ORIGINAL PAPER

RELEVANCE AND PRACTICAL USE OF OPTICAL COHERENCE TOMOGRAPHY IN THE DIAGNOSIS AND FOLLOW UP OF LOCALISED SCLERODERMA

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Abstract. *HD-OCT (high definition optical coherence tomography) is a promising non-invasive imaging tool with demonstrated utility in the in vivo accurate diagnosis of skin cancers but with slightly reduced applicability in other skin pathology, such as inflammatory or chronic connective tissue diseases. This technique can deliver high- resolution images of the skin layers similar with the histological aspect. The present study sought to detect and describe typical features regarding the pathological micro architectural pattern of localized scleroderma using HD- OCT and to see the utility in monitoring non-invasively the effects of first line treatments over relatively short period of time in this specific disease.*

Keywords: *high definition optical coherence tomography, inflammatory, non-invasive, localised scleroderma, dermo epidermal junction.*

1. INTRODUCTION

Optical coherence tomography (OCT) is an advanced imaging technique capable of bringing important information about skin architecture thus being very useful in the diagnosis of skin tumors, both melanoma and non melanoma skin cancer [1, 2]. This imaging tool is based on the principle of low coherence interferometry, and it provides details of the skin up to a penetration depth of 3um, by reassemble reflections of infrared light scattered in the skin to create cross-sectional images of tissue with micrometer resolution [3, 4].

High definition optical coherence tomography (HD-OCT) is based on the same technical background but it has the advantage of a deeper penetration into the lower parts of the dermis, and also providing slice (vertical images), en face (horizontal images) and 3D reconstruction of the skin, thus being closer to an in vivo biopsy procedure. Because of the high resolution of the images obtained and the absence of invasivity this imaging tool can also be useful in the diagnosis of other skin diseases, like inflammatory or connective tissue disorders and also for the follow up of treatment response in chronic cases [3-7].

It is well known the importance of HD OCT in the in vivo diagnosis of skin tumors, especially melanoma and BCC but fewer information is provided up to present in other chronic skin afflictions, like psoriasis, different type of eczema, lupus erythematosus , scleroderma [8-14]. In this current study we aimed to explore the practical utility of HD- OCT

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in finding characteristic morphological features of localised scleroderma, plaque type-morphea, and to evaluate the onset of topical treatment response. By revealing the usefulness of this non invasive method, additional biopsies that could worsen the unbalanced scarring process can be avoided.

Localised scleroderma with it's subtype plaque morphea, is a connective tissue disorder defined by uncontrolled collagen deposition in the dermis thus leading to the thickening of this skin layer, which can be encountered at any age, even in children [15].

2. MATERIALS AND METHODS

Patients with confirmed plaque type morphea were included in the study. 10 morphea plaques belonging only to women aged 39-46 years old and a female child aged 12 years old, were clinically analyzed and after words by HD-OCT. Some of the plaques were reevaluated a few months later after the beginning of potent topical corticosteroids to notice and measure the possible treatment response. For every lesion included in the study a series of HD-OCT images were captured both slice en face mode and even 3D. The OCT device used was represented by HD-OCT -Skintell System (Agfa HealthCare, Belgium) provided with a central wavelength of 1300 nm, an improved penetration depth up to 1 mm and with a lateral and axial optical resolution of 3 microns. The scattered light beam absorbed by the analyzed tissue is evaluated through a 1.8 x1.5 mm field of view. Usually flat and extended skin lesions like morphea plaques permits facile and fast capturing of any sort of OCT images the only appeal being the direct contact with the lesional skin [16, 17]. Images of the surrounding perilesional skin were captured for every analyzed plaque, thus facilitating the evaluation of the abnormal morphological features. For an improved quality of the images the skintell optical gel was used. The participants were asked to withhold the use of caffeine and nicotine a few hours before the study. Every participant has received proper information and has signed the informed consent before the study.

3. RESULTS AND DISCUSSION

The clinical aspect of localised plaque type scleroderma is characterised by round-ovalar, well circumscribed indurated plaques with an average dimension of less than 10 cm but with the possibility to extend more than 20 cm alone or confluated with other lesions. Recent developed plaques are associated with abnormal blood flow and tend to have an erythematous aspect (red to violet colour) meanwhile older lesions have a brownish colour. With disease progression , the affected tissue undergoes sclerotic changes translated clinically by a smooth and shiny surface from the center of the plaque, as the lesion tend to expand peripherally. With time loss of hair follicles and sweat glands are common, and after months to years evolution the dermis atrophies and the skin becomes soften [15, 18-21].

The HD-OCT images revealed some specific features of the affected skin. The changes were noticed both in the epidermis and dermis. In recent lesions the presence of inflammation and oedema was translated on the OCT captures as dense uniform aspect of the dermis, due to the abnormal network of collagen fibres (Fig. 1). The presence of uniform thickened collagen fibres mainly arranged in a parallel pattern with the upper layers of the epidermis, were associated with the lack of penetration of the light beam in the deeper

reticular part of the dermis, and generating the continuous homogeneity in the papillary dermis.

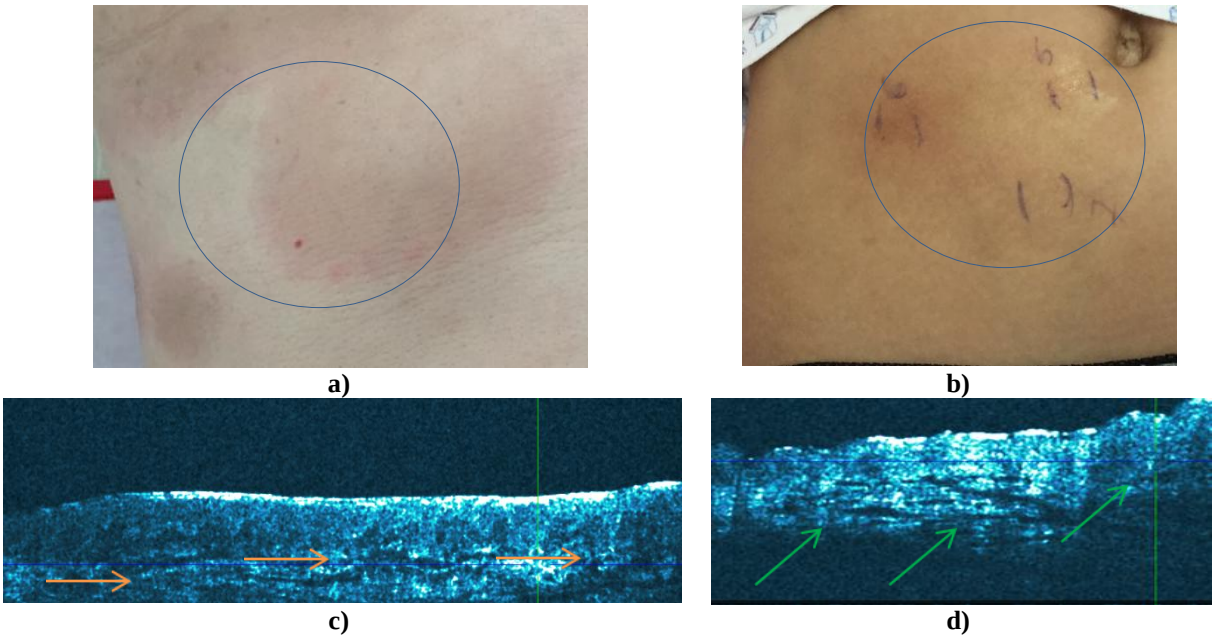

Figure 1. a) Clinical aspect of plaque morphea-inflamed patch on the abdomen (blue circle); b) Clinical aspect of plaque morphea-inflamed patch on the abdomen (blue circle); c) HD-OCT slice mode shows homogeneity and lack of skin adnexa in the papillary dermis(orange arrows); d) HD- OCT slice mode of the same lesion showing the absence of skin appendages and continuous dark homgeneity in the upper dermis(green arrows) and absence of clear dermacation of the JDE.

The dermal epidermal junction was clear and uninterrupted in the sclerotic state morphea, described as a dark linear dividing area while recent plaques were associated with the irregular enfacement of the basal membrane, probably related with the presence of various degree of inflammatory infiltrate mostly in the upper dermis (Figs. 1d, 2 and 3).

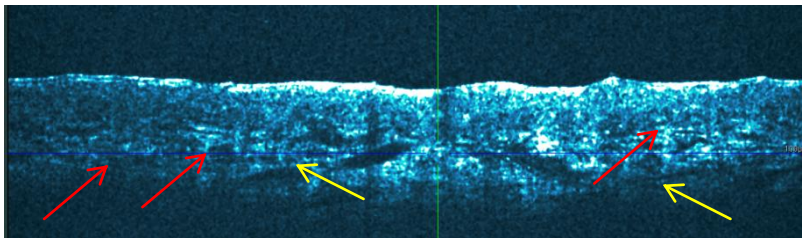

Figure 2. OCT vertical image of an inflamed patch of morphea on the abdomean area - enfacement of the JDE because of the oedema and inflamatory infiltrate (red arrows); capillaries are present and are enlarged (yellow arrow).

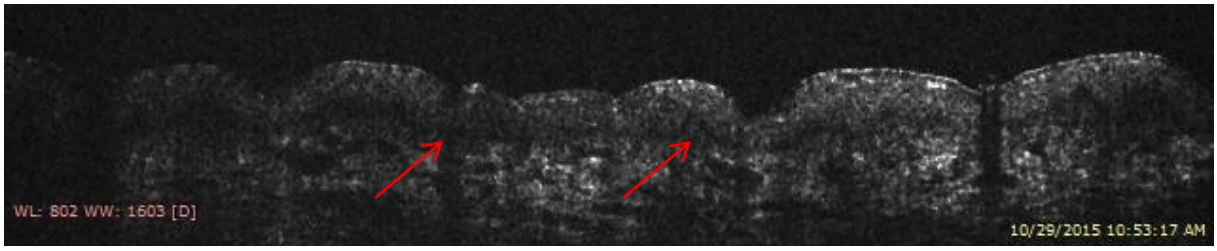

Figure 3. OCT slice mode of normal skin-clear and uninterupted JDE (red arrows).

The exact components of the inflammatory infiltrate could not be identified in HD OCT scan in this study in comparison with others [22]. In some long term lesions,

hyperreflective dots interspersed in the upper dermis were correlated with the presence of active fibroblasts. The dense homogenous darkness of the dermis was noticed in all indurated chronic plaques in contrast with the perilesional skin, marked by a more heterogeneously pattern due to normal vascularity adnexal structures and connective tissue fibres (Fig. 3). The vascular pattern also showed alterations. In the affected skin only few and decreased in size blood vessels could be distinguished, mainly as small oval to roundish signal-poor areas in the dermis (Fig. 2). Again this was different in recent affected areas were there was an active inflammatory process and slightly increased number of capillaries. Skin appendages like hair follicles had a decreased number or were not at all found in chronic plaques localised scleroderma. Some of the sclerotic state plaques were evaluated a few months after the treatment with potent corticosteroid agents like clobetasol propionate, and a scarce improvement could be noticed in the papillary dermis , by the presence of a light dense band–scattering in the collagen structures parallel to the surface, thus associated with increased dermal brightness on HD-OCT imaging (Fig. 4) [23].

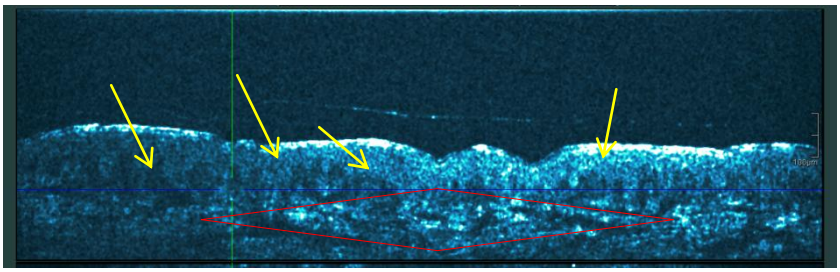

Figure 4. OCT slice mode of a chronic plaque morphea after 2 months with topical corticosteroid – the dermal epidermal junction rete ridges , dermal papillae are visibile and uniinterrupted without the flattened aspect (yellow arrows), there is a slightly increased reflectivity in the upper part of the dermis (red figure).

HD-OCT is a promising imaging technique with high potential in establishing accurate diagnosis of other inflammatory skin disease beside skin cancers. The main feature found in the sclerotic state morphea were the homogeneity of the papillary dermis translated on HD-OCT images into a dense band like darkness, together with the absence of adnexal structures like hair follicles or sweat glands. The intense homogeneity is due to the presence of collagen fibers disposed in broadened bundles with more or less parallel orientation. The absence of a proper number of blood vessels was also found in chronic plaques in reverse with recently developed ones, were the presence of the inflammatory infiltrate disturbs the continuousness of the dermal epidermal junction. The results are in line with other related studies. The features described in this study are in line with other researches on similar topic [13, 23-30].

4. CONCLUSIONS

The limitations of this study are mainly associated with the small number of lesions analyzed and with the relatively narrow penetration depth of the light beam in the affected tissue that obstructs the visualisation of some details in the embedded structures. HD-OCT images were insufficient in differentiating elastin and collagen fibers in the dermal layers but could differentiate the normal perilesional skin from the localised scleroderma plaques due to a higher cohesive backscattering indicating the abnormal changes of the collagen density in the dermis compared to normal skin.

In conclusion there is a necessity of improving non invasive imaging techniques like HD-OCT to obtain 3D complimentary information about the micro architectural changes in the pathological affected skin thus refining the clinical diagnosis and enhance the patients satisfaction and compliance to long term treatments. Further studies to test the sensitivity and specificity of HD-OCT related with the above features described are essential in this direction [3-7, 23, 25].

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