaging in the diagnosis of psoriasis.

Keywords

Psoriasis, Skin Imaging Technology, High Frequency Ultrasound, Optical Coherence Tomography

1. Introduction

There are many kinds of diseases in the department of dermatology and venereology, and many diseases are related to auto-immunity. Psoriasis is a common chronic inflammatory skin disease closely related to immunity in clinic. Its pathogenesis is complex. Currently, it is believed that environmental inducement factors act on patients with special genetic background, leading to abnormal immune response, resulting in a series of characteristic pathological changes such as excessive keratinization of keratinocytes accompanied by insufficiency of keratinization, disappearance of granular layer, formation of epidermal microabscess, and dilatation of dermal vessels [1]. Abnormal activation and infiltra-

*First author.
#Corresponding author.

tion of T lymphocytes in the epidermis or dermis are important pathophysiological features of psoriasis, indicating that the immune system is involved in the occurrence and development of the disease. Many inflammatory factors are closely related to the onset of psoriasis. The characteristic of immune correlation makes it complicated in assisting clinical diagnosis, prediction and treatment of disease. The rapid development of dermoscopy, high-frequency ultrasound, reflection confocal microscopy and optical coherence tomography in clinical applications has made this difficulty easily solved. From the magnification and precision of the instrument to the computer algorithm-assisted recognition, the accuracy of clinical diagnosis has been greatly improved.

2. Application of Dermoscopy in Psoriasis

Dermoscope is a kind of skin magnifying glass with polarized light source, which can reduce the refraction of light by the skin stratum corneum, facilitate the clear view of the skin surface, epidermis, epidermal and dermal junction and the structure of the dermal papillary layer, and become the link between macro clinical dermatology and micro skin histopathology [2]. Some dermoscopes come with computer software equipped with intelligent programs for archiving dermoscope images and making diagnoses and reports. Advanced equipment can magnify lesions up to 200 times, facilitating the examination of different skin structures.

2.1. Plaque Psoriasis in Dermoscope

The common cutaneous vascular morphology in plaque psoriasis includes spot, line, branch and line curve. Vascular distribution includes uniform, fascicled, peripheral, reticular, and nonspecific distribution. Plaque psoriasis is a common clinical manifestation of red papules fusing into plaques with clear boundaries and silver-white scales covering the surface and positive Auspitz sign. The dermoscope features uniformly distributed punctate, spherical, annular, or hairpin blood vessels on a bright red background with diffuse white scales. Jgolimska, MSR-Pomian, L Rudnicka *et al*. systematically searched three medical databases, and a total of 45 articles were included in the analysis. In all studies, skin psoriasis lesions evaluated at low magnification showed a regular distribution of red dots. At 50 or higher magnification, capillary plexus (glomerular vessels) with a diameter of 50 - 146 μm are visible. The background color is described as red or pink with white or yellow scales. The most common trichoscopy features of scalp psoriasis are the appearance of red spots/balls and twisted red rings. The typical dermoscopic (onychoscopic) signs of psoriasis A are nail lysis, salmon spots, and bleeding from lobes [3].

2.2. Nail Psoriasisin Dermoscope

Ren Dan, Zhao Hua *et al*. collected dermoscopic images of all 350 nails in the case group, and the study showed that 277 nails were damaged, accounting for 79.14% of all nails tested. The lesions were 145 (52.35%) distal nail dissociation,

138 (49.82%) splintery hemorrhage, 124 (44.77%) nail pit, 115 (41.52%) oil patch, 109 (39.35%) deck fragmentation, 65 (23.47%) subungual keratosis and 36 (23.47%) subungual telangiectasia. 13.00%), 30 semilunar erythema (10.83%), other features such as white onychia, Beau line, longitudinal ridge of onychia also appeared, but relatively rare [4].

2.3. Scalp Psoriasis in Dermoscope

Brunif AlessandriniA, StaraceM OrlandoG, PiraccinіBM et collected by scalp psoriasis effect of 156 patients, appraisal has seven clinical specificity three-phase relevant mode [5]. At low power: Plaque psoriasis with erythematous, silvery-white scales and curved circular blood vessels and red spots. At high resolution magnification: greasy yellowish adherent scales, red spots, erythematous, spherical and twisted thick hairpin blood vessels, some also include pustular lesions. Dermatoscopes can also be used to observe the structure of blood vessels, Some lesions have unique vascular changes that can aid clinical diagnosis. The most significant features of dermatoscopy for scalp psoriasis were white/silvery-white scales (87.9%), regular red dots/spherical vessels (90.9%) at low magnification, glomerular vessels (87.6%) at high magnification, and circular vessels/hairpin vessels (84.8%) [6].

3. Application of High-Frequency Ultrasound in Psoriasis

Cutaneous ultrasound is a non-invasive dermatological examination method that assists in early and more accurate diagnosis during clinical examination. Using sound waves passing through the skin, the echoes reflected by different skin tissues return to the transducer, forming a visual image. The echo of each epidermal structure is determined by its density, which affects the speed of sound waves passing through it. High-frequency ultrasound (HFUS) performs high-resolution visualization of the skin and the upper subcutaneous tissue in vivo at wavelengths above 15 MHz, with sufficient depth to capture the full thickness of the skin. HF-USG was originally used to measure skin thickness. At 15 - 20 MHZ, the normal skin layer of hairless skin appears as a highly echoic epidermal line, followed by a highly echoic true belt, and a larger hypoechoic subcutaneous layer. In the hairless skin of the palms and soles of the feet, the epidermis has a highly echoic double-layer structure due to the thicker stratum corneum. The main sources of echo in each layer of skin are keratinocytes in the epidermis, collagen in the dermis and subcutaneous fat.

3.1. Nail Psoriasis in HFUS

Skin ultrasound can also be used for psoriatic nails. Under skin ultrasound, there are two parallel high-echo bands on the healthy deck. The dorsal and ventral decks of the nails show strong linear echo, and the gap between the decks shows no echo on ultrasound. The deck is a three-layer structure composed of the back and the ventral decks; The nail bed is a low echo area below the ventral deck. Ultrasonography showed that the three-layer structure of psoriatic nail deck was

not clearly developed, the deck was uneven, and the subnail keratosis was excessive. The thickness of the deck and nail bed of psoriatic nail was thicker than that of the control group. The nail bed thickness of the left index finger, middle finger, and ring finger was positively correlated with the total score of NAPSI [3]. Changes in the US of the deck in patients with psoriasis can be detected by loss of echo in the ventral plate at an early stage and by total loss of echo involving the dorsal plate at an advanced stage. The qualitative severity of psoriatic nail changes can be evaluated ultrasonically according to the classification proposed by Wortsman *et al.*: Type I is defined as focal, punctate hyperechoic involvement of abdominal plates; Type II is continuous loss of web edge; Type III is the identification of wave plate; And type IV for both plates completely lost definition [7].

3.2. Plaque Psoriasis in HFUS

In plaque psoriasis, the most intuitive part is that skin ultrasound can measure the thickness of psoriasis plaque, and the deeper part is that skin ultrasound can show the condition of subcutaneous blood vessels and evaluate the severity of skin psoriasis. High-frequency ultrasound analysis of psoriatic plaques revealed epidermal thickening with hyperechoic bands, which represented hyperkeratosis and hypokeratosis with lower vocal cords [8]. The linear acoustic shadows below the epidermis of psoriatic plaques behind the lower vocal cords and epidermis significantly increased compared with surrounding normal skin tissue, and the dermal echo in psoriatic plaques decreased compared with surrounding normal tissue. Elongation of the dermal papilla corresponding to the lesion can even be found compared to adjacent healthy tissue, and the higher the resolution, the clearer the details of the epidermis, dermis, subcutaneous fat and fascia. Psoriatic plaque significantly increased the thickness of epidermal layer, dermis thickness, dermis elastic strain ratio and dermis microblood flow signal compared to the surrounding normal skin [9].

Skin ultrasound is based on the reflection of ultrasound at the interface of two media with different acoustic properties. When the ultrasonic beam penetrates each skin tissue interface, corresponding echoes are generated due to different physical properties. Using this property, we can distinguish between regions of tissue with a density difference of 0.1% [10].

4. Application of Reflection Confocal Microscopy in Psoriasis

Skin in vivo reflection laser confocal scanning microscope (RCM), referred to as skin CT, is a kind of inspection equipment using the optical principle of imaging, from the principle of it and radiology department's large CT is different. Large CT is generally the use of X-ray tomography of the human body, the use of a certain limitation. The imaging principle of skin CT is to use a low-energy semiconductor laser through the skin to scan the skin epidermis to the superficial dermis, without radiation and applicable to patients of any age, non-invasive, real-time and dynamic observation and observation of skin disease

occurrence, development and skin lesions. It is essentially based on the principle of optical focusing, using a light source with a wavelength of 830 nm to scan the skin horizontally and vertically under a microscopic objective, Advanced detection instruments that utilize computer 3D tomography to form images. Skin CT can not only improve the early diagnosis rate of skin diseases, but also reduce unnecessary skin biopsies, providing diverse choices for different populations.

4.1. Scalp Psoriasis in RCM

In scalp psoriasis, RCM can be used to tomography the microstructure of the skin at a depth of 200 microns. In the skin tissue, the optical penetration depth of CLSM is 200 - 300 μm, and the pattern of Murno microabscess, vascular changes in the dermal papilla, interspinous edema, and acanthous hyperplasia can be clearly observed [11]. Compared with dermoscopy, it can be more accurately identified with other diseases, and reduce unnecessary skin biopsies and reduce patient pain.

4.2. Plaque Psoriasis in RCM

The main features of guttate and patchy psoriasis in RCM are hyperkeratosis, hypokeratosis, Munro microabscess, thinning or absence of granular layer, thickening of spinous layer, tortuosity and dilation of capillaries in dermal papilla, liquification of basal cell layer, inflammatory cell infiltration in dermal papilla [12] [13]. Among them, the dermal papillaries and capillaries were clearly visible under RCM microscope, almost comparable to skin biopsy.

4.3. Nail Psoriasis in RCM

In the nail, due to the fewer organelles that absorb light and the lower refractive index of the nail, the depth of optical penetration can reach 400 - 500 μm*13. RCM can penetrate the translucent deck to image the nail bed, where light refracts through the deck in three layers: a brighter shallow layer, a darker middle layer and a brighter deep layer, where melanin, collagen and keratin are strongly reflected. RCM can help doctors fully understand the size, shape and location of the lesion, so as to formulate a more rational treatment plan. At the same time, RCM can also be used to evaluate the feasibility and safety of surgery, providing an important reference for surgical operations [14].

5. Application of Optical Coherence Tomography in Psoriasis

Optical coherence tomography is an advanced laser imaging technique in which each scanning waveform of the laser is used to probe individual layers of the skin. Light is diffused back into the tissue at different depths depending on the refractive index. The collected light is combined into a reference beam in the interferometer and is detected and digitized to produce a high-resolution image of the skin at a depth of up to 2 mm, helping to identify important features that aid

in diagnosis without the need for a biopsy. Optical coherence tomography (OCT) has been able to establish itself not only in academic science, but also in everyday dermatology practice. It focuses on tumors of the skin that can be visually diagnosed in seconds. Therefore, it can be used to diagnose and monitor basal cell carcinoma, actinic keratosis, and skin carcinomas at different stages to understand response to treatment or possible recurrence. Recently, the field of OCT and its latest advancements Dynamic OCT (D-OCT) has expanded to include non-neoplastic skin diseases. Includes analysis of inflammatory skin diseases and physiological skin parameters, such as hydration. Thanks to automated angiography and measurement of objective parameters such as epidermal thickness, deep blood flow, optical attenuation coefficient, and skin roughness, more and more skin features can be studied in a non-invasive and standardized manner [15].

5.1. Skin Vascular Changes in OCT

Optical coherence tomography (OCT) is a fast, high-resolution imaging form that visualises the skin structure and vascular system. Optical coherence tomography is widely used in ophthalmology, and the most important one is fundus blood vessels. Angiography (dynamic OCT), which can carry out high-resolution imaging of skin blood vessels, has the same application in skin diseases. In the diagnosis of psoriasis, including epidermal thickness, vascular density, plexus depth, vessel diameter, and vessel count are of great significance [16] [17]. Corsini, ETrovato GCortonesi, PRubegni LTognetti, ECinotti and others to evaluate according to the three micro standards [18]: the thickness of cuticle, the thickness of epidermis and dermal-epidermal junction of ups and downs. Clinical severity of individual lesions in moderate-to-severe plaque psoriasis was assessed using a lesion score designed with three parameters in mind: erythema, desquamation, and infiltration. The LC-OCT images were segmented by artificial intelligence and found a high correlation between changes in the score and the thickness of the stratum corneum and the thickness of the living epidermis. This also illustrates the potential of optical coherence tomography for non-invasive monitoring of microscopic changes associated with moderate-to-severe plaque psoriasis.

5.2. Nail Psoriasis in OCT

In psoriatic nails, the clinical features of psoriasis in OCT scans include the distal psoriatic nail with a malnourished, wavy, layered deck, containing parallel white stripes. The surface of the nail is rough and irregular, and the surface is cracked. White stripes in the deck are clinically associated with white nails, mainly in the middle layer of nails. However, psoriatic nails appear to be more abundant in white spots and black loops, with wavy irregular thickening of the deck, thickening of the epidermis at the proximal nail fold with decreased capillary density. The thickness and blood flow of the nail bed increase, You can track

measurable depths with oct. Cross-sectional view shows pitting as a focal dark irregularity with an underlying shadow [19]. Compared with psoriatic nail, normal nail has no nail bed pustules, the microscopic deck shape is restored, the nail bed is thinner, and blood flow is significantly reduced [14]. OCT can identify the unique structural and vascular features of nail psoriasis, and has great value in the diagnosis of psoriatic nail.

Table 1. Differences and similarities in skin imaging technology.

1) Application	2) Difference		
	Principle	Invasiveness	Depth
3) Dermoscope	4) Polarized light	0	0
5) HFUS	6) Ultrasonic	0	All
7) RCM	8) Semiconductor Laser	0	0.5 mm
9) OCT	10) Interference of Light	0	2 mm

Skin imaging technology benefits patients due to its non-invasive nature.

6. Conclusion

Skin imaging is very important in the diagnosis and differentiation of skin diseases. Multiple skin imaging technologies cover multiple levels and various diseases (Table 1), and can avoid many invasive examinations in clinical applications, providing great convenience for patients. Its development prospect is very promising. With the improvement of tissue resolution and post-processing technology, images are becoming more and more easy to observe. In turn, changes at the cellular and molecular level can be shown, thus making the evaluation of disease more complete and more specific. Information science—with the development of electronics and computers, the diagnostic mode of imaging will also develop from "qualitative" to "quantitative" image analysis. In addition, the progress of interventional therapy and its integration with minimally invasive therapy, surgery and other multidisciplinary development. Skin imaging technology is increasingly becoming an indispensable means for us to diagnose diseases.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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