

The Effect of Microneedling on Skin Histology: Review of Literature

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ABSTRACT

Aim: explore the advantages of using microneedling technique for treating dermatological disorders.

Background: The microneedling process has been expanded in the last decade, since it is considered as a safe, effective, low-cost and accessible aesthetic technique. It is a process of mechanical induced skin reconstruction. Microneedling is a technique composed of fine needles, which create a fine superficial skin perforations that initiate factors such as fibroblast growth factor (GF), platelet-derived factor and transforming GF α and β , which stimulate fibroblasts enabling them to form and reorganize new elastin as well as collagen fibers via a process of fibronectin matrix formation resulting in new skin tissues remodeling.

There are many types of microneedling include: Roller microneedling device, it has a drum-like head with numbers of tiny needles; Electronic microneedling which is a pen-like instrument; Radio frequency microneedling device, which works as a microneedling pen plus bipolar radio frequency energy. Microneedling induces histological changes in the skin, such as mild epidermal hyperplasia, dermal deposition of extracellular glycosaminoglycans and fibrin, in addition to proliferation of keratinocytes and fibroblast, there are an increase in elastic material in mid and papillary dermis, marked thickening of skin dermis and improvement of collagen material.

Conclusion: microneedling is advised for treatment of various skin diseases like facial scars, stretch marks, dyschromial conditions, rejuvenate photoaged skin, alopecia, actinic keratoses and pigmentary disorders.

Keywords: Microneedling, skin, histological changes, scar.

تأثير الوخز بالإبر الدقيقة على أنسجة الجلد: مراجعة مقالات

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الخلاصة

الهدف: استكشاف مزايا استخدام الوخز بالإبر الدقيقة لعلاج الاضطرابات الجلدية.
الخلفية: توسعت عملية الوخز بالإبر الدقيقة في العقد الماضي ، لأنها تعتبر تقنية جمالية آمنة وفعالة ومنخفضة التكلفة ويمكن الحصول إليها. إنها عملية إعادة بناء الجلد المستحثة ميكانيكياً. هي تقنية تتكون من إبر دقيقة ، والتي تخلق ثقباً سطحياً دقيقاً للجلد تبدأ عوامل مثل عامل نمو الخلايا الليفية (GF) ، والعامل المشتق من الصفائح الدموية ومحول عامل النمو GF الفا و بيتا ، والتي تحفز الخلايا الليفية مما يمكنها من تكوين وإعادة تنظيم الإيلاستين الجديد بالإضافة إلى ألياف الكولاجين عبر عملية تكوين مصفوفة الفبرونيكتين مما يؤدي إلى إعادة تشكيل أنسجة الجلد الجديدة.

هناك العديد من أنواع الوخز بالإبر الدقيقة منها: جهاز الوخز بالإبر الدقيقة الدوارة ، له رأس يشبه الطبلعة مع عدد من الإبر الصغيرة؛ الإبر الدقيقة الإلكترونية وهي أداة تشبه القلم؛ جهاز الوخز بالإبر الدقيقة للترددات الراديوية ، والذي يعمل كقلم الوخز بالإبر الدقيقة بالإضافة إلى طاقة تردد الراديو ثنائية القطب. يحفز الوخز بالإبر الدقيقة إلى تغييرات نسيجية في الجلد ، مثل تضخم البشرة الخفيف ، وترسب جلدي من الجليكوزامينوجليكان والفيبرين خارج الخلية ، بالإضافة إلى تكاثر الخلايا الكيراتينية والخلايا الليفية ، وهناك زيادة في المواد المرنة في الأدمة الوسطى والحليمية وسماكة ملحوظة في الأدمة الجلدية وتحسين مادة الكولاجين.
الخلاصة: ينصح بالوخز بالإبر الدقيقة لعلاج الأمراض الجلدية المختلفة مثل ندبات الوجه وعلامات التمدد وحالات خلل التصبغ وتجديد شباب الجلد المتأثر بأشعة الشمس والتعبلة والتقران السفعي والاضطرابات الصبغية أثناء الحمل.

INTRODUCTION

The method of microneedling has been expanded in the last decade, since it is considered as a safe, effective, low-cost and accessible aesthetic technique.¹ Like other skin renewal procedures, it is a process of mechanical induced skin reconstruction.^{2,3,4} Microneedling is a slightly invasive technique composed of fine needles, which create a superficially controlled punctures in the skin.⁵ These cutaneous penetrations will initiate a cascade of factors such as fibroblast growth factor (GF), platelet-derived factor and transforming GF α and β , these lead to inducement of fibroblasts, enabling them to form and reorganize new elastin as well as collagen fibers via a process of fibronectin matrix formation 5 days following the treatment, thus improving the skin tightening.⁶

Microneedling stimulates the route of normal healing of wound where an early inflammatory response leads to extracellular matrix proliferation resulting in new skin tissues remodeling.⁷ Beside wound healing and tissue remodeling, microneedling is related to other physiological changes including proliferation as well as differentiation of skin epithelium, immune cell enrollment and inhibition of pro-inflammatory cytokines by upregulation of associated genes.⁸ Also it significantly increases proliferation of baseline collagen types one, three, and seven, and newly produced tropoelastin and collagen.⁹

The first use of microneedling was by Orentreich and Orentreich (1995), who firstly describe the dermal needling (subcision) for treating skin scars.¹⁰ Then Camirand and Doucet in 1997 used tattoo pistol to treat skin scar and described it as needle dermabrasion.¹¹ Thereafter, Fernandes (2006) developed the dermaroller device for percutaneous induced therapy of collagen repair,¹² and since that time, the procedure of microneedling has been advised for treatment of various skin diseases like facial scars,¹³⁻¹⁵ stretch marks,^{16,17} dyschromial conditions, rejuvenate photoaged skin,⁹ alopecia, actinic keratoses and pigmentary disorders.^{18,19}

Types of Microneedling

First type is the roller microneedling device, it has a drum-like head with numbers of tiny needles, this head is rolled by handle which induces thousands of microchannels in the papillary dermis.²⁰

Second type is an electronic microneedling which use a pen shaped instrument with adjustment roller to control depth and speed of needle penetration.²¹

Third type is a radio frequency microneedling device which works as a microneedling pen plus bipolar radio frequency energy delivered by the same microneedles and transferred directly through the skin to produce fractional radiofrequency thermal lesions.^{22,23}

Histological Changes

Epidermal Changes

Microneedling induces mild epidermal hyperplasia, dermal deposition of extracellular glycosaminoglycans and fibrin, in addition to proliferation of keratinocytes and fibroblast after 7 days of the procedure.²⁴⁻²⁶

The epidermis showed increase in the thickness with improvement of rete ridges. El-Domyati et al. found an increment in the thickness of epidermis about 5 μm after one month treatment and 14 μm after three months.⁹ Moreover, microneedling causes restoration of basement membrane and it increases the turnover of epidermal layers which leads to weak attachment of melanocytes with the release of melanogenic stimuli like endothelins, hepatocyte GF, stem cell factor and an increase in the epidermal melanin clearance.²⁷⁻²⁹

A pilot study of 6 women with facial recalcitrant melasma treated by two microneedling sessions of one month each, followed by applying a daily broad spectrum sunblock and triple mixture of cream for treatment of pigmentation. They used skin colorimetry, standardized pictures, histological parameters and histological stains including haematoxylin and eosin, picosirius-red, Fontana-Masson and periodic acid Schiff to compare between skin before and after fifteen days of last microneedling session. Most cases showed thickening of epithelium, decreased melanin pigment and densification of upper dermal collagen. Melasma causes damaging of the basement membrane but after treatment by microneedling the basement membrane restoration will result.³⁰⁻³²

Derma Changes

Through various years of life, both qualitative as well as quantitative changes of collagen and elastic fibers were noticed. The histological features of skin related to age involve an increase in elastic material in mid and papillary dermis, as a result of process called solar elastosis.^{33,34} The skin aging features are estimated by measuring the percentage of total dermal elastin which are immunohistochemically stained. Elastin is a connective tissue protein initially created as tropoelastin which is a main compound of elastic fibers.^{9,35}

The elastin level decrease after 1 month of treatment with microneedling, but the decrease was significant 3 months following treatment in comparison to baseline. At the same time, they observed slight increase in tropoelastin after one month of treatment and a significant increase after three months of last session.³⁶

The decrement in the content of elastin was in association with partial repair of the normal elastic fibers in the reticular and papillary dermis post solar elastotic material displacement away from the aged skin epidermis.^{35,36}

Sixteen Korean patients with striae distensae were enrolled. Patients received three sessions using microneedling roller at 4-week intervals for three months. The histological features of the skin specimens showed a regulated elastic fibers and an increased number of collagen. The clinical results revealed good skin texture, color, and tightness.^{37,38}

In the study of Lee et al in 2013 the histologic evaluation showed marked thickening of skin dermis and improvement of collagen material after three treatments of 15 wrinkled face women with fractional radio frequency microneedling in one half of women's face and other half with fractional radio frequency microneedling plus stem cell conditioned medium. Clinical results showed a perfect skin roughness, hydration, erythematic index, and melanin pigmentation.^{39,40}

Another work found that 6 microneedling treatments at two weeks interval created a significant increase in collagen types I, III, VII, and tropoelastin, with noticeable clinical enhancement of photoaged skin in ten patients with III and IV Fitzpatrick skin Type and Glogau class II to III wrinkles.⁹

In Aust et al. study, after microneedling treatment of post burn scar of 16 patients, the histologic investigation after 12 months revealed significant increase in elastin and collagen deposition, with complete removal of post burn scar reported in more than 80% of patients.⁴¹⁻⁴³

The Radiofrequency microneedling has been applied for treating hyperhidrosis. Kim et al. study on 20 patients suffered from "primary axillary hyperhidrosis" [PAH] they experienced 2 sessions of microneedling treatment with bipolar radiofrequency at intervals of four week. They observed a significant decrease in score of "Hyperhidrosis Disease Severity Scale" (HDSS) following 1-2 months of post-operative follow-up. Clinical results of 70% of patients expressed decrease in their sweating. The histological assessment revealed a decreased size and number of eccrine and apocrine glands one month after last session.^{44,45}

Side Effects

The commonest adverse effects of microneedling treatment involve local edema, flaking of skin, and mild erythema, which normally preserves after two to three days, in addition pinpoint bleeding can be resolved immediately after minutes of the procedure.⁴⁶

Although histologically there is no change in melanocytes number after 24 hours of procedure, dyspigmentation can occur as a side effect in dark-skin persons [Fitzpatrick IV, V, VI],⁴⁷ but it is seldom occurred by protecting the skin following microneedling session with sunscreen or preventing exposure to ultraviolet light.

A case series study in 2014 observed that development of skin granuloma in three patients after microneedling treatment with vitamin C serum.⁴⁸ The local medications applied with or directly after the procedure can increase the side effects, since microneedling creates channels (gateways) through skin epidermis and dermis allowing for the stimulation of an immune system.⁴⁹ In contrast, other study observed that to avoid or minimize the risks of most common complications after microneedling procedures physicians should use topical agents to the skin immediately of after sessions.⁵⁰

CONCLUSION

Microneedling is a safety aesthetic procedure, effective and valuable that can be used in treating dermatological disorders including scars, striae, rhytides, and aged skin. It converse the histopathological and clinical signs of aging, with the benefit of fast recovery and minimal side effects.

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