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Using microneedling in the treatment of vitiligo

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Abstract

The acquired pigmentary skin disorder known as vitiligo, which appears as white macules and patches all over the body, is brought on by the lack of pigment-producing cells from the epidermis. Micro needling has been utilized in Vitiligo treatment. Simple injection needles or microneedling tools like manual rollers, derma rollers, automated needle pens, and micro needling fractional radiofrequency tools can be used to perform the procedure. Microneedling is superior to traditional needle injections because it allows greater control over the injection's depth and reduces pain. Transdermal medicine delivery with micro needle delivery systems is non-painful and requires no cutting or stitching. Minimal harm to the epidermis is caused by the needles as they puncture the stratum corneum and form micro-conduits. In the dermal papillary layer, this causes a cascade of events that culminates in the creation of growth factors that drive collagen and elastin synthesis. Solid, coated, dissolving, hollow, and swell able polymer micro needles manufactured using micro fabrication process are all viable options for this application. According to the information that is currently available, micro needling is an effective and enjoyable treatment for vitiligo. It can also be useful for treating difficult-to-treat areas like the extremities or stubborn regions.

Keywords: Microneedling, manual rollers, derma rollers, automated needle pens

Introduction

The acquired pigmentary skin disorder known as vitiligo, which appears as white macules and patches all over the body, is brought on by the lack of pigment-producing cells from the epidermis. The most frequent autoimmune disease associated with the illness is thyroid dysfunction. Despite the fact that the cause of vitiligo is unknown, there are many theories to explain it. Vitiligo, which is characterised by evenly spaced white spots on the body, is more noticeable in people with darker skin tones ^[1].

Repeatedly puncturing the skin with sterile microneedles is known as microneedling (MN) or collagen induction treatment ^[2]. MN is a low-cost, minimally invasive method for treating a variety of skin and aesthetic issues ^[3]. Treatments for enlarged pores, dyschromia, melasma, acne scars, rhytides, surgical scars, dyschromia, and transdermal drug administration were among the many uses ^[2].

Increased patient satisfaction and clinician familiarity with microneedling result from the procedure's reported excellent efficacy, safety, and minimum post-treatment recovery rates ^[4].

The social isolation and stigma associated with vitiligo make it more than just a cosmetic disorder and place a heavy psychological burden on those who suffer from it ^[5, 6]. Topical, intralesional, and systemic corticosteroids, narrowband UVB (phototherapy), calcineurin inhibitors, monochromatic excimer light laser therapy, afamelanotide, prostaglandin F2 alpha analogue (latanoprost), CO2 fractional laser, erbium laser-assisted dermabrasion, and surgical techniques are just some of the treatment modalities that have been used, but vitiligo has no effective cure at the moment ^[7-9].

Needling was recently used in a method that resulted in favourable levels of repigmentation. Simple injection needles or microneedling tools like manual rollers, derma rollers, automated needle pens, and microneedling fractional radiofrequency tools can be used to perform the procedure. Microneedling is more effective than a standard injection needle at regulating the depth of penetration and reducing the amount of pain experienced during the injection ^[10].

It results in a micro inflammation of the epidermal layer, which promotes the migration of melanocytes and keratinocytes and prompts repigmentation of the areas affected by vitiligo ^[11]. Additionally, it facilitates melanocytes' effective grafting from pigmented to UN pigmented areas and improves topical medications' penetration of the skin ^[12].

It may be used as a stand-alone therapy or in conjunction with therapeutic injection to cure vitiligo. Without adopting a standardised methodology, microneedling has only slightly increased in recent years.

Mechanism of Action

Physical injury is important to the development of MN. It was hypothesized that the dermis regenerates in response to the stress caused by needle insertion ^[13]. Minimal harm to the epidermis is caused by the needles as they puncture the stratum corneum and form micro-conduits. As a result, growth factors are produced, which in turn drive collagen and elastin synthesis in the dermal papillary layer.

The natural wound healing cascade is induced as platelets and neutrophils are recruited to release growth factors such as TGF- α , TGF- β , and platelet-derived growth factor (PDGF) ^[14]. The needles also break down the old hardened scar strands and allow it to revascularize. Neovascularization and neocollagenesis are initiated by migration and proliferation of fibroblasts and laying down of intercellular matrix.

Because it skips the stratum corneum and delivers the medicine straight into the vascularized dermis, microneedling greatly improves the transport of many pharmaceuticals across the skin barrier. The enhanced medicine penetration across the epidermal barrier may be partially explained by the fact that it has been demonstrated to create a considerable expansion of the follicular infundibulum by 47%. Scales and sebum deposits near the infundibulum are also eliminated.

Healing phases after microneedling therapy

Skin microneedling induces normal wound healing which occurs in three stages. Inflammation stage: It starts rapidly after the injury in which platelets produce chemotactic factors causing penetration of other platelets, neutrophils, and fibroblasts ^[14, 15]. The proliferation stage: After neutrophils are replaced, monocytes become macrophages and produce numerous growth Factors such as platelet-derived growth factor, fibroblast growth factor, and transforming growth factors α and β which make the fibroblasts migrate, stimulate the keratinocytes to proliferate, and enhance the formation of laminin and collagen types IV and VII ^[14, 15]. The remodeling stage (Maturation): It stays for months after the injury and is mainly done by the fibroblasts; production of collagen in the upper dermis needs a year or longer ^[14, 15]. Collagen III is the main type of collagen formed in the early wound healing phase. It is replaced by collagen I gradually over a year or more. Collagenases and matrix proteinases are involved in the conversion of collagen III into collagen I ^[16].

Advantages of microneedling

This procedure can be done with topical anesthesia, no sedation is needed, the patient can go to work the next day, bruising is rare to occur. Skin needling can be safely done on all skin types and on areas not suitable for peeling or

laser resurfacing, such as near eyes, and no risk of inflammatory hyperpigmentation resulting from skin trauma because the melanocytes and the dermis remain intact during skin needling. It has a low risk of skin infection and with an affordable cost ^[17, 18].

Disadvantages

Although erythema (redness) may appear following microneedling for up to two days, most people handle the procedure well. Tightness and itching of the skin are also possible, but they usually go away after 12 to 48 hours ^[18].

Precautions ^[17]

Photo protection is advised for a week after the procedure. Topical antibiotic cream is applied for a few days to minimize the chance of bacterial infection. Avoidance of harsh chemicals or any cosmetic procedure over the face for at least one week is recommended.

Microneedling devices

Microneedle delivery systems

A microneedle delivery system is a non-invasive and painless way to provide transdermal drugs ^[19]. Solid, coated, dissolving, hollow, and swell able polymer micro needles manufactured using micro fabrication process are all viable options for this application ^[20].

Temporary aqueous micro channels in the stratum corneum are created by applying and then removing solid micro needles from the skin. When a transdermal patch, solution, cream, or gel is administered topically, an external drug reservoir is formed ^[21]. After inserting the array under the skin, the micro needle tips dissolve in the interstitial fluid of the skin. And then the medication trickles out gradually ^[22]. Continuous distribution of molecules across the skin is made possible by hollow microneedles, which are implanted into the skin and filled with a fluid formulation before being injected ^[23].

Derma roller

The derma roller is the most used tool for cosmetic microneedling. Microneedles are mounted on a revolving concentric cylinder in this apparatus. Standard derma rollers are made with 200 stainless steel microneedles, but users can choose from a variety of models with varied microneedle lengths and densities to best suit their skin type and aesthetic goals. The derma roller has been tried and tested at the clinic, and now it's ready for purchase by the general public ^[24]. Home-care Transdermal distribution of substances like lipopeptides and other anti-aging medicines are possible with the use of derma rollers, which are used by patients themselves and have shorter needles. You can use them every other week ^[18].

Derma-stamp

Miniaturized versions of the derma roller, suitable for usage on isolated scars like varicella scars, are available with needle lengths ranging from 0.2 to 3 mm and a diameter of 0.12 mm. The benefit over the derma roller is that it allows for targeted treatment of certain scars. Ideal for application on isolated scars and wrinkles, it stimulates vertical penetration to establish infusion channels in the skin ^[20].

Dermapen

Automatic microneedling with the pen-shaped Dermapen.

The disposable needles and guides used by this ergonomic instrument make fractional mechanical resurfacing possible. There are 12-36 needles in a row at the tip ^[25]. The disposable needles allow for reuse in different patients, while the shielded needle tips make it safer to use in sensitive locations like the nose, around the eyes, and the lips without fear of causing harm to the surrounding skin. It lessens the potential for discomfort during the process and saves money by eliminating the need to constantly replace the tool. This robotic device was developed to address the problems caused by the discrepancy between the MN depth of penetration accomplished and the pressure applied by doctors and patients ^[20].

Fractional radiofrequency microneedling

The potential uses of microneedling increased when combined with radiofrequency. Without harming the epidermis, radiofrequency currents are released from the needle tips using insulated needles, creating hot zones in the dermal structural components and accessory glands ^[26]. This causes neocollagenesis and neocollagenesis (the formation of new collagen) in the dermis over time. Needle depths range from 0.5 mm to 3.5 mm, allowing for selective dermal layer targeting ^[27]. By changing the energy pulse's intensity and length, the surgeon has fine control over tissue damage. A disposable tip with 49 gold-plated needles is the primary means of energy delivery. Microneedling radiofrequency (MNRF) technology is safe even for darker skin types because it does not harm the epidermis. Scar removal, sweat control, skin firming, and anti-aging are just few of the many uses for this product ^[27].

Applications of Microneedling in Dermatology

Numerous clinical research corroborated the benefits of microneedling for a variety of applications. Chemical peels, platelet-rich plasma, radiofrequency, subcision, punch elevation, and lasers were all explored in addition to this method. When used with a topical preparation, it increases the efficacy of both ^[17, 26, 28].

Skin rejuvenation

As a result of microneedling, existing collagen fibers are reorganized, and new collagen, elastin, and capillaries are laid down, which has the effect of tightening the skin. Six microneedling treatments spaced at 2-week intervals resulted in a significant rise in the level of collagen type I, III, and VII, freshly produced collagen, and tropoelastin compared to baseline. By decreasing the appearance of fine lines and wrinkles, shrinking the size of pores, and increasing the skin's suppleness and elasticity, percutaneous collagen induction can help the skin regain a more youthful appearance.

When paired with anti-aging vitamin C serum and tretinoin, the technique yields even better results ^[29]. Significant improvements in wrinkle and pigmentation reduction were shown when microneedling was paired with endothelial precursor cell-conditioned media generated from human embryonic stem cells ^[30].

Androgenic alopecia and alopecia areata

Androgenetic alopecia can be treated with microneedling, which stimulates hair growth via several different mechanisms, including the release of platelet-derived growth factor, the activation of stem cells in the hair bulge

area under wound healing conditions, and the overexpression of genes involved in hair growth, vascular endothelial growth factor, and B catenin, Wnt3a and Wnt 10b ^[31]. One of its benefits is microneedling over the scalp for alopecia. The results showed that the combination was superior to minoxidil alone. ^[32] Alopecia areata patients who used microneedling in conjunction with topical triamcinolone acetonide saw improved results ^[33].

Scars and Striae

Microneedle therapy enhances healing with less epidermal damage ^[25]. Clinical improvement of acne scars was substantiated by histologic skin changes. Rolling and boxcar acne scars were shown to be more effectively treated than ice pick scars ^[29]. Similarly, other types of atrophic scars and burn scar contractures and striae distensae were also improved with microneedling ^[34, 35]. Unlike full ablative laser skin resurfacing which is typically limited to the treatment of full cosmetic units, it is possible to microneedle discrete areas of scarring without producing lines of demarcation between treated and nontreated areas ^[36].

Vitiligo

Microneedling makes skin cell proliferation and releases pro-pigmentary cytokines by inserting needles into the skin and promoting the traumatic inflammatory infiltrate with regional antigen presentation and wound healing leading to the removal of pathogenic cells and melanotoxins ^[37].

Microneedling assists drug penetration and may become an effective therapeutic modality for refractory vitiligo ^[38]. Microneedling combined with 5-fluorouracil or tacrolimus is effective in the treatment of vitiligo with a higher response in the acral parts with 5-fluorouracil than tacrolimus ^[39]. Also, microneedling combined with calcipotriol plus betamethasone was proved to be effective in the treatment of vitiligo ^[38].

Microneedling monotherapy

The idea behind microneedling is that the micro injuries caused by the needles stimulate the body's natural healing processes, specifically neovascularization and neocollagenesis.

Two clinical trials showed that microneedling is successful in treating vitiligo using a five-grade system to evaluate repigmentation ^[40, 41]. There were a total of 57 people who had experienced stable localized vitiligo for at least three years. The lesion was treated with a topical anesthetic lotion containing lidocaine. To induce bleeding, an electronic Dermapen with a needle thickness of 1 mm, 1.5 mm, or 2 mm was used. Six to twelve sessions were given to the patient at two-week intervals ^[40, 41]. 38.5 percent of patients showed a clinical response, with 17.5 percent exhibiting good repigmentation. The facial area showed the greatest reaction, followed by the upper body ^[41].

Microneedling with topical tacrolimus

Vitiligo can be treated well with topical tacrolimus. Since microneedling improves transdermal medication distribution ^[41], following microneedling, patients were instructed to apply tacrolimus ointment beneath occlusive dressing for 6 hours and then once daily for 2 weeks ^[39, 41]. Except for one research where patients received 4 sessions with a 15-day break, all patients underwent 12 sessions (at 2-week intervals) of microneedling ^[38, 41].

Microneedling combined with tacrolimus was more efficient than microneedling monotherapy [41]. A clinical response was seen in 83.6% (n = 97) of patients receiving combined therapy [38-41]. The clinical response grades were: partial clinical response (n = 10, 11.6%), G1 (n = 14, 16.3%), G2 (n = 24, 31.4%), G3 (n = 15, 17.4%), G4 (n = 4, 4.7%), G2 (n = 42, 48.8%), >24% repigmentation (n = 12, 14%). The highest repigmentation rate was noted on the face (n = 12, 70% repigmentation) [41]. In the same study, excellent repigmentation (grade G4, >75% repigmentation) was recorded in three patients with vitiligo patches of the legs but these results were not achieved on acral parts or bony prominences [41, 42]. However, Ibrahim *et al.*, showed excellent results in vitiligo of the elbows (n = 3, 83.33% repigmentation) [38].

Microneedling with topical calcipotriol plus betamethasone

Microneedling with calcipotriol (0.05 mg/g) and betamethasone (0.5 mg) was compared to tacrolimus for the treatment of vitiligo in one clinical investigation. Microneedling was performed on symmetrical patches over the elbows, knees, extremities, and acral areas every 2 weeks for 12 sessions, and calcipotriol plus betamethasone or tacrolimus was applied right after [38].

In contrast to microneedling with tacrolimus, vitiligo patients saw better results with microneedling with topical calcipotriol + betamethasone. Clinical improvement occurred faster, and fewer sessions were required. We found that the treated areas of the extremities repigmented substantially better than the untreated areas [38]. Repigmentation rates were highest in the elbows (n = 3, 99%) and the extremities (n = 8, 83.3%), moderate in the acral areas (n = 6, 50%), and lowest in the knees (n = 8, 67.5%) [38].

Microneedling in combination with 5-FU biotherapy

Microneedling and 5-FU were evaluated in two studies. Microneedling was performed on patients six times, or twelve times at two-week intervals [39, 40]. After microneedling, an occlusive bandage containing 5% 5-FU solution was placed on the afflicted areas for one day [39, 40]. The patient was instructed to administer 5-FU once each day for 14 days [39].

Attwa, *et al.* demonstrated that adding 5-FU to microneedling boosted its effectiveness by 3.8-fold compared to microneedling alone [39, 40].

The secondary purpose of this research was to evaluate the relative effectiveness of microneedling with 5-FU and tacrolimus. Excellent repigmentation and a greater number of clinical responses were seen when 5-FU was combined with microneedling, as shown by this study [39]. Forty percent of acral areas (repigmentation >75%) and 57.1% of bony prominence areas (elbows and knees) responded favorably to 5-FU [39].

Complete repigmentation was reported in locations treated with 5-FU and microneedling, including the acral, the face, and the back [43, 44].

Conclusion

According to the information that is currently available, microneedling is an effective and enjoyable treatment for vitiligo. It can also be useful for treating difficult-to-treat areas like the extremities or stubborn regions. To come to an

understanding of the utilisation of microneedling in vitiligo, further randomised clinical trials are required, as well as the standardisation of therapeutic dose methods.

Conflict of Interest

Not available

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