

Microneedling in Acne Scars

Asmaa A. Abdo, Shymaa M. Rezk, and Nader N. Nazmy

Department of Dermatology, Venereology and Andrology Faculty of Medicine, Benha university

E-mail: asmaa.abdelrhman41@gmail.com

Abstract:

Scarring is a cosmetic issue, a potential threat to patients' mental health that is caused by the buildup of collagen after an outbreak of inflammatory acne. It takes so long for acne scars to fade. A more modern approach to treat these scars is microneedling treatment, which is formally called percutaneous collagen induction. It is used in atrophic acne scars effectively. In microneedling, a non-surgical technique for skin treatment, a specialized apparatus and needles are used to create microscopic punctures on the skin's surface to stimulate the body to produce more collagen and elastin, this therapy improves the skin's innate healing capabilities. Microneedling has several beneficial effects on the look of skin that has been impacted by acne like, improving the skin's texture. Microneedling improves the absorption and penetration of topical skincare products by creating microscopic channels in the skin. This improved delivery mechanism enables the targeted administration of acne-fighting compounds, such as retinoids, anti-inflammatory medicines and topical antibiotics to the affected areas. The purpose of this study was to research the effectiveness and safety of microneedling for treatment of acne scars.

Keywords: Acne Scars; Microneedling, Skin-texture

Introduction

Individuals who are not immune to acne vulgaris, a complex skin condition that disproportionately impacts the world's youth. Despite being often described as a minor skin problem, the disorder still causes a financial burden due to healthcare expenses and lost productivity. Not only the physical symptoms, but also it has far-reaching implications; serious emotional and social problems, including low self-esteem, loneliness, and despair [1].

Acne vulgaris has a complicated etiology, including inherited traits, environmental factors, hormone fluctuations, and lifestyle choices. It manifest with a wide range of pathological symptoms, such as comedones, pustules, nodules, inflammatory papules, and scarring. It caused by hyperkeratinized sebum occluding hair follicles, inflammation due to bacterial colonization, particularly *Propionibacterium acnes* [2].

First-line treatments of this disease include; topical medicines like azelaic acid, benzoyl peroxide, retinoids (tretinoin, adapalene, tazarotene), salicylic acid with antibiotics (clindamycin, erythromycin, tetracycline). In more serious instances, doctors may prescribe antibiotics like doxycycline, erythromycin, minocycline, or tetracycline, as well as the potent oral retinoid isotretinoin and oral contraceptives like estrogen and progesterone [3].

Acne treatment plans often include dermatological procedures; chemical peels that include alpha and beta hydroxy acids,

trichloroacetic acid to help removing the dead skin cells and reduce sebum production. Professionals may also use tools designed specifically for the removal of comedones by hand. The use of light-and laser-based therapies helps to target the bacteria that cause acne, decrease inflammation, and speed up the healing process of the skin. Corticosteroids may be injected directly into large lesions experiencing high levels of inflammation to decrease inflammation and accelerate healing [4].

A lot of people are interested in microneedling as a cure for acne. Microneedling, sometimes called percutaneous collagen induction treatment (PCIT) or collagen induction therapy (CIT), a technique that is used to induce controlled micro-injuries in the skin using small needles. This process helps the body's natural wound-healing abilities by increasing the production of collagen and elastin, by making small punctures in the skin using specialized equipment with thin needles. This method smooths out skin, reducing the appearance of scars from acne, accelerating the healing process [5].

In the early 1990s, South African plastic surgeon Dr. Desmond Fernandes was the first to employ microneedling to treat scars and skin imperfections by stimulating collagen production. With the advancement of technology, it became more popular for a variety of dermatological concerns, including acne scars and skin regeneration [6].

Microneedling in acne skin

• A description of the procedure

Microneedling is a non-surgical method for treating skin by creating tiny punctures on the skin's surface using a specialized device and needles. This procedure boosts the skin's inherent ability to heal by increasing the production of collagen and elastin. Needle length is determined by type of skin disease,

For acne-prone skin, the derma roller is a lightweight tool that glides over the skin using a cylindrical drum covered with little needles or electric microneedling devices (microneedling pens). they allow the user to

and even different for each patient according to specific therapeutic requirements. When expertly performed by healthcare professionals, microneedling creates microchannels across the treatment area to target specific areas, enhance skin texture and treat acne scars. [7]

control the depth of penetration of small needles into the skin to target acne scars precisely. Table 1 shows the most popular devices including needle depth, application locations, and cartridge types [8].

Table (1) Overview of microneedling devices and their characteristics ^[7]

Device Type	Needle Depth Range	Application Areas	Cartridge Types
Dermarollers	0.2–2.5 mm	Face, neck, body (e.g., thighs, abdomen)	A cylindrical drum made of titanium or stainless steel that contains several tiny needles
Microneedling pens	0.25–3.0 mm	Face, neck, décolletage, body	Twelve, twenty-four, and thirty-six needle swappable cartridges
Microneedling stamps	0.5–1.5 mm	Targeted areas (e.g., small scars, delicate facial areas)	Fixed needle heads or replaceable cartridges with fewer needles

These microneedling devices may have disposable or reusable needle cartridges, coming with a variety of alternatives to treat different parts of the skin and different issues. Microneedling equipment used on acne-prone skin must comply to strict sterile and safety standards for optimal treatment results and to reduce the risk of infection (9).

Comparing the effectiveness of microneedling types:

1. Traditional microneedling: this method generally uses a manual pen or roller to create micro-channels in the skin. It's effective for improving skin texture and minimizing fine lines. Results may take several weeks to appear, but many clients notice a more youthful appearance within a few months.

2. Automated microneedling: utilizing a motorized device, automated microneedling allows for quicker treatments and more consistent depth penetration. Many find this type less painful and see more immediate results. It's particularly effective at addressing acne scars and enlarged pores.

3. Radiofrequency microneedling (RFM): it pairs radiofrequency, which uses heat energy, with microneedling technology, which uses a wand studded with tiny needles, this combo treatment triggers collagen production, reduces crepiness, dull skin, sagging, uneven texture and acne scarring as regular microneedling devices do not penetrate skin deeply, only reach the most superficial layers of skin (about 0.25 mm deep) and no RF thermal energy is

delivered into skin, while the depth of RF microneedles can typically be adjusted from 0.5 to 3.5 mm, varying from device to device (10).

4. Vampire facial (PRP microneedling): this technique involves applying platelet-rich plasma (PRP) from the patient's blood onto the skin post-treatment. It enhances healing and rejuvenation, making it ideal for those seeking optimal skin revitalization. The results, while impressive, can be dependent on the quality of the PRP.

5. Nano-Needling: this less invasive option employs smaller needles and primarily focuses on enhancing product absorption rather than creating deep wounds. While it might not be as effective for deeper skin issues, nano-needling is great for improving skin hydration and texture (11).

A way things work

Because it addresses many causes simultaneously, microneedling is an excellent treatment for acne-prone skin. Microneedling is a technique that involves making tiny, precisely controlled holes in the skin in order to stimulate the body's own healing processes. Acne scars are less noticeable after this operation because it enhances collagen remodeling, which strengthens the skin. Microneedling improves the look and feel of acne-affected skin by stimulating the development of collagen and elastin, which in turn makes the skin feel smoother (12).

The micropunctures created, inducing a controlled skin injury without significant damage to the epidermis. These microinjuries lead to minimal superficial bleeding and set up a wound healing cascade with releasing of various growth factors such as platelet-derived growth factor, transforming growth factor alpha and beta, connective tissue activating protein, connective tissue growth factor, and fibroblast growth factor. In treating scars, the needles break down the scar strands, allowing them to revascularize. Neovascularization and neocollagenesis are initiated by the migration and proliferation of fibroblasts and the laying down of the intercellular matrix. A fibronectin matrix forms after 5 days of injury that determines collagen deposition, in the form of collagen type III. The depth of neocollagenesis is 5 to 600 μm when a 1.5-mm length needle is used for the procedure (13). **as shown in figures (1,2,3).**

The tiny punctures that microneedling uses reach deeper layers of skin, making it a significantly more effective method for treating acne on the skin. These tiny cuts trigger the skin's natural healing processes, which in turn make the skin seem younger and more radiant by encouraging the generation of new skin cells to progressively replace any injured or scarred tissue. Another possible benefit of microneedling for sebum management is that it influences sebaceous gland activity and triggers a localized inflammatory response. This method regulates sebum production by decreasing sebaceous gland hyperactivity; this, in turn, helps clean pores and postpones the expansion of acne-causing microbes. An excellent therapy for acne-prone skin, microneedling promotes a more balanced sebum production, which in turn reduces the frequency of breakouts and prevents the creation of new lesions (14).

A deeper penetration of topical skincare products is made possible by microneedling, which forms microchannels that increase absorption. The targeted areas are more efficiently provided with acne-fighting

chemicals such topical antibiotics, retinoids, or anti-inflammatory medicines. Applying microneedling to skin that is prone to acne offers several advantages. When it comes to treating acne-prone skin, microneedling is a great alternative due to its many advantages (15).

• Ingredients and method for microneedling

Microneedling techniques, procedures, and chemicals are tailored to each patient based on **selection criteria; skin sensitivity**: Shorter needles are recommended for more delicate skin types, whereas longer lengths are suitable for acne scarring or wrinkles. **Needle depth**: not too shallow nor too deep. A quality device should have adjustable needle depths, there should be indicators that clearly show what level has been chosen so accuracy can be maintained throughout treatment sessions. **Needle size and shape**: according to the user's personal objectives and degree of desired skin penetration. **Needle Types**: The most common types are stainless-steel short and long needles ranging from 0.2mm up to 3.0 mm in size. **Needle Lengths**: shorter needles are ideal for treating smaller and more sensitive areas such as the eyes or lips, while longer needles work best on larger surfaces like the face or body. **The size of the treatment area**: in a large area, it may be beneficial to use several shorter needles rather than just one long one in order to reduce pain and ensure accuracy. **Time of the session**: finer ones suited for faster treatments, while coarser options taking longer to apply. **Number Of Needles**: For those new to microneedling, or who have particularly sensitive skin, starting off with shorter length needles (0.25-0.3mm) is recommended before progressing to longer lengths (1-2mm) (16).

Then patient should wash your face well before a treatment to remove any makeup, oils, or grime that might harm it. A local anesthetic may help alleviate pain throughout the process, especially if it's going to take a lengthy time. Repeating the process many times ensures consistent coverage and precise results. Patients need to get detailed post-care instructions in order to maximize recovery and results. Skincare routine recommendations and sun protection tips should be included of these guidelines (17).

Microneedling may be performed using a number of different tools, such as automated pens, manual derma rollers, or other specialized equipment. Practitioners may adjust their technique using vertical, horizontal, or diagonal movements according to the treatment area and intended results. Gently and consistently apply pressure to get uniform coating and precise needle penetration

depth. At the same time, you should not treat the same areas more than once, since this might cause skin damage and inadequate outcomes (18).

Several medications show promise when used in conjunction with microneedling. It is standard procedure to provide growth factors or hyaluronic acid serums before to or after surgery to promote adequate hydration, collagen activation, and accelerated healing. Incorporating platelet-rich plasma (PRP) into microneedling sessions is another effective strategy for promoting skin regeneration and increasing collagen production. Following

treatment, many patients find that using an antioxidant-rich formulation or serum containing ascorbic acid (vitamin C) helps maintain healthy skin and stimulates collagen formation. Applying topical skincare products designed to address specific skin concerns may enhance the results of microneedling even more. Reminoid, peptide, or other active ingredient compounds are possible. Here are a few chemicals that are often used with microneedling for skin that is prone to acne, along with their key benefits, as shown in Table 2.

Table (2) Substances used in microneedling for acne-prone skin ⁽¹²⁾

Substance	Benefits	Application
Anti-inflammatory agents	Reduce swelling and discomfort, promoting faster recovery	Applied post-treatment to calm the skin
Antimicrobial agents	Help reduce bacterial load on the skin, preventing potential post-treatment infections	Applied during or after microneedling
Antioxidant agents	Protect the skin from free radicals, reduce inflammation, and support skin repair	Applied post-treatment to enhance protection
Ascorbic acid (Vitamin C)	Protects against oxidative stress, supports collagen synthesis, and brightens the skin	Applied post-treatment for antioxidant effects
Growth factors (platelet-derived growth factor (PDGF), fibroblast growth factor (FGF), epidermal growth factor (EGF))	Stimulate collagen production, support tissue repair, and accelerate skin regeneration	Applied before or after microneedling
Hyaluronic acid	Hydrates the skin, improves skin elasticity, and promotes healing by enhancing moisture retention	Applied before or after microneedling
Niacinamide	Reduces inflammation, minimizes pores, and improves skin texture and barrier function	Applied post-treatment to soothe skin
Peptides	Promote collagen production, improve skin texture, and support skin barrier function.	Applied post-treatment to target skin concerns
Platelet-rich plasma (PRP)	contains high concentrations of platelets& growth factors; platelet-derived growth factor (PDGF), transforming growth factor β (TGF- β), vascular endothelial growth factor (VEGF), epidermal growth factor (EGF), insulin-like growth factor (IGF) and fibroblast growth factor (FGF)	Applied during or after microneedling
Retinoids	Increase cell turnover, reduce acne, and improve the appearance of acne scars and pigmentation	Applied post-treatment with caution

• Side effects and limitations

Temporary redness, swelling, and minor pain are possible side effects of microneedling, albeit they are infrequent. In most cases, patients need to be patient and undergo numerous treatments spaced several weeks apart in order to get the desired outcomes. Some people may not see much of a difference

after microneedling, especially with more severe ice-pick wounds. Microneedling may improve certain acne scars, but there's a danger of infection if done incorrectly or with unsterilized equipment. Thorough pre-treatment evaluation and suitable post-care may reduce the likelihood of post-inflammatory hyperpigmentation, which may affect individuals with darker skin tones. Rare

but possible severe side effects include scarring, allergic reactions, or acne flare-ups due to improper operation execution or inappropriate patient selection (19).

• **Advantages**

Acne scars, comedones (blackheads and whiteheads), inflammatory acne, and other acne lesions may be effectively reduced with microneedling, making it a promising treatment option for acne-prone skin. It promotes skin regeneration and collagen synthesis, making it especially helpful in reducing the appearance of rolling and boxcar scars, two types of acne scars. Cleaner, smoother skin with improved tone, elasticity, and texture is possible with this therapy. Topical skincare treatments, such as those for acne and general skin health, are boosted in their efficacy by its enhanced absorption. Its low invasiveness and lack of recovery time make it a good choice for those who lead busy lives (20).

Nevertheless, more study is necessary to determine the best settings for microneedling, including the depth of needle penetration, the frequency of treatments, and any possible interactions with other treatments. To validate

microneedling's effectiveness, safety, and long-term advantages in acne management, systematic reviews and well-designed clinical studies are required (21).

• **Long term safety concerns:**

Microneedling is generally safe when performed by a trained professional, but there are potential long-term safety concerns that should not be overlooked including the risk of scarring, hyperpigmentation or hypopigmentation, skin thinning, chronic sensitivity, and the possibility of abnormal scarring for those prone to keloids. Repeated or aggressive microneedling treatments, especially without proper aftercare, can exacerbate these issues (16).

• **Comparison with laser and chemical peeling:**

microneedling demonstrates promising results with minimal downtime and lower risks, chemical peels are effective for superficial scars and pigmentation issues, with limited impact on deeper scarring. Laser therapies, though highly effective, come with higher costs and longer recovery times (22) as shown in table 3& figure 4.

Table 3: showing comparison between microneedling, chemical peels and laser therapy ⁽²²⁾

Metric	Microneedling	Chemical peels	Laser therapy
Improvement in scar depth	85%	60%	70%
Patient satisfaction	High	moderate	moderate
Complication rate	Low	low	Moderate- high
Average recovery time	3-5 days	5-7 days	7-14 days

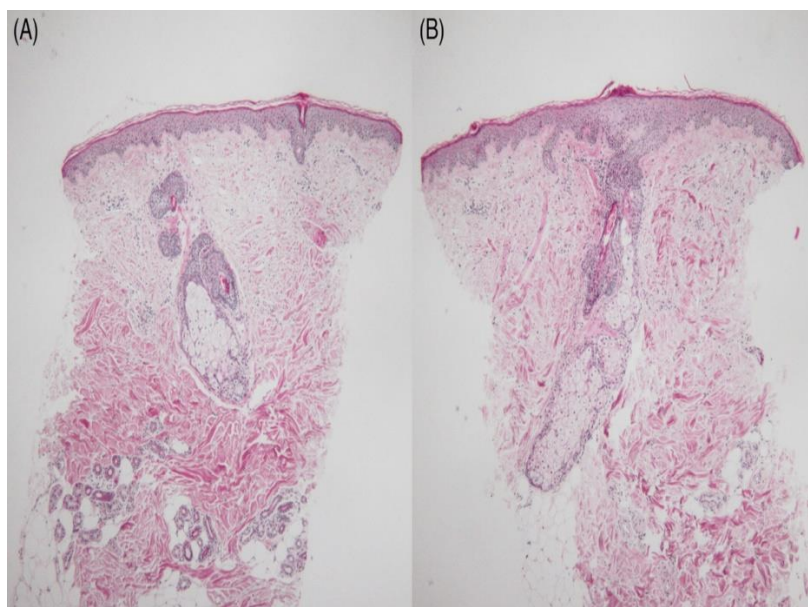


Fig. (1): showing biopsy samples taken from the preauricular region, H&E staining shows atrophic and flat epidermis before treatment (A) and thicker epidermis with papillae at 4 months follow-up after RFM (B) (x40).

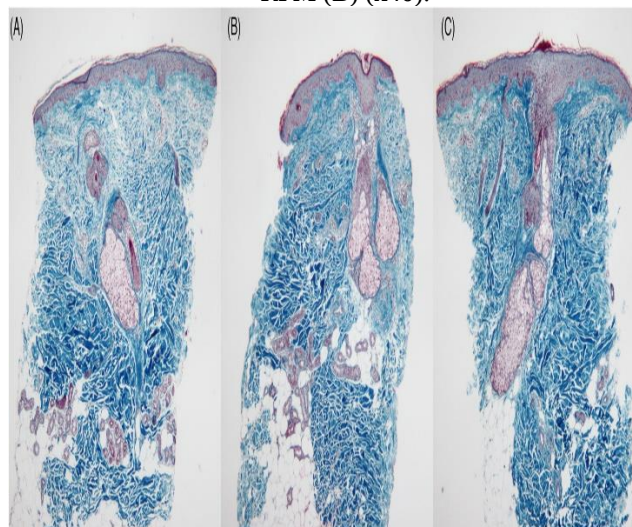


Fig. (2): showing A 54-year-old female participant with initially disorganized collagen fibers (A), partial denaturation accompanied by dermal shrinkage immediately after RFM (B) and replacement with thick collagen bundles at 4-months follow-up (C) (Masson's trichrome stain) (x40).

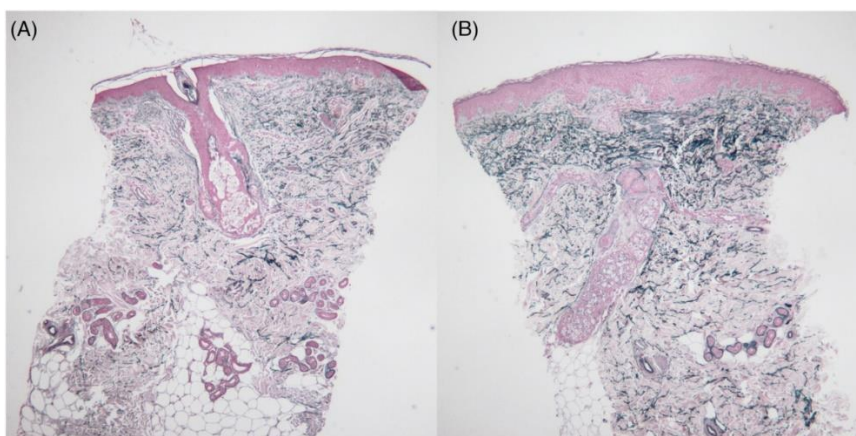


Fig. (3): showing abundant elastotic material in the upper and mid dermis from a 54-year-old woman (A) is replaced with long stretched elastic fibers after RFM (B) (Victoria blue stain) (x40).

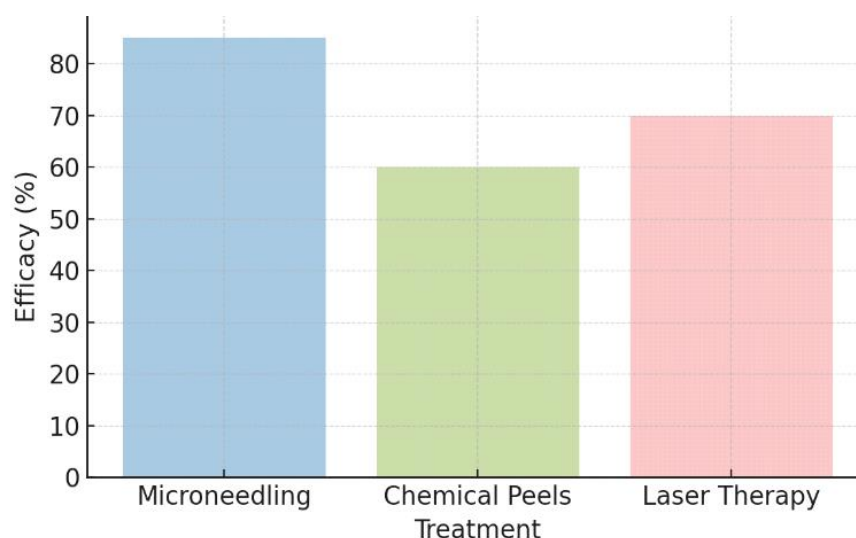


Fig. (4): showing comparison between microneedling, chemical peels and laser therapy (22)

Results from microneedling for acne-prone skin

The use of microneedle dermarollers to treat atrophic acne scars was investigated in a prospective study by Minh et al. (23). Thirteen people with Goodman-Baron grades of two or four were included in the patient group. Baseline, post-treatment, and one to two months after the three months of therapy were complete were the times of assessment. There were notable improvements in the Goodman-Baron grades, as well as in skin texture and decreased hyperpigmentation. Minor adverse effects, such as reddening of the skin and a temporary burning feeling, were often gone within a day or two. Hyperpigmentation after inflammation and other major adverse effects were not reported throughout the trial. Concerning the treatment, a high percentage of patients (83.3%) reported being satisfied. These findings suggest that microneedle dermaroller therapy is a safe and effective way to treat atrophic acne scars.

In their study, Saadawi et al. (24) compared the efficacy and safety of three treatments for atrophic acne scars: glycolic acid peels, dermapen microneedling, and a hybrid of the two. Quantitative global scar grading, a quartile grading system, and patient satisfaction were all components of the clinical assessment. Acne scar grades decreased across the board, according to the statistics, but the combo therapy group showed the most significant improvement. Importantly, boxcar, ice-pick, and rolling scars improved across the board in every therapy group. Dermapen and glycolic acid peels seem to work better together than either one alone for treating atrophic acne scars; patients in the combination

therapy group were far more satisfied with the results.

Amer et al. [25] conducted a study to find out whether microneedling alone or in conjunction with platelet-rich plasma (PRP) was a safer and more effective treatment for healing atrophic acne scars. Although microneedling alone did not provide statistically significant outcomes, it was shown to be more effective when combined with platelet-rich plasma (PRP) or hyaluronic acid.

Participants in the open-label, single-center study by von Dalwig-Nolda and Ablon [26] were healthy individuals (aged 18–65) who had facial atrophic acne scars. They had four microneedling treatments, spaced one month apart. Both before and three months after the last treatment session were assessed. A combination of the Goodman-Baron scale and the Jacob classification was used to assess the severity of acne scars. Furthermore, individuals reported redness, irritation, and pain after the operation. The Goodman-Baron scale for facial acne scars improved significantly to 0.91 grades after three months of treatment. A wide range of Fitzpatrick skin types demonstrated steady progress. Rolling scars demonstrated the most remarkable recovery, with an average increase of 1.06, as per the Jacob classification. Microneedling improved facial acne scarring with less pain, discomfort, and downtime than more aggressive techniques, according to this study. The procedure required four sessions, four weeks apart, and was well-tolerated.

A study conducted by Abbas et al. (27), which compared the effectiveness of microneedling with topical ascorbic acid (vitamin C) vs topical insulin in repairing atrophic post-acne scars, found that the combination of the two was more successful. Insulin and vitamin C serum were applied to

the faces of each of the thirty participants. With four treatments spaced out over a month, scar assessment metrics demonstrated statistically significant improvements relative to baseline on both sides. A little more progress was achieved by the group that received vitamin C. This study found that microneedling, when combined with topical insulin and vitamin C, significantly reduced the visibility of acne scars. Insulin has great potential as a novel anti-scarring therapy, but more large-scale controlled studies are needed to confirm its efficacy.

Microneedling and chemical peels containing 35% glycolic acid were evaluated by Ishfaq et al. [28] for the treatment of atrophic acne scars in patients with Fitzpatrick Skin Phototypes IV-VI. When it comes to treating acne scars, microneedling works better than 35% glycolic acid peels for those with Fitzpatrick Skin Phototypes IV-VI.

The three techniques that Ismail et al. [29] examined for the goal of treating atrophic post-acne scars were microneedling alone, PRP injection intradermally alone, and microneedling and PRP together. While both microneedling and PRP alone were effective in treating various types of atrophic post-acne scars, the results demonstrated that a combination of the two was even more effective.

Alqam et al. evaluated microneedling's efficacy and safety in treating acne vulgaris [30]. Microneedling has the potential to be a safe and effective treatment for acne vulgaris, according to this study's findings. Following therapy, no adverse effects or changes in skin microbiota were noted.

Participants in the split-face prospective interventional study by Krishnegowda et al. (31) had atrophic acne scars. Autologous injectable platelet-rich fibrin (i-PRF) was used to fill each scar on the right side of the face, whereas normal saline was used on the left side. The next step was to use microneedling on both sides. There were a total of four treatments, with each one given at a month apart and a follow-up appointment set for two months downstream. A physician's subjective score, patient satisfaction ratings, and the Goodman-Baron scale were used to assess the efficacy of the treatments. By the end of the 24th week, the experimental group had a much lower average Goodman-Baron grade than the control group. There was a striking difference between the two sides in terms of the average patient satisfaction score. Scars from rolling, boxcar, and ice-pick operations were the most obvious in terms of progress. Results were much better when microneedling and

autologous i-PRF were used together to treat atrophic acne scars compared to microneedling alone.

Two different needle penetration depths were investigated, and the results showed that Dermapen microneedling helped repair atrophic post-acne scars (El-Domyati et al., 32). According to the study, acne scars on the right side of the face showed better improvement after treatment with 2.5 mm needles compared to the left side, which received 1.5 mm needles. After six sessions, the collagen bundle and elastic fiber properties were noticeably enhanced on both sides.

To find out whether method is more effective for repairing atrophic acne scars, Sadeghzadeh-Bazargan et al. [33] compared microneedling with and without 1% phenytoin cream. Ages 18–40 were represented among the 25 subjects of this randomized controlled trial. The patient was instructed to use 1% phenytoin cream three times a day for a week after therapy. Then, microneedling was done on both sides of the face at the same time. Each patient had microneedling three times within a month. We collected baseline data throughout treatment and again two months after our final session, and we evaluated progress thereafter. The assessments included grading the severity of scars, analyzing pores and spots, measuring patient satisfaction, and keeping tabs on complications. Over time, both treatment groups showed significant improvements in pore area, spot count, area, and pore count. The phenytoin group outperformed the microneedling-only group at every follow-up visit and had significantly better outcomes in terms of acne scar grade.

Harthmann et al. [34] compared the effectiveness of nonablative fractional laser alone with that of alternating nonablative fractional laser with microneedling and radiofrequency in treating atrophic acne scars. On each side of their faces, twenty people received four treatments. Neither therapy was noticeably different from the other, although they both significantly reduced the visibility of their acne scars. This study demonstrated that a combination of nonablative fractional lasers, microneedling, and radiofrequency was not more effective than nonablative fractional lasers alone in treating atrophic acne scars.

Evidence from the reviewed literature suggests that microneedling may be an effective therapy for acne and scars, both new and old, across a range of skin types and patient demographics. When combined with other treatments, such as glycolic acid peels, PRP, or topical medications like vitamin C, microneedling may reduce the look, texture,

and severity of acne. Several comparison studies have shown that microneedling is superior to other treatment methods, such as chemical peels, in terms of scar reduction and patient satisfaction. Microneedling in conjunction with platelet-rich plasma (PRP) or glycolic acid peels, for example, has shown a synergistic impact that is more noticeable in scar appearance than each treatment alone [35].

Furthermore, microneedling is generally safe and well-tolerated, and there are very few adverse effects reported in research. The majority of patients report little pain following surgery, and those who do have side effects often find them to be manageable. Microneedling significantly reduces the appearance of acne scars and makes patients pleased since it is a safe, effective, and less intrusive method of treatment. There has to be an increase in large-scale randomized controlled trials to determine the long-term safety and efficacy of microneedling for acne scar management [30]. This will help to standardize procedures and find the best treatment settings.

One possible advantage of microneedling for acne-prone patients is that it may enhance skin texture and lessen the appearance of acne scars. It is possible to include this method into tailored treatment plans because of its adaptability. When combined with adjuvant treatments like as glycolic acid peels or platelet-rich plasma (PRP), its effectiveness is amplified even more. The less invasive and generally safe microneedling procedure has made it an invaluable asset to modern dermatological treatment [36].

Conclusion

Sessions of skin microneedling, which promote the healing processes, are an effective and often risk-free treatment for atrophic scars left behind by acne.

References

- [1] Eichenfield DZ, Sprague J and Eichenfield LF. Management of Acne Vulgaris: A Review. *JAMA*. 2021;326(20):2055-67.
- [2] Akl EM, Ibrahim SE, Fouad NA and Mowafy EA. Etiopathogenesis of Acne Vulgaris. *Benha J Appl Sci*. 2024;9(7):7-10.
- [3] Leung AK, Barankin B, Lam JM, Leong KF and Hon KL. Dermatology: how to manage acne vulgaris. *Drugs Context*. 2021;10:35-70.
- [4] Castillo DE and Keri JE. Chemical peels in the treatment of acne: patient selection and perspectives. *Clin Cosmet Investig Dermatol*. 2018;11:365-72.
- [5] Ramaut L, Hoeksema H, Pirayesh A, Stillaert F and Monstrey S. Microneedling: Where do we stand now? A systematic review of the literature. *J Plast Reconstr Aesthet Surg*. 2018;71(1):1-14.
- [6] Fernandes D. A Short History of Skin Needling. *Microneedling: Global Perspectives in Aesthetic Medicine* 2021. p. 10-21.
- [7] Alster TS and Graham PM. Microneedling: A Review and Practical Guide. *Dermatol Surg*. 2018;44(3):55-68.
- [8] Singh A and Yadav S. Microneedling: Advances and widening horizons. *Indian Dermatol Online J*. 2016;7(4):244-54.
- [9] Aldawood FK, Andar A and Desai S. A Comprehensive Review of Microneedles: Types, Materials, Processes, Characterizations and Applications. *Polymers (Basel)*. 2021;13(16):30-50.
- [10] Tan MG, Jo CE, Chapas A, Khetarpal S, Dover JS. Radiofrequency microneedling: a comprehensive and critical review. *Dermatologic Surgery*. 2021 Jun 1;47(6):755-61.
- [11] Ziaefar E, Ziaefar F, Mozafarpour S, Goodarzi A. Applications of microneedling for various dermatologic indications with a special focus on pigmentary disorders: A comprehensive review study. *Dermatologic therapy*. 2021 Nov;34(6):e15159.
- [12] Mujahid N, Shareef F, Maymone MBC and Vashi NA. Microneedling as a Treatment for Acne Scarring: A Systematic Review. *Dermatol Surg*. 2020;46(1):86-92.
- [13] Litchman G, Nair PA, Badri T, et al. Microneedling. [Updated 2022 Sep 26]. In: StatPearls [Internet].
- [14] Hou A, Cohen B, Haimovic A and Elbuluk N. Microneedling: A Comprehensive Review. *Dermatol Surg*. 2017;43(3):321-39.
- [15] Khare N and Shende P. Microneedle system: a modulated approach for penetration enhancement. *Drug Dev Ind Pharm*. 2021;47(8):1183-92.
- [16] Chu S, Foulad DP, Mesinkovska NA. Safety profile for microneedling: a systematic review. *Dermatologic Surgery*. 2021 Sep 1;47(9):1249-54.
- [17] Juhasz MLW and Cohen JL. Microneedling for the Treatment of Scars: An Update for Clinicians. *Clin Cosmet Investig Dermatol*. 2020;13:997-1003.

- [18] Alster TS and Li MKY. Microneedling of Scars: A Large Prospective Study with Long-Term Follow-Up. *Plast Reconstr Surg.* 2020;145(2):358-64.
- [19] Villani A, Annunziata MC, Luciano MA and Fabbrocini G. Skin needling for the treatment of acne scarring: a comprehensive review. *J Cosmet Dermatol.* 2020:20-30.
- [20] Harris AG, Naidoo C and Murrell DF. Skin needling as a treatment for acne scarring: An up-to-date review of the literature. *Int J Womens Dermatol.* 2015;1(2):77-81.
- [23] Minh PPT, Bich DD, Hai VNT, Van TN, Cam VT, Khang TH, et al. Microneedling Therapy for Atrophic Acne Scar: Effectiveness and Safety in Vietnamese Patients. *Open Access Maced J Med Sci.* 2019;7(2):293-7.
- [24] Saadawi AN, Esawy AM, Kandeel AH and El-Sayed W. Microneedling by dermapen and glycolic acid peel for the treatment of acne scars: Comparative study. *J Cosmet Dermatol.* 2019;18(1):107-14.
- [25] Amer A, Elhariry S and Al-Balat W. Combined autologous platelet-rich plasma with microneedling versus microneedling with non-cross-linked hyaluronic acid in the treatment of atrophic acne scars: Split-face study. *Dermatol Ther.* 2021;34(1):57-60.
- [26] Von Dalwig-Nolda DF and Ablon G. Safety and Effectiveness of an Automated Microneedling Device in Improving Acne Scarring. *J Clin Aesthet Dermatol.* 2020;13(8):17-22.
- [27] Abbas MAM, Elgamal E, Zaky MS and Elsaie ML. Microneedling with topical vitamin C versus microneedling with topical insulin in the treatment of atrophic post-acne scars: A split-face study. *Dermatol Ther.* 2022;35(5):76-85.
- [28] Ishfaq F, Shah R, Sharif S, Waqas N, Jamgochian M and Rao B. A Comparison of Microneedling versus Glycolic Acid Chemical Peel for the Treatment of Acne Scarring. *J Clin Aesthet Dermatol.* 2022;15(6):48-52.
- [29] Ismail SA, Khella NAH and Abou-Taleb DAE. Which is more effective in atrophic acne scars treatment microneedling alone or platelet rich plasma alone or combined both therapeutic modalities? *Dermatol Ther.* 2022;35(12):25-36.
- [30] Alqam ML, Jones BC and Hitchcock TM. Study to determine the safety and
- [21] Lopez Q. Treatment of Acne Scars with Microneedling and Chemical Reconstruction of Scarred Skin Therapy (CROSS) Using Penol/Croton Oil Combination. *J Drugs Dermatol.* 2024;23(6):418-22.
- [22] Khattak A, Almusawi MAY, Mistarihi D, Makkiyah RA, AlShehhi MK, Kasargod AS, et al. Comparative effectiveness of microneedling, chemical peels, and laser therapy for acne scarring: a meta-analysis of clinical and long-term outcomes. *J Popul Ther Clin Pharmacol.* 2024;31(11):1443-145
- [22] efficacy of microneedling as an effective treatment for acne vulgaris. *Skin Health Dis.* 2023;3(5):64-78.
- [31] Krishnegowda R, Pradhan SN and Belgaumkar VA. A Split-Face Study to Evaluate Efficacy of Autologous Injectable Platelet-Rich Fibrin With Microneedling Against Microneedling With Normal Saline (Placebo Control) in Atrophic Acne Scars. *Dermatol Surg.* 2023;49(10):938-42.
- [32] El-Domyati M, Moftah NH, Ahmed AM and Ibrahim MR. Evaluation of microneedling depth of penetration in management of atrophic acne scars: a split-face comparative study. *Int J Dermatol.* 2024;63(5):632-8.
- [33] Sadeghzadeh-Bazargan A, Pashaei A, Ghassemi M, Dehghani A, Shafiei M and Goodarzi A. Evaluation and comparison of the efficacy and safety of the combination of topical phenytoin and microneedling with microneedling alone in the treatment of atrophic acne scars: A controlled blinded randomized clinical trial. *Skin Res Technol.* 2024;30(6):66-80.
- [34] Hartman N, Loyal J, Borsack S and Goldman M. Alternating Treatment With Nonablative Fractional Laser and Radiofrequency Microneedling for the Treatment of Acne Scars: A Prospective, Randomized, Split-Face Study. *Dermatol Surg.* 2024;50(1):81-5.
- [35] Meghe SR, Madke B, Singh A, Kashikar Y and Rusia K. Microneedling with PRP for Acne Scars: A New Tool in Dermatologist Arsenal - A Scoping Review. *J Pharm Bioallied Sci.* 2024;16(2):17-9.
- [36] Măgeruşan ŞE, Hancu G and Rusu A. Current Understanding of Microneedling Procedures for Acne Skin: A Narrative Review. *Cosmetics.* 2024;11(6):19-33.