cosmetics

MDPI

*Review*

# Current Understanding of Microneedling Procedures for Acne Skin: A Narrative Review

**Șoimița Emiliana Măgerușan, Gabriel Hancu * and Aura Rusu**

Department of Pharmaceutical and Therapeutic Chemistry, Faculty of Pharmacy, "George Emil Palade" University of Medicine, Pharmacy, Science and Technology of Târgu Mureș, 540120 Târgu Mureș, Romania; emiliana.magerusan@umfst.ro (Ș.E.M.); aura.rusu@umfst.ro (A.R.)

* Correspondence: gabriel.hancu@umfst.ro

**Abstract:** Acne vulgaris, the most prevalent skin disorder among teenagers and young adults, is often perceived as a moderate skin condition; however, it imposes a substantial economic and psychological burden on individuals and society. Microneedling emerges as a valuable therapeutic option for acne vulgaris. The procedure involves using fine needles to create controlled micro-injuries in the skin, stimulating collagen production and enhancing the skin's natural healing processes. This minimally invasive technique effectively reduces acne lesions, improves skin texture, and increases collagen production with minimal adverse effects and downtime. This narrative review evaluates the efficacy and safety of microneedling procedures in treating acne vulgaris. A comprehensive research strategy was employed across various databases (PubMed, Google Scholar, Cochrane Library) to identify relevant studies. Inclusion criteria encompassed studies investigating microneedling procedures for acne, including controlled trials and case studies. Outcomes such as reduced acne lesions, improved skin texture, adverse effects, and patient satisfaction were analyzed. While further well-designed studies are warranted to elucidate optimal treatment protocols and long-term outcomes, current evidence supports the integration of microneedling into managing acne-prone skin. Moreover, the long-term consequences of microneedling in acne management remain an area for future research.

**Keywords:** acne vulgaris; skin; microneedling; acne treatment; collagen induction therapy

check for updates

**Citation:** Măgerușan, Ș.E.; Hancu, G.; Rusu, A. Current Understanding of Microneedling Procedures for Acne Skin: A Narrative Review. *Cosmetics* **2024**, *11*, 193. https://doi.org/10.3390/cosmetics11060193

Academic Editor: Sophia Letsiou

Received: 12 September 2024
Revised: 8 November 2024
Accepted: 13 November 2024
Published: 14 November 2024

**Copyright:** © 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

## 1. Introduction

Acne vulgaris, a common dermatological condition primarily affecting adolescents and young adults worldwide, poses a complex challenge with significant consequences for individuals and society. Although it is often classified as a moderate skin disorder, its impact reaches beyond physical symptoms, leading to a substantial economic burden due to healthcare expenses and lost productivity. Additionally, acne vulgaris brings considerable psychosocial challenges, including lowered self-esteem, social isolation, and an increased risk of depression [1,2].

The etiology of acne vulgaris is intricate and multifactorial, involving a combination of genetic predisposition, hormonal fluctuations, environmental factors, and lifestyle habits. Pathologically, acne vulgaris manifests through the development of comedones, inflammatory papules, pustules, nodules, and, in severe instances, scarring. The pathogenesis generally begins with the obstruction of hair follicles by hyperkeratinized sebum, which is subsequently followed by inflammation triggered by the colonization of bacteria, particularly *Propionibacterium acnes* [2,3].

Topical treatments, including azelaic acid, benzoyl peroxide, retinoids (tretinoin, adapalene, tazarotene), salicylic acid, and antibiotics (clindamycin, erythromycin, tetracycline), are commonly prescribed as first-line therapy. For moderate to severe cases, oral medications such as antibiotics (doxycycline, erythromycin, minocycline, tetracycline), hormonal agents (oral contraceptives containing estrogen and progesterone), and isotretinoin (a potent oral retinoid) may be prescribed [1,4,5].

Dermatological procedures are frequently recommended as part of acne treatment. Chemical peels, which commonly use alpha and beta hydroxy acids or trichloroacetic acid, exfoliate the skin and unclog pores. Professionals may also manually extract comedones, such as black and whiteheads, using specialized tools. Laser and light-based therapies are employed to target acne-causing bacteria, reduce inflammation, and promote skin healing. For cases involving severe inflammation and large lesions, corticosteroid injections may be administered directly into the affected areas to accelerate healing and diminish inflammation [5,6].

In recent years, microneedling has gathered significant attention as a promising therapeutic approach for treating acne-related issues. Microneedling, or percutaneous collagen induction therapy (PCIT) or collagen induction therapy (CIT), involves the creation of controlled micro-injuries in the skin using fine needles. This process stimulates the body's natural wound-healing response, promoting collagen and elastin production. By utilizing specialized devices equipped with fine needles to create micro-perforations in the skin, microneedling initiates the skin's natural regeneration and repair mechanisms. As a result, this procedure can lead to improved skin texture, enhanced wound healing, and a potential reduction in the visibility of acne scars [7,8].

Microneedling was first introduced in the early 1990s by Dr. Desmond Fernandes, a South African plastic surgeon, who developed the technique to treat scars and skin imperfections by stimulating collagen production. Over the years, the procedure has evolved with technological advancements, becoming widely adopted for various dermatological conditions, including acne scarring and skin rejuvenation [9].

Despite the increasing popularity of microneedling for acne treatment, substantial evidence supporting its efficacy and safety profile remains limited. Consequently, there is a pressing need for thorough evaluation through systematic review and analysis of the existing literature. The current review aims to critically assess the effectiveness, safety, and potential benefits of microneedling procedures in managing acne vulgaris. By carefully reviewing, comparing, and integrating the findings of relevant studies, we aim to offer valuable insights into the role of microneedling as a therapeutic intervention for individuals with acne. This approach enhances our understanding of its position within the broader context of acne management strategies.

## 2. Materials and Methods

A comprehensive search strategy was developed to identify relevant studies published over the past decade (2014–2024), utilizing databases such as PubMed, Google Scholar, and the Cochrane Library. Keywords such as "microneedling", "acne", "acne vulgaris", "dermaroller", and "microneedling pen" were used in combination to ensure thorough research. The titles and abstracts of the retrieved studies were carefully examined to identify those with potential relevance. Following this initial screening, full-text articles were rigorously assessed against predefined inclusion criteria to determine their suitability for the review. These criteria were meticulously designed, considering factors such as study design, participant demographics, the specifics of the interventions, and the outcome measures related to microneedling procedures for acne treatment.

## 3. Microneedling in Acne Skin

### *3.1. Procedure Description*

Microneedling is a minimally invasive dermatological procedure that uses a specialized device with fine needles to create controlled micro-injuries on the skin's surface. This process stimulates the skin's natural healing response, leading to the production of collagen and elastin. The length of the needles can vary depending on the specific treatment requirements and the targeted skin condition [7,10].

Microneedling, when performed by trained healthcare professionals, is executed with meticulous precision to ensure consistency in creating microchannels across the treatment area. Typically carried out in a clinical setting, the procedure can be tailored to target

specific areas affected by acne, providing a promising approach for improving skin texture and reducing the visibility of acne scars [10].

There are several types of microneedling devices commonly used for treating acne-prone skin. Dermarollers are handheld devices featuring a cylindrical drum covered with fine needles that roll across the skin. Microneedling pens, also known as electronic microneedling devices, are motorized handheld tools that vertically oscillate fine needles into the skin at adjustable depths and speeds. Microneedling stamps are designed to target specific areas affected by acne scars or lesions [11].

Table 1 presents a detailed overview of the characteristics of the most used devices, including needle depth, application areas, and cartridge types.

**Table 1.** Overview of microneedling devices and their characteristics [10,11].

| Device Type | Needle Depth Range | Application Areas | Cartridge Types |
|---|---|---|---|
| Dermarollers | 0.2–2.5 mm | Face, neck, body (e.g., thighs, abdomen) | Cylindrical drum with multiple fine needles (stainless steel or titanium) |
| Microneedling pens | 0.25–3.0 mm | Face, neck, décolletage, body | Interchangeable needle cartridges (12, 24, 36 needles) |
| 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 can be disposable or reusable and are typically equipped with various needle cartridge options to address different treatment areas and skin concerns. The equipment used for microneedling on acne-prone skin must adhere to strict sterilization and safety protocols to minimize the risk of infection and ensure the best possible treatment outcomes [11].

### *3.2. Mechanism of Action*

Microneedling on acne-prone skin operates through a complex mechanism that addresses multiple facets of the condition. By creating controlled micro-injuries, microneedling triggers the skin's natural healing response. This process stimulates collagen remodeling, strengthening the skin's structure and reducing acne scars' visibility. The enhanced production of collagen and elastin also contributes to smoother skin texture, making microneedling an effective treatment for improving the overall appearance of acne-affected skin [10,12].

Additionally, microneedling creates micro-injuries that significantly enhance the absorption and effectiveness of topical acne treatments, allowing these products to penetrate deeper layers of the skin. These micro-injuries stimulate the skin's regenerative processes, generating new skin cells that gradually replace damaged or scarred tissue, contributing to a smoother and healthier appearance. Moreover, microneedling plays a role in normalizing sebum production by triggering a localized inflammatory response and influencing the function of sebaceous glands. This process reduces hyperactivity in the sebaceous glands, leading to a moderated output of sebum, which helps to unclog pores and reduces the proliferation of acne-causing bacteria. By promoting a more balanced sebum production, microneedling can help minimize the frequency of acne breakouts and prevent the formation of new lesions, making it an effective strategy for managing acne-prone skin [8,13].

The microchannels formed during microneedling significantly improve the absorption of topical skincare products, allowing them to penetrate deeper into the skin. This enhanced delivery system ensures that acne-fighting ingredients, such as topical antibiotics, retinoids, or anti-inflammatory agents, reach the targeted areas more effectively, thereby increasing their efficacy in treating acne [11,14].

Microneedling's mechanism on acne-prone skin involves multiple beneficial processes. These combined effects make microneedling a promising therapeutic option for individuals looking to improve acne-affected skin's appearance and overall health.

### *3.3. Protocol and Substances Used in Microneedling*

Microneedling protocols, techniques, and substances can vary depending on the treatment goals and the practitioner's expertise. Before the procedure, thorough skin cleansing is crucial to remove makeup, oils, and debris, ensuring the skin is adequately prepared. A topical numbing cream may be applied to minimize discomfort, especially during more extensive treatments. The choice of the microneedling device is carefully tailored to the patient's specific needs and the treatment area. Needle penetration depth must be precisely determined based on the skin's condition and the desired outcomes. The procedure typically involves multiple passes to ensure even coverage and consistent results. Patients should receive detailed post-care instructions, including recommended skincare routines and sun protection measures, to optimize healing and results [12,15].

Microneedling involves various techniques that utilize manual derma rollers, automated pens, or other specialized devices. Practitioners adjust their technique using vertical, horizontal, or diagonal movements, depending on the treatment area and the desired results. Gentle, consistent pressure is applied to ensure even coverage and precise needle penetration depth. At the same time, care is taken to avoid overlapping treated areas, which helps to minimize skin trauma and ensures optimal outcomes [15].

Various substances can be used in conjunction with microneedling to enhance results. Hyaluronic acid serums or growth factors are often applied before or after the procedure to hydrate the skin, stimulate collagen production, and accelerate healing. Combining microneedling with platelet-rich plasma (PRP) is another effective approach, as it further boosts collagen production and enhances overall skin rejuvenation. After the treatment, ascorbic acid (vitamin C) serums or antioxidant-rich formulations are commonly used to protect the skin from oxidative stress and support collagen synthesis. Additionally, practitioners may incorporate specialized skincare products containing peptides, retinoids, or other active ingredients to target specific skin concerns, further optimizing the benefits of microneedling [10,16].

Table 2 presents a list of substances commonly used with microneedling for acne-prone skin and their primary benefits.

**Table 2.** Substances used in microneedling for acne-prone skin [10–12].

| 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) | Boosts collagen production, enhances skin rejuvenation and accelerates healing. | 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 |

### 3.4. Limitations and Side Effects

While adverse effects from microneedling are rare, they can include temporary redness, swelling, and mild discomfort following the procedure. Achieving the best results typically requires multiple treatment sessions spaced several weeks apart, necessitating patience from the patient. The effectiveness of microneedling can vary among individuals, with some experiencing limited improvement, particularly in cases of deeper ice-pick scars. Although microneedling is effective for enhancing certain types of acne scars, improper technique or inadequate equipment sterilization can increase the risk of infection. Individuals with darker skin tones may be at risk for post-inflammatory hyperpigmentation, which can be mitigated through careful pre-treatment assessment and appropriate post-care. Severe complications such as scarring, allergic reactions, or acne flare-ups are uncommon; they may occur if the procedure is incorrectly performed or the treatment is unsuitable for the patient [17,18].

### 3.5. Benefits

Microneedling shows significant potential in treating acne-prone skin by reducing the severity of acne lesions, including inflammatory acne, comedones (blackheads and whiteheads), and acne scars. It is particularly effective in diminishing the appearance of various acne scars, such as rolling and boxcar scars, by stimulating collagen production and promoting skin regeneration. The procedure helps achieve cleaner, smoother skin while enhancing overall texture, tone, and elasticity [12,15].

It also enhances the absorption of topical skincare products, making them more effective in treating acne and promoting overall skin health. Its minimally invasive nature requires little downtime, making it an appealing option for individuals with active lifestyles [17].

However, ongoing research is crucial to refine our understanding of the optimal parameters for microneedling, such as appropriate needle penetration depth, ideal treatment frequency, and potential synergies with other therapeutic approaches. Systematic reviews and well-designed clinical trials are necessary to confirm the efficacy, safety, and long-term benefits of microneedling in managing acne.

## 4. Efficacy of Microneedling on Acne Skin

Several studies have been published supporting the effectiveness of microneedling on acne skin in the last ten years (2014–2024). Next, these studies are briefly discussed in chronological order.

Alam et al. (2014) conducted a single-center randomized clinical trial to evaluate the effectiveness of microneedling devices in diminishing acne scars. This study involved 20 healthy adults who received three microneedling treatments at 2-week intervals, with one side of the face randomly assigned for treatment. The results revealed a notable decrease in the mean scar scores in the treated group at the 6-month mark compared to baseline, with initial improvements seen at the 3-month assessment. The pain levels during the procedure were minimal, with the participants reporting an average rating of 1.08 out of 10. Moreover, the participants perceived a substantial 41% mean enhancement in their scar appearance. Notably, no adverse events were reported throughout the trial. The findings of this study present promising evidence for the efficacy of microneedling in reducing acne scars, highlighting its potential as a safe and effective acne treatment option [19].

Dogra et al. (2014) conducted a study to assess the efficacy of microneedling treatment in improving atrophic facial acne scars. A total of 36 patients, comprising 26 females and 10 males, underwent a series of five dermaroller sessions spaced one month apart, administered under topical anesthesia. This study revealed a notable decrease in the mean acne scar scores, dropping from $11.73 \pm 3.12$ at baseline to $6.5 \pm 2.71$ post-treatment. A photographic evaluation demonstrated significant improvement, with most of the patients experiencing a 50–75% enhancement. On a visual analog scale, 22 patients reported a “good response”,

while 4 reported an "excellent response". The procedure was well-tolerated overall, with only five patients experiencing post-inflammatory hyperpigmentation and two developing "tram-trek" scarring. Despite these side effects, microneedling with a dermaroller was deemed a straightforward and cost-effective method for acne scar remodulation, offering satisfactory outcomes with minimal downtime, particularly in individuals with Asian skin types [20].

El-Domyati et al. (2015) conducted a prospective clinical study to assess the effectiveness of skin microneedling in treating atrophic acne scars in 10 patients. For 3 months, the participants underwent 6 microneedling sessions at 2-week intervals. Assessments were conducted at baseline, one month, and 3 months, including photography and skin biopsies. The results revealed a noticeable clinical improvement in the acne scars, accompanied by significant increases in collagen types 1, 3, and 7, and newly synthesized collagen. Additionally, there was a decrease in elastin post-treatment. Microneedling emerged as an effective and minimally invasive procedure, requiring minimal patient recovery time and offering promising results for scar management [21].

Asif et al. (2015) investigated the effectiveness and safety of combining PRP with microneedling to treat atrophic acne scars in a cohort of 50 individuals aged 17–32. Microneedling was conducted on both of the face halves, with PRP administered on the right side and distilled water on the left side. The participants underwent three treatment sessions at monthly intervals. An evaluation utilizing Goodman's Quantitative and Qualitative scales revealed a significant improvement of 62.20% on the right and 45.84% on the left. Furthermore, Goodman's Qualitative scale demonstrated excellent or good responses in 90% of the patients on the right and 76% on the left sides. This study concluded that combining PRP with microneedling is a practical approach to managing atrophic acne scars, resulting in superior outcomes compared to microneedling alone [22].

In a study conducted by Rana et al. (2017), the efficacy of microneedling alone versus microneedling combined with 70% glycolic acid peel in managing atrophic acne scars was compared. Sixty patients were randomly assigned to two groups: one group received microneedling alone at 0, 6, and 12 weeks, while the second group received microneedling with a glycolic acid peel at 0, 6, and 12 weeks, along with additional peels at 3, 9, and 15 weeks. Acne scar scoring was conducted using ECCA (Echelle d'evaluation clinique des cicatrices d'acne) at baseline and after 22 weeks. The patients also assessed their improvement using a visual analog scale. Of the participants, 52 completed the study. The results indicated that the second group exhibited a more significant mean ECCA score reduction than the first group ($39.65 \pm 2.50$ vs. $29.58 \pm 0.18$), signifying superior scar improvement. Additionally, the second group demonstrated a more noticeable improvement in skin texture on the visual analog scale. Combining sequential 70% glycolic acid peels with microneedling resulted in superior scar improvement and enhanced skin texture compared to microneedling alone [23].

In a study conducted by Ibrahim et al. (2018) involving 35 patients with post-acne atrophic scars, the efficacy of skin microneedling alone was compared to microneedling combined with PRP. Each side of the face received four treatments sequentially, spaced 3 weeks apart. Blinded dermatologists assessed the clinical response using the Goodman–Baron grading system. Both of the treatment approaches showed significant improvement in scar severity, with no notable difference in patient satisfaction. Both microneedling alone and with PRP demonstrated satisfactory results for treating post-acne atrophic scars [24].

Al Qarqaz and Al-Yousef (2018) conducted a study targeting patients with darker skin tones to assess the efficacy of microneedling in improving the pigmentation of acne scarring, alongside evaluating overall scar enhancement and treatment safety. A total of 39 patients with skin types 3, 4, and 5 completed the study. A baseline assessment utilizing the Post Acne Hyperpigmentation Index (PAHPI) and Goodman–Baron scales was followed by microneedling treatment and subsequent evaluations. Both the PAHPI and the Goodman–Baron scales exhibited statistically significant improvement from baseline

post-treatment, with minor and transient side effects noted. Microneedling demonstrated effectiveness in addressing both acne scars and associated pigmentation issues in patients with dark skin, indicating its safety as a treatment option. However, additional sessions may have been required for optimal pigmentation improvement [25].

In a study by Ali et al. (2019) involving 60 patients with atrophic acne scars, 3 treatment groups were compared: dermapen alone, Jessner's solution peeling alone, and a combination of a dermapen and Jessner's solution. A clinical assessment utilizing the Goodman–Baron scarring grading system revealed significant improvement in the acne scars compared to the other two groups in the combined treatment group. Notably, boxcar scars showed the most prominent improvement across all the groups. Furthermore, a negative correlation was observed between scar improvement and lesion duration/age. The combined technique of a dermapen and Jessner's solution yielded the most substantial clinical improvement with the fewest sessions, followed by a dermapen alone and then Jessner's solution peeling for treating atrophic acne scars [26].

In a multicenter, open-label, randomized, prospective study conducted by Biesman et al. (2019), the effectiveness and safety of microneedling alone were compared to microneedling followed by the injection of a polymethylmethacrylate (PMMA)–collagen gel filler for correcting atrophic facial acne scars. Forty-four subjects with atrophic acne scars underwent three microneedling sessions over 12 weeks. Following this, the subjects were randomized into a treatment group receiving PMMA–collagen gel injection or a control group receiving no further treatment. The results at 24 weeks revealed a significant improvement in the acne scores for the combination treatment group compared to microneedling alone, with continued improvement noted at 36 weeks. Additionally, the treatment group exhibited notable enhancement on the Physician Global Aesthetic Improvement Scale at 24 weeks. These findings suggest that microneedling followed by PMMA–collagen gel filler injection may offer superior outcomes for correcting atrophic facial acne scars compared to microneedling alone [27].

In a study by Bhargava et al. (2019) involving 45 patients, 4 sessions of subcision and microneedling, spaced 4 weeks apart, were administered to treat acne scars. Three months after the final treatment, 95.6% of the patients showed overall improvement by at least one scar grading. Mild side effects such as erythema, edema, and transient pain lasting one to two days were reported. Patient-reported assessments revealed significant perceived improvements, with 17.8% reporting a 75–100% improvement and 24.4% reporting a 50–74% improvement. Rolling and boxcar scars exhibited more significant improvement compared to ice-pick scars. The combination treatment was well-tolerated across different skin types, with high patient satisfaction and minimal downtime observed [28].

A prospective study by Minh et al. (2019) evaluated microneedle dermaroller treatment in 31 patients with atrophic acne scars ranging from Goodman–Baron grades 2 to 4. The treatment spanned over 3 months, with assessments conducted at baseline, post-treatment, and 1–2 months afterwards. Significant improvements were observed in the Goodman–Baron grades, along with enhancements in the skin texture and reduction in hyperpigmentation. Mild side effects, such as a transient burning sensation and erythema, were reported to resolve within 1–2 days. No severe complications or post-inflammatory hyperpigmentation occurred during this study. Most of the patients (83.3%) reported reasonable satisfaction with the treatment. These findings suggest that microneedle dermaroller therapy is effective and safe for managing atrophic acne scars [29].

In a study conducted by Saadawi et al. (2019), the efficacy and safety of a glycolic acid peel, microneedling with a dermapen, and their combination, were compared in 30 patients with atrophic acne scars. The patients were randomly allocated into three groups: glycolic acid peel, microneedling, and a combination of both treatments. All the groups underwent 6 sessions at 2-week intervals. The clinical assessment involved qualitative global scar grading, quartile grading scale, and the evaluation of patient satisfaction. The results demonstrated a statistically significant reduction in acne scar grades across

all the groups, with the combination therapy group showing the highest improvement. Notably, improvement in boxcar, ice-pick, and rolling scars was observed in all of the treatment groups. Patient satisfaction was notably higher in the combination therapy group, indicating that the combination of a dermapen and a glycolic acid peel is more effective than monotherapy in treating atrophic acne scars [30].

In an open clinical trial conducted by Chalabi et al. (2020), 25 patients with grade 3 and 4 acne scars underwent 4 sessions of dermapen microneedling treatment at 6-week intervals. The results revealed a reduction in the Goodman–Baron global quantitative acne scar grading system from a mean of 16.39 $\pm$ 3.43 to 7.78 $\pm$ 2.79 at the end of the sessions. Most of the patients demonstrated moderate to good improvement in their acne scars, with an observed inverse relationship between the baseline severity score and the degree of improvement. Dermapen microneedling therapy primarily affected scar depth, followed by scar number and size. Notably, no severe complications were reported post-treatment [31].

Amer et al. (2020) conducted a study to assess the efficacy and safety of combining PRP with microneedling compared to microneedling with non-cross-linked hyaluronic acid for treating atrophic acne scars. Forty-one patients aged 20–40 underwent microneedling on both sides of their face, with PRP applied to one side and hyaluronic acid to the other. Treatment sessions were administered monthly for a total of four sessions. The results, evaluated using Goodman's Qualitative scale and quartile grading, demonstrated statistically significant improvement in acne scars with both modalities. Notably, there was no significant difference in improvement between the PRP and hyaluronic acid treatments. This study concludes that combining microneedling with either PRP or hyaluronic acid enhances clinical outcomes compared to microneedling alone, with no significant difference observed between the two modalities [32].

In an open-label, single-center study conducted by von Dalwig-Nolda and Ablon (2020), healthy individuals aged between 18 and 65 with facial atrophic acne scarring underwent four microneedling sessions spaced a month apart. Assessments were carried out at baseline and 3 months after the final treatment. Acne scars were categorized using the Jacob classification, and severity was graded using the Goodman–Baron scale. The subjects also reported redness, pain, and discomfort post-treatment. The findings revealed a significant improvement in facial acne scars by 0.91 grade on the Goodman–Baron scale three months post-treatment. Improvement was consistent across different Fitzpatrick skin types. Rolling scars exhibited the most substantial improvement, with a mean improvement of 1.06, according to the Jacob classification. This study concludes that 4 microneedling treatments spaced 4 weeks apart effectively enhance facial acne scarring with minimal pain, discomfort, and downtime, making it a well-tolerated option compared to more aggressive technologies [33].

In a study led by Casabona et al. (2021), 22 patients with a mean age of 38 $\pm$ 7.6 years participated in two or three microneedling treatment sessions to reduce their facial acne scars. Standardized scales were used to assess their acne scars before and after treatment. The results demonstrated statistically significant improvements in the appearance of acne scars, with mean improvements ranging from 1.41 to 1.66 on various assessment scales compared to baseline. Patient-reported outcomes indicated minimal discomfort, and no unexpected adverse events were reported. The study's findings suggest that microneedling treatments are safe and effective for reducing acne scarring, leading to high patient satisfaction [34].

In a retrospective cross-sectional study conducted by Tirmizi et al. (2021) spanning over 6 months, the efficacy of microneedling in treating moderate to severe-grade atrophic acne scars was evaluated. Fifty patients were enrolled and underwent three treatment sessions spaced over 4-week intervals. Using Goodman–Baron's acne scar grading system, the scar grades were assessed before and after treatment. The results revealed a decrease in scar grade from grade 3 to grade 2 post-treatment, with a significantly higher proportion of patients achieving grade 2 after treatment. Additionally, more patients with moderate

acne scars attained grade 2 compared to severe cases. While improvements were observed, the study's retrospective nature emphasizes the need for further investigation through prospective randomized controlled trials to validate the role of microneedling in acne scar reduction [35].

In a split-face comparative study conducted by Abbas et al. (2022), the efficacy of microneedling combined with topical ascorbic acid (vitamin C) was compared to topical insulin for treating atrophic post-acne scars. Thirty subjects participated, with insulin applied to one side of the face and vitamin C serum to the other. Following four treatments over one month, both sides exhibited statistically significant improvements in scar assessment scales compared to baseline. However, the side treated with vitamin C showed slightly more considerable progress. This study suggests that topical insulin and vitamin C, when paired with microneedling, can significantly improve post-acne scars. Insulin holds promise as a potential novel anti-scarring therapy, pending further large-scale controlled studies to confirm its efficacy [36].

In a study conducted by Ishfaq et al. (2022), the efficacy of microneedling was compared to 35% glycolic acid chemical peels for treating atrophic acne scars in patients with Fitzpatrick Skin Phototypes IV–VI. Sixty patients were randomized into two groups: one received microneedling every 2 weeks for 12 weeks, while the other received chemical peels every 2 weeks for the same duration. Acne scar improvement was assessed using the Goodman–Baron scarring grading system 2 weeks after the last treatment session. The results indicated that the microneedling group had significantly better outcomes, with 73.33% of the patients achieving treatment efficacy compared to 33.33% in the chemical peel group. Additionally, fewer patients in the microneedling group showed no efficacy after treatment (26.67% vs. 66.67%). This study concluded that microneedling was more effective than 35% glycolic acid peels for treating acne scars in patients with Fitzpatrick Skin Phototypes IV-VI [37].

In a study conducted by Ismail et al. (2022) comparing microneedling alone, the intradermal injection of PRP alone, and combined microneedling with PRP for treating atrophic post-acne scars, 30 adult patients were randomly assigned to 2 groups. In the first group, microneedling with PRP was administered on one side of the face, while microneedling alone was given on the other. In the second group, microneedling with PRP was performed on one side, and PRP injection alone was conducted on the other. The treatments were repeated every 3 weeks for up to 4 sessions. The evaluation before treatment and 3 weeks post-treatment showed better improvement in the group with combined microneedling and PRP, although not statistically significantly. However, compared to PRP injection alone, the second group demonstrated a significant reduction in scars on the side treated with combined microneedling and PRP. This study concludes that microneedling, PRP, and combined microneedling with PRP are effective modalities for treating atrophic post-acne scars, with combined therapy demonstrating better results and tolerance across all the scar types [38].

In a study conducted by Alqam et al. (2023), the safety and efficacy of microneedling as a treatment for acne vulgaris were evaluated. Two subjects received different treatment schedules: one group underwent 3 treatments spaced 4 weeks apart, while the other received 4 treatments spaced 2 weeks apart. Both of the groups demonstrated significant reductions in non-inflammatory and inflammatory acne lesions at the 2-month follow-up compared to baseline. The first group experienced a 48.20% reduction in non-inflammatory lesions and a 57.97% reduction in inflammatory lesions, while the second group experienced reductions of 54% and 36.67%, respectively. This study concluded that microneedling could be a well-tolerated and effective therapeutic option for acne vulgaris, with no post-treatment complications or disruption to the skin microbiome [39].

A study by Solanki et al. (2023) aimed to compare the efficacy of microneedling combined with either a 15% trichloroacetic acid (TCA) peel or a 25% pyruvic acid peel in treating atrophic acne scars. A total of 30 patients were randomized into two groups, receiving microneedling on both sides of the face at 0, 6, and 12 weeks, and either 15%

TCA or 25% pyruvic acid peels on alternate sides at 3, 9, and 15 weeks. The patients and physicians assessed the efficacy using the ECCA score and visual analog scales (VASs) at various intervals and at 21 weeks. The results showed a statistically significant reduction in the ECCA scores on both the TCA and pyruvic acid-treated sides, though the difference between the two was not significant at 21 weeks. Both of the treatments led to moderate-to-marked improvements in scar appearance, particularly in rolling and boxcar scars, with enhanced skin texture and patient satisfaction. However, no significant difference was observed between the two peel types in overall efficacy [40].

A split-face prospective interventional study was conducted by Krishnegowda et al. (2023) involving 40 patients with atrophic acne scars. On the right side of the face, autologous injectable platelet-rich fibrin (i-PRF) was injected into each scar, while normal saline was used on the left side. Both sides then underwent microneedling; 4 treatment sessions were conducted at monthly intervals, with a follow-up at 2 months post-treatment. The efficacy of the treatments was assessed using the Goodman–Baron scale, a physician's subjective score, and patient satisfaction scores. At 24 weeks, the mean Goodman–Baron grade was significantly reduced on the study side than the control side. The mean patient satisfaction score was significantly higher on the right side than the left. Among the types of scars, rolling scars showed the most improvement, followed by boxcar and ice-pick scars. Combining autologous i-PRF with microneedling provided a synergistic effect, significantly enhancing the treatment of atrophic acne scars compared to microneedling alone [41].

El-Domyati et al. (2024) evaluated the effectiveness of two different needle penetration depths in dermapen microneedling for treating atrophic post-acne scars. A split-face study was conducted involving 14 subjects with atrophic post-acne scars. Each participant underwent 6 microneedling sessions, with treatments administered every 2 weeks. The right side of the face was treated with a 2.5 mm needle length, while the left side was treated with a 1.5 mm needle length. The study found a significantly greater improvement in acne scars on the right side of the face (treated with 2.5 mm needles) compared to the left side (treated with 1.5 mm needles). Both of the sides showed enhanced collagen bundle and elastic fiber characteristics after six sessions, indicating overall improvement [42].

A study by Sadeghzadeh-Bazargan et al. (2024) aimed to assess the therapeutic outcomes of microneedling alone versus microneedling combined with 1% phenytoin cream in treating atrophic acne scars. This split-face clinical trial involved 25 patients aged 18 to 40 years. One side of the face was treated with microneedling, while the other side received microneedling, followed by the application of 1% phenytoin cream three times daily for one week post-procedure. Each patient underwent three microneedling sessions over a month. Baseline data were collected, and follow-up assessments were performed during the treatment sessions and 2 months after the last session. Evaluations included pore and spot analysis, scar severity grading, patient satisfaction, and complication monitoring. Both of the treatment groups showed significant improvement in their pore area, pore count, spot count, and area over time. The phenytoin-treated side showed significantly better outcomes in acne scar grade and patient satisfaction during all the follow-up sessions than the microneedling-only side [43].

A clinical trial by Hartmann et al. (2024) compared the effectiveness of nonablative fractional laser alone versus alternating nonablative fractional laser with microneedling and radiofrequency in treating atrophic acne scars. Twenty patients received four treatments on their split facial halves. Both of the treatment methods significantly improved their acne scars, but no significant difference was found between the two approaches. This study concluded that alternating nonablative fractional lasers with microneedling and radiofrequency is not superior to nonablative fractional lasers alone in treating atrophic acne scars [44]. Table 3 presents a chronological overview of studies from 2014 to 2024 on the application of microneedling in acne treatment.

**Table 3.** Summary of studies published between 2014 and 2024 regarding microneedling use in acne (studies are listed chronologically).

| Study | Participants | Treatment Protocol | Outcome Measures | Results |
| --- | --- | --- | --- | --- |
| Alam et al. (2014) [19]. | 20 patients | Three microneedling treatments at 2-week intervals, one side of the face treated | Mean scar scores, pain levels, perceived enhancement in scar appearance | Decrease in the mean scar scores at the 6-month mark compared to baseline; initial improvements were seen at the 3-month assessment, with a 41% mean enhancement in the scar appearance; no serious adverse events were reported |
| Dogra et al. (2014) [20]. | 36 patients | Five dermaroller sessions spaced one month apart, administered under topical anesthesia | Mean acne scar scores, improvement percentage, visual analog scale ratings | Decrease in mean acne scar scores post-treatment, 50–75% enhancement observed, 22 patients reported "good response," 4 reported "excellent response," 5 patients experienced post-inflammatory hyperpigmentation, 2 developed "tram-trek" scarring |
| El-Domyati et al. (2015) [21]. | 10 patients | Six microneedling sessions at 2-week intervals | Clinical improvement in acne scars, collagen, and elastin levels | Clinical improvement in acne scars, significant increases in collagen types 1, 3, and 7, and newly synthesized collagen |
| Asif et al. (2016) [22]. | 50 patients | Three microneedling sessions combined with PRP at monthly intervals | Improvement in acne scars assessed using Goodman's Quantitative and Qualitative scales | Significant improvement in acne scars with combined PRP and microneedling compared to microneedling alone |
| Rana et al. (2017) [23]. | 60 patients | Microneedling alone vs. microneedling with 70% glycolic acid peel | Reduction in mean ECCA score | A more significant reduction in the mean ECCA score was observed in the group receiving microneedling with the glycolic acid peel, and considerable improvement in the skin texture was observed |
| Ibrahim et al. (2018) [24]. | 35 patients | Microneedling alone vs. microneedling combined with PRP | Improvement in scar severity assessed using the Goodman–Baron grading system | Both microneedling alone and combined with PRP significantly improved scar severity, with no notable difference in patient satisfaction |
| Al Qarqaz and Al-Yousef (2018) [25]. | 39 patients | Microneedling treatment for dark skin tones | Improvement in Post Acne Hyperpigmentation Index (PAHPI) and Goodman–Baron scales | Statistically significant improvement in PAHPI and Goodman–Baron scales and minor and transient side effects were reported |
| Ali et al. (2019) [26]. | 60 patients | Dermapen alone, Jessner's solution peeling alone, or combined dermapen and Jessner's solution | Improvement in acne scars assessed using the Goodman–Baron scarring grading system | Combined treatment of dermapen and Jessner's solution yielded the most substantial clinical improvement, with a negative correlation between scar improvement and lesion duration |
| Biesman et al. (2019) [27]. | 44 patients | Microneedling alone vs. microneedling followed by injection of PMMA–collagen gel filler | Improvement in acne scores, Physician Global Aesthetic Improvement Scale ratings | Microneedling followed by PMMA–collagen gel filler injection resulted in superior outcomes for correcting atrophic facial acne scars compared to microneedling alone |

**Table 3.** *Cont.*

| Study | Participants | Treatment Protocol | Outcome Measures | Results |
|---|---|---|---|---|
| Bhargava et al. (2019) [28]. | 45 patients | Subcision and microneedling combination treatment | Overall improvement by scar grading, patient-reported assessments | 95.6% of patients showed overall improvement by at least one scar grading, mild side effects were reported, and there was high patient satisfaction and minimal downtime |
| Minh et al. (2019) [29] | 40 patients | Four microneedling sessions at 3-week intervals with PRP on one side, saline on the other | Improvement in scar appearance, patient satisfaction | Significant improvement in scar appearance on the PRP-treated side compared to the saline-treated side |
| Saadawi et al. (2019) [30] | 30 patients | Microneedling, glycolic acid peel, and combination therapy | Global scar grading, patient satisfaction | Combination therapy showed the highest improvement, with significant enhancement in boxcar, ice-pick, and rolling scars |
| Chalabi et al. (2020) [31] | 25 patients | Four dermapen microneedling sessions at 6-week intervals | Goodman–Baron global quantitative acne scar grading | Significant reduction in acne scar grading, with moderate to good improvement in most patients |
| Amer et al. (2021) [32] | 41 patients | Microneedling with PRP vs. non-cross-linked hyaluronic acid | Goodman's qualitative scale, quartile grading | Both PRP and hyaluronic acid treatments showed significant improvement, with no significant difference between the two |
| von Dalwig-Nolda and Ablon (2021) [33] | 30 patients | Four microneedling sessions spaced 4 weeks apart | Goodman–Baron scale, Jacob classification | Significant improvement in facial acne scars, particularly rolling scars, with minimal pain and discomfort |
| Casabana et al. (2021) [34] | 22 patients | Microneedling treatment sessions | Improvement in acne scars, patient satisfaction | Statistically significant improvements in acne scars; high patient satisfaction |
| Tirmizi et al. (2021) [35]. | 50 patients | Microneedling treatment for moderate to severe-grade atrophic acne scars | Decrease in scar grade from grade III to grade II | Significant decrease in scar grade post-treatment; a higher proportion of patients achieved grade II after treatment |
| Abbas et al. (2021) [36]. | 30 patients | Microneedling combined with topical vitamin C vs. topical insulin for treating atrophic post-acne scars | Improvement in scar assessment scales | Both sides exhibited statistically significant improvements in scar assessment scales compared to baseline, with slightly higher improvement observed with vitamin C treatment |
| Ishfaq et al. (2022) [37]. | 60 patients | Microneedling vs. 35% glycolic acid chemical peels | Improvement in acne scar treatment efficacy | Microneedling was more effective than 35% glycolic acid peels for treating acne scars. |
| Ismail et al. (2022) [38]. | 30 patients | Microneedling alone vs. intradermal injection of PRP vs. combined microneedling with PRP | Reduction in scars, improvement in the combined treatment group | Better improvement in combined microneedling with the PRP group compared to PRP injection alone, and no significant difference in improvement between microneedling alone and microneedling with PRP groups |
| Alqam et al. (2023) [39]. | Not specified | Microneedling for treating acne vulgaris | Reduction in non-inflammatory and inflammatory acne lesions | Significant decreases in non-inflammatory and inflammatory acne lesions at 2-month follow-up compared to baseline |

**Table 3.** *Cont.*

| Study | Participants | Treatment Protocol | Outcome Measures | Results |
|---|---|---|---|---|
| Solanki et al. (2023) [40] | 30 patients | Microneedling with 15% TCA peel vs. 25% pyruvic acid peel | ECCA score, visual analog scales | Statistically significant reduction in ECCA scores with both peels, moderate-to-marked improvement in scar appearance |
| Krishnegowda et al. (2023) [41] | 40 patients | Microneedling with injectable platelet-rich fibrin (i-PRF) on one side, saline on the other | Goodman–Baron scale, patient satisfaction scores | Significant improvement in scar grading and patient satisfaction on the i-PRF-treated side compared to the control side |
| El-Domyati et al. (2024) [42] | 14 patients | Microneedling with 2.5 mm needle vs. 1.5 mm needle | Improvement in acne scars, collagen bundle and elastic fiber characteristics | Greater improvement in acne scars with 2.5 mm needles compared to 1.5 mm needles |
| Sadeghzadeh-Bazargan et al. (2024) [43] | 25 patients | Microneedling with 1% phenytoin cream vs. microneedling alone | Acne scar grading, patient satisfaction | Significant improvement on the phenytoin-treated side compared to microneedling alone |

## 5. Discussion

The evidence from the reviewed studies indicates that microneedling is a promising therapeutic option for managing various types of acne, including atrophic and post-acne scars, across different skin types and ethnicities. Microneedling, whether used alone or in combination with adjunctive therapies such as PRP, glycolic acid peels, or topical agents like vitamin C, has shown significant improvements in acne appearance, skin texture, and overall acne severity.

Comparative studies between microneedling and other treatment modalities, such as chemical peels, consistently demonstrate favorable outcomes for microneedling, often resulting in superior scar reduction and higher patient satisfaction. Additionally, combined therapies, particularly those involving microneedling with PRP or glycolic acid peels, have exhibited enhanced efficacy compared to monotherapy, suggesting a synergistic effect that further improves scar appearance [45,46].

Moreover, microneedling is generally safe and well-tolerated, with minimal adverse effects reported across various studies. Pain during the procedure is typically low, and post-treatment complications are usually transient and manageable.

These findings support microneedling as an effective, safe, and minimally invasive treatment option for acne scars, significantly improving scar appearance and patient satisfaction. However, further large-scale randomized controlled trials are needed to establish standardized protocols, determine optimal treatment parameters, and assess the long-term efficacy and safety of microneedling in managing acne scars.

## 6. Conclusions

Microneedling demonstrates significant potential as a therapeutic option for individuals with acne-prone skin, offering notable improvements in the reduction in acne lesions and the enhancement of skin texture, particularly in the appearance of acne scars. The technique's effectiveness is further amplified when combined with adjunctive therapies such as PRP or glycolic acid peels, highlighting its versatility in tailored treatment plans. Its minimally invasive nature and favorable safety profile underscores microneedling's value in modern dermatological practice. Future research should aim to standardize treatment protocols, optimize patient outcomes, and explore long-term benefits to solidify microneedling's role in comprehensive acne management strategies.

**Author Contributions:** Conceptualization, Ș.E.M. and G.H.; methodology, G.H.; validation, Ș.E.M., G.H. and A.R.; formal analysis, Ș.E.M.; investigation, Ș.E.M.; data curation, Ș.E.M., G.H. and A.R.; writing—original draft preparation, Ș.E.M., G.H. and A.R.; writing—review and editing, Ș.E.M., G.H.

and A.R.; visualization, Ș.E.M.; supervision, G.H.; project administration, G.H.; funding acquisition, G.H. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research received no external funding.

**Conflicts of Interest:** The authors declare no conflicts of interest.

## References


1. Eichenfield, D.Z.; Sprague, J.; Eichenfield, L.F. Management of acne vulgaris: A review. *JAMA* **2021**, *326*, 2055–2067. [CrossRef]
2. Heng, A.H.S.; Chew, F.T. Systematic review of the epidemiology of acne vulgaris. *Sci. Rep.* **2020**, *10*, 5754. [CrossRef] [PubMed]
3. Akl, E.M.; Ibrahim, S.E.; Fouad, N.A.; Mowafy, E.A. Etiopathogenesis of Acne Vulgaris. *Benha J. Appl. Sci.* **2024**, *9*, 7–10. [CrossRef]
4. Habeshian, K.A.; Cohen, B.A. Current issues in the treatment of acne vulgaris. *Pediatrics* **2020**, *145*, S225–S230. [CrossRef] [PubMed]
5. Leung, A.K.; Barankin, B.; Lam, J.M.; Leong, K.F.; Hon, K.L. Dermatology: How to manage acne vulgaris. *Drugs Context* **2021**, *10*, 2021-8-6. [CrossRef] [PubMed]
6. Hazarika, N. Acne vulgaris: New evidence in pathogenesis and future modalities of treatment. *J. Dermatol. Treat.* **2021**, *32*, 277–285. [CrossRef] [PubMed]
7. Ramaut, L.; Hoeksema, H.; Pirayesh, A.; Stillaert, F.; Monstrey, S. Microneedling: Where do we stand now? A systematic review of the literature. *J. Plast. Reconstr. Aesthet. Surg.* **2018**, *71*, 1–14. [CrossRef]
8. Iriarte, C.; Awosika, O.; Rengifo-Pardo, M.; Ehrlich, A. Review of applications of microneedling in dermatology. *Clin. Cosmet. Investig. Dermatol.* **2017**, *10*, 289–298. [CrossRef]
9. Fernandes, D. A short history of skin needling. In *Microneedling: Global Perspectives in Aesthetic Medicine*; Shiffman, M., Ed.; Springer: Cham, Switzerland, 2021; pp. 10–21.
10. Alster, T.S.; Graham, P.M. Microneedling: A review and practical guide. *Dermatol. Surg.* **2018**, *44*, 397–404. [CrossRef]
11. Singh, A.; Yadav, S. Microneedling: Advances and widening horizons. *Indian Dermatol. Online J.* **2016**, *7*, 244–254.
12. Mujahid, N.; Shareef, F.; Maymone, M.B.; Vashi, N.A. Microneedling as a treatment for acne scarring: A systematic review. *Dermatol. Surg.* **2020**, *46*, 86–92. [CrossRef] [PubMed]
13. Majid, I.; Sheikh, G.; September, P.I. Microneedling and its applications in dermatology. *Prime Int. J. Aesthet. Anti-Ageing Med. Healthc.* **2014**, *4*, 44–49.
14. Khare, N.; Shende, P. Microneedle system: A modulated approach for penetration enhancement. *Drug Dev. Ind. Pharm.* **2021**, *47*, 1183–1192. [CrossRef]
15. Juhasz, M.L.; Cohen, J.L. Microneedling for the treatment of scars: An update for clinicians. *Clin. Cosmet. Investig. Dermatol.* **2020**, *13*, 997–1003. [CrossRef]
16. Chu, S.; Foulad, D.P.; Mesinkovska, N.A. Safety profile for microneedling: A systematic review. *Dermatol. Surg.* **2021**, *47*, 1249–1254. [CrossRef]
17. Villani, A.; Annunziata, M.C.; Luciano, M.A.; Fabbrocini, G. Skin needling for the treatment of acne scarring: A comprehensive review. *J. Cosmet. Dermatol.* **2020**, *19*, 2174–2181. [CrossRef]
18. Gowda, A.; Healey, B.; Ezaldein, H.; Merati, M. A systematic review examining the potential adverse effects of microneedling. *J. Clin. Aesthet. Dermatol.* **2021**, *14*, 45–51. [PubMed]
19. Alam, M.; Han, S.; Pongprutthipan, M.; Disphanurat, W.; Kakar, R.; Nodzenski, M.; West, D.P. Efficacy of a needling device for the treatment of acne scars: A randomized clinical trial. *JAMA Dermatol.* **2014**, *150*, 844–849. [CrossRef]
20. Dogra, S.; Yadav, S.; Sarangal, R. Microneedling for acne scars in Asian skin type: An effective low-cost treatment modality. *J. Cosmet. Dermatol.* **2014**, *13*, 180–187. [CrossRef]
21. El-Domyati, M.; Barakat, M.; Awad, S.; Medhat, W.; El-Fakahany, H.; Farag, H. Microneedling therapy for atrophic acne scars: An objective evaluation. *J. Clin. Aesthet. Dermatol.* **2015**, *8*, 36–42.
22. Asif, M.; Kanodia, S.; Singh, K. Combined autologous platelet-rich plasma with microneedling versus microneedling with distilled water in the treatment of atrophic acne scars: A concurrent split-face study. *J. Cosmet. Dermatol.* **2016**, *15*, 434–443. [CrossRef]
23. Rana, S.; Mendiratta, V.; Chander, R. Efficacy of microneedling with 70% glycolic acid peel vs. microneedling alone in treatment of atrophic acne scars—A randomized controlled trial. *J. Cosmet. Dermatol.* **2017**, *16*, 454–459. [CrossRef] [PubMed]
24. Ibrahim, M.K.; Ibrahim, S.M.; Salem, A.M. Skin microneedling plus platelet-rich plasma versus skin microneedling alone in the treatment of atrophic post-acne scars: A split-face comparative study. *J. Dermatol. Treat.* **2018**, *29*, 281–286. [CrossRef] [PubMed]
25. Al Qarqaz, F.; Al-Yousef, A. Skin microneedling for acne scars associated with pigmentation in patients with dark skin. *J. Cosmet. Dermatol.* **2018**, *17*, 390–395. [CrossRef] [PubMed]
26. Ali, B.; ElMahdy, N.; Elfar, N.N. Microneedling (Dermapen) and Jessner's solution peeling in treatment of atrophic acne scars: A comparative randomized clinical study. *J. Cosmet. Laser Ther.* **2019**, *21*, 357–363. [CrossRef] [PubMed]
27. Biesman, B.S.; Cohen, J.L.; DiBernardo, B.E.; Emer, J.J.; Geronemus, R.G.; Gold, M.H.; Teller, C.F. Treatment of atrophic facial acne scars with microneedling followed by polymethylmethacrylate-collagen gel dermal filler. *Dermatol. Surg.* **2019**, *45*, 1570–1579. [CrossRef]

28. Bhargava, S.; Kumar, U.; Varma, K. Subcision and microneedling as an inexpensive and safe combination to treat atrophic acne scars in dark skin: A prospective study of 45 patients at a tertiary care center. *J. Clin. Aesthet. Dermatol.* **2019**, *12*, 18–23.
29. Minh, P.P.T.; Bich, D.D.; Van, T.N.; Khang, T.H.; Gandolfi, M.; Satolli, F.; Lotti, T. Microneedling therapy for atrophic acne scar: Effectiveness and safety in Vietnamese patients. *Open Access Maced. J. Med. Sci.* **2019**, *7*, 293–297. [CrossRef]
30. Saadawi, A.N.; Esawy, A.M.; Kandeel, A.H.; El-Sayed, W. Microneedling by dermapen and glycolic acid peel for the treatment of acne scars: Comparative study. *J. Cosmet. Dermatol.* **2019**, *18*, 107–114. [CrossRef]
31. Al Chalabi, Q.S.; Al Malah, M.N.; Al Badrani, H.B. Rejuvenation of severe acne scars by microneedling. *Eur. J. Mol. Clin. Med.* **2020**, *7*, 2020–2026.
32. Amer, A.; Elhariry, S.; 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*, e14457. [CrossRef]
33. Von Dalwig-Nolda, D.F.; Ablon, G. Safety and effectiveness of an automated microneedling device in improving acne scarring. *J. Clin. Aesthet. Dermatol.* **2020**, *13*, 17–23.
34. Casabona, G.; Alfertshofer, M.G.; Kaye, K.O.; Frank, K.; Mercado-Perez, A.; Hargiss, J.B.; Cotofana, S. Safety and efficacy of microneedling technology in the treatment of acne scars. *J. Cosmet. Dermatol.* **2021**, *20*, 3482–3491. [CrossRef]
35. Tirmizi, S.S.; Iqbal, T.; Mansoor, M.; Farooq, N.; Ather, S.; Fatima, F.; Hashmi, A.A. Role of microneedling in atrophic post-acne scars: An experience from a tertiary care hospital. *Cureus* **2021**, *13*, e12718. [CrossRef]
36. Abbas, M.A.M.; Elgamal, E.E.A.E.; Zaky, M.S.; Elsaie, M.L. 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*, e15376. [CrossRef] [PubMed]
37. Ishfaq, F.; Shah, R.; Sharif, S.; Waqas, N.; Jamgochian, M.; Rao, B. A comparison of microneedling versus glycolic acid chemical peel for the treatment of acne scarring. *J. Clin. Aesthet. Dermatol.* **2022**, *15*, 48–55.
38. Ismail, S.A.; Khella, N.A.; Abou-Taleb, D.A. 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*, e15925. [CrossRef] [PubMed]
39. Alqam, M.L.; Jones, B.C.; Hitchcock, T.M. Study to determine the safety and efficacy of microneedling as an effective treatment for acne vulgaris. *Ski. Health Dis.* **2023**, *3*, e264. [CrossRef] [PubMed]
40. Solanki, B.; Relhan, V.; Sahoo, B.; Sarkar, R.; Choudhary, P. Microneedling in combination with 15% trichloroacetic acid peel versus 25% pyruvic acid peel in the treatment of acne scars. *Dermatol. Surg.* **2023**, *49*, 155–160. [CrossRef]
41. Krishnegowda, R.; Pradhan, S.N.; Belgaumkar, V.A. 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*, 938–942. [CrossRef]
42. El-Domyati, M.; Moftah, N.H.; Ahmed, A.M.; Ibrahim, M.R. Evaluation of microneedling depth of penetration in management of atrophic acne scars: A split-face comparative study. *Int. J. Dermatol.* **2024**, *63*, 632–638. [CrossRef] [PubMed]
43. Sadeghzadeh-Bazargan, A.; Pashaei, A.; Ghassemi, M.; Dehghani, A.; Shafiei, M.; 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. *Ski. Res. Technol.* **2024**, *30*, e13766. [CrossRef] [PubMed]
44. Hartman, N.; Loyal, J.; Borsack, S.; 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*, 81–85. [CrossRef] [PubMed]
45. Meghe, S.R.; Madke, B.; Singh, A.; Kashikar, Y.; Rusia, K. Microneedling with PRP for acne scars: A new tool in dermatologist arsenal—A scoping review. *J. Pharm. Bioallied Sci.* **2024**, *16*, S1417–S1419. [CrossRef] [PubMed]
46. Li, H.; Jia, B.; Zhang, X. Comparing the efficacy and safety of microneedling and its combination with other treatments in patients with acne scars: A network meta-analysis of randomized controlled trials. *Arch. Dermatol. Res.* **2024**, *316*, 505–517. [CrossRef]


**Disclaimer/Publisher's Note:** The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.