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Review Article

Microneedling for Medical and Aesthetic Purposes: Current Indications and New Advances

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Abstract

Microneedling has become a valuable tool in dermatology, offering a non-surgical option to treat various skin conditions. The procedure creates microchannels in the skin, triggering the release of growth factors and promoting non-fibrotic skin remodeling. The current utilities for microneedling include treating wrinkles, scars, stretch marks, pigmentation disorders, warts, skin texture issues, rosacea, and hair regrowth. Multiple studies have shown its efficacy in improving these conditions, with significant improvements in patient assessments. However, further research is needed to optimize protocols and determine the ideal needle size, frequency, and interval between treatments for the best clinical outcomes for subjects. Through their novel research, clinicians have made significant advancements in microneedling, expanding its uses, and revolutionizing its application. Despite previous beliefs, microneedling can effectively treat active acne lesions without exacerbating the condition. It has also shown promise in treating facial spider veins, providing comparable efficacy to other methods with a better safety profile. Initiating microneedling treatment at an earlier stage for surgical scars improves outcomes compared to waiting for scar maturation. Microneedling combined with topical agents has shown positive results in treating gingival hyperpigmentation. Its expanding applications and recent advancements highlight the potential benefits of integrating microneedling into clinical practice.

Keywords: Acne scars; Aesthetics; Androgenetic alopecia; Dermatology; Dyschromia; Microneedling; Skin-remodeling; Stretch marks; Surgical scars

Introduction

In recent years, microneedling has become a valuable tool in dermatology, offering a non-surgical option for individuals seeking skin rejuvenation and improvement to address various aesthetic or medical concerns [1-4]. The procedure relies on controlled physical trauma, where needles penetrate into the skin generating micro-channels, creating minimal epidermal damage, and stimulating dermis regeneration. This process triggers the release of growth factors and the recruitment of platelets and neutrophils to induce the natural wound-healing cascade leading to non-fibrotic skin remodeling [5,6].

The applications of microneedling have expanded beyond aesthetic indications such as acne scars, surgical scars, stretch marks, and fine line and wrinkles into treating various dermatological conditions [2,7]. Clinical trials have demonstrated its effectiveness in treating pigmentation disorders [2]. Additionally, microneedling has gained attention as a potential treatment for hair pathology by stimulating stem cells in the dermal papilla, increasing blood flow to hair follicles, and recruiting growth factors and signaling pathways involved in hair growth [8].

With proven high efficacy outcomes, a favorable safety profile, and minimal post-treatment recovery time, microneedling has granted clinicians a result-oriented gold standard in aesthetics before opting for more invasive procedures. High patient satisfaction rates in clinical studies have raised awareness amongst new patients intending to pursue an aesthetic procedure. With the rise in demand for non-surgical or minimally invasive procedures, microneedling has become integral to treating facial and neck rhytides and acne scarring correction [9]. This literature review aims to explore the latest advancements and current applications of microneedling, specifically for practitioners seeking to integrate this procedure into their practice. The review will focus on identifying innovations and developments that have emerged since the previous review.

Methods

The studies included in this review were collected through comprehensive searches conducted on databases such as PubMed, MEDLINE, and google scholar, as well as electronic journals specializing in dermatology. The search terms utilized for this review encompassed “microneedling,” “collagen induction,” “reviews,” “trials,” and “case reports.”

Mechanism of Action and Current Microneedling Devices

Microneedling has been studied to investigate its mechanism of action. This controlled injury initiates the natural wound-healing cascade in the deeper layer of the dermis, involving inflammation, proliferation, and remodeling [3,4,10]. It is understood that microneedling atrophic acne scars disrupts the collagen bundles in the top layer of the skin while simultaneously triggering the production of new collagen, elastin, and skin remodeling [2,7,11]. In wrinkled skin, microneedling promotes skin remodeling and the formation of a robust extracellular matrix [2,12]. Pinpoint bleeding during microneedling leads to forming a fibronectin matrix, which serves as a scaffold for the deposition of non-fibrotic tissue during the skin remodeling process.

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The micro-injury caused by microneedling triggers release of growth factors such as platelet-derived growth factor, fibroblast growth factor, and transforming growth factor. These growth factors stimulate the proliferation and migration of fibroblasts, leading to neovascularization and neocollagenesis [2,5,6]. Studies have shown that undergoing multiple microneedling sessions increases collagen deposition during the skin remodeling process, resulting in a normal and organized lattice structure [2,10,13,14].

Additionally, analysis has revealed the downregulation of pro-inflammatory cytokines [3]. This indicates that microneedling treatment suppresses the production of these inflammatory molecules, which are typically associated with inflammation and tissue damage. A key feature of non-fibrotic skin remodeling initiated by microneedling could be attributed to the downregulation of pro-inflammatory cytokines. This downregulation can help create a more favorable environment for collagen synthesis and remodeling, leading to improved skin texture and appearance.

An alternative theory for the mechanism of action proposes that the wounds created by microneedling are exceptionally small and cannot be classified as true wounds, thereby not activating the usual repair mechanisms. Instead, this theory suggests that the presence of the needles near cell membranes induces a change in the membrane's electrical potential [15]. Thus, triggering the release of growth factors into the extracellular matrix, promoting the migration of fibroblasts and the induction of collagen production.

Multiple microneedling devices are on the market, with the first automated microneedling pen cleared by the US FDA in 2018 (SkinPen Precision medical device, Crown Aesthetics, Dallas, Texas). Automated pens have gained popularity as an alternative to standard roller drum devices. They utilize single-use, sterile disposable cartridges, eliminating the risk of contamination that arises from multiple uses of rolling devices. Additionally, electric pens create significantly more microchannels due to their efficient and precise operation. To ensure the best possible clinical results for patients, it is crucial to adjust the needle depths based on the precise location, skin thickness, and the condition being treated. Not all automated pens are equal in their performance. A previous study discovered that when a device was configured with a needle length of 3mm, its actual penetration into the skin reached only a depth of 1.5 to 2 mm [2].

Current Indications

Microneedling effectively treats various skin concerns, including facial wrinkles, scars and stretch marks, pigmentation disorders, and androgenetic alopecia. Multiple studies have demonstrated the efficacy of microneedling for improving the appearance of wrinkles, with significant improvements observed in wrinkle assessments and global aesthetic improvement [3,4,10]. To achieve optimal results, patients are advised to undergo a series of 3 to 6 microneedling sessions, spaced biweekly or monthly [2-4,11]. For scars and stretch marks, microneedling has been shown to improve their appearance and texture significantly. Patients with facial and non-facial scars of different origins (acne, trauma, surgery) experienced substantial improvement, with over 80% of patients showing a 50-75% improvement and 65% demonstrating over 75% improvement [16]. Stretch marks also showed reduction after multiple microneedling sessions, with some patients experiencing a 51% to 100% reduction in appearance after three treatments [11,17]. In treating pigmentation disorders such as melasma and periorbital hyperpigmentation, microneedling has shown promise. Combining microneedling with topical agents has resulted in better treatment responses than skin-lightening agents alone. Significant improvement has been observed in patient assessments, and the treatment is generally well-tolerated with transient side effects [7,18]. Minimal damage to the epidermis limits the risks of post inflammatory hyperpigmentation compared to other aesthetic procedures. In addition, implementing adequate pre microneedling use of sunscreen at least a few weeks prior to treatment is highly recommended when managing pigment disorders.

Vitiligo is a complex skin condition that causes the loss of pigmentation, resulting in the appearance of depigmented macules on the skin. Finding an effective vitiligo treatment has proven challenging, primarily due to the incomplete understanding of its exact cause. However, it is widely believed to be an autoimmune disorder. It's important to note that the effectiveness of treatment can vary from person to person, and the choice of treatment often depends on the extent of vitiligo, the person's preference, and the potential side effects of the treatment. Combination therapies with topical agents and UV light therapy have shown significant repigmentation of vitiligo lesions, while adding microneedling to another combination therapy did not yield improved outcomes [18-20].

Microneedling has been found to promote hair growth by increasing certain proteins and improving blood flow to the hair follicles. When combined with topical solutions like minoxidil, growth factors, or platelet-rich plasma, microneedling has shown significant hair regrowth in individuals with alopecia [15].

Microneedling also enhances transdermal drug delivery by creating pores in the skin. This has been observed in studies where topical agents, such as lidocaine-prilocaine anesthetics, were more effectively absorbed after microneedling [11,18]. When comparing the effectiveness of a single bleomycin injection against microneedling and bleomycin combination for treating warts, it was observed that the combination approach resulted in a higher clearance rate of 83.3% in contrast to the injection. Suggesting that microneedling could have played a significant role in enhancing the absorption of bleomycin [21]. Although studies have shown the efficacy of microneedling in treating the above conditions, further research is necessary to optimize microneedling protocols. This includes investigating the optimal size of the microneedles and determining the ideal frequency and interval between treatments. Conducting more well-controlled randomized trials with larger sample sizes is crucial to establish stronger evidence and draw more reliable conclusions. These studies will contribute to refining microneedling techniques and providing clearer guidelines for its use in clinical practice. The latest comprehensive review on microneedling for treating the mentioned indications was published in 2017 [11], and Table 1 provides a summary of publications covering these indications from 2018 to 2023.

New Directions

There is a growing trend among clinicians to expand the utilization of microneedling beyond its current indications. This shift is accompanied by a reevaluation of previously held misconceptions regarding the appropriate timing and application of microneedling. Notably, microneedling extends beyond dermatology and finds relevance in other fields, such as dentistry. This broader perspective highlights the versatility of microneedling and its potential benefits across various medical disciplines. As a result, the understanding and application of microneedling are undergoing significant changes, driven

Indication	Author	Year	Sample Size	Device	Needle Depth	Treatment Number (Interval)	Study Aim	Primary Outcome Results	Adverse Events
Skin Rejuvenation									
Fine lines and wrinkles	Alqam, et al.	2022	30 Female 2 Males	Electric Pen	Up to 2.5mm	4 (1 month)	This study aimed to evaluate the effectiveness of microneedling in reducing wrinkles	The assessment of wrinkles revealed significant improvement in the face areas after microneedling	No unanticipated adverse events were reported throughout the course of this study
Fine line and wrinkles	Alqam,et al.	2022	30 Female 2 Males	Electric Pen	Up to 2.5mm	4 (1 month)	The study aimed to evaluate the effectiveness of microneedling in treating wrinkles of the neck	Subjects treated had significantly improved neck wrinkles ($p < 0.001$)	No unanticipated adverse events were reported throughout the course of this study
Fine line and wrinkles	Wamsley, et al.	2020	30 females 2 Males	Electric Pen	Up to 2.5mm	4 (1 month)	The study aimed to evaluate the effectiveness of microneedling in reducing fine lines and wrinkles on the face	After microneedling treatment, there were significant improvements observed in fine lines and wrinkles. Facial dermal and epidermal density increased compared to baseline	No unanticipated adverse events were reported throughout the course of this study
Fine line and wrinkles	Maia, et al.	2021	30 Females	Dermaroller	1.5mm	2 (1 month)	A study of the effects of microneedling combined with the application of topical actives (growth factors) for facial rejuvenation	Subjects showed positive clinical outcomes in the 2D photographic analysis	No unanticipated adverse events related to treatment were reported in this study
Fine line and wrinkles	Merati, et al.	2020	20 Females	Electric Pen	.5mm	3 (1 month)	A randomized controlled trial to assess the effectiveness of combining microneedling with a new regenerative complex (growth factor) for skin rejuvenation	The microneedling + active topical group showed significantly greater skin texture improvement than the control group	No treatment associated unanticipated adverse events were reported
Fine line and wrinkles	Amer, et al.	2018	20 Females 8 Males	Electric Pen	1mm	6 (2 weeks)	To assess if microneedling effectively treats wrinkles in cigarette smokers and aged skin	The study revealed a statistically significant overall improvement in skin texture and tightness in all patients.	No treatment associated unanticipated adverse events were reported
Fine line and wrinkles	Yusharyahya, et al.	2023	30 Females	Electric Pen	2mm	2 (2 weeks)	A study to compare the effectiveness of microneedling and a laser in delivering stem cells for the treatment of aging skin	Both the microneedling and laser groups showed significant improvements in wrinkles. However, the laser group reported lower comfort levels than the microneedling group	No unanticipated adverse events were documented in this study apart from erythema, pain, burning, and itching which are considered to be anticipated events
Fine line and wrinkles	El-Domyati, et al.	2018	24 Females	Dermaroller	1mm	6 (2 weeks)	A study to compare the effectiveness of combining microneedling with either PRP or TCA peel for facial rejuvenation	Combining microneedling with PRP or TCA resulted in significant improvement alone. The combination of microneedling+PRP showed better improvement in dermal structures compared to microneedling+TCA	No treatment associated unanticipated adverse events were reported

Scars and stretch marks									
All scars	Alster, et al.	2020	101 Females 19 Males	Electric Pen	2.5-3mmm	6 (1 month)	Patients with facial and non-facial scars received treatment without any additional topical or intralesional treatments	Microneedling treatments significantly improved all types of scars, with an average of 2.5 treatments needed for a minimum of 50% improvement. Most patients (80%) experienced 50-75% improvement, and 65% of patients demonstrated over 75% improvement, with no notable differences observed based on scar location or type.	Transient anticipated events documented. Unanticipated events: uncommon purpura formation (4.2%) and HSV reactivation (2.1%). Cases of uncommon purpura resoloved within 1 week without intervention, further HSV reactivation prevented by introducing anti-viral preventative treatment.
All facial Scars	Bandral, et al.	2019	50 Patenits	Derma-roller	1.5mm	4	A study aimed to assess the effectiveness microneedling of in treating facial scars caused by acne, trauma, and surgery	Out of the 50 patients, 14% showed excellent response, 52% had a good response, 28% had a fair response, and 6% had a poor response to MN	No unanticipated adverse events were documented in this study
Atrophic acne scars	Ali, et al.	2019	60 Patients	Electric Pen	2.5mm	Group I: 4-8 sessions Group II: 5-9 sessions Group III: 3-6 sessions	Patients were divided into three equal groups. Group I received microneedling alone, Group II received a chemical peel, and Group III received a combination	The combination treatment demonstrated a significant clinical improvement compared to other treatments	No unanticipated adverse events were documented in this study
Atrophic acne scars	Pakla-Misiur, et al.	2020	120 patients	Electric Pen	2mm	4 (20 days)	Evaluate the effectiveness of three treatments for atrophic post-acne scars: MN alone, CP, and a combination of both	Among the treatment groups, the MN + CP group showed the most improvement	No major treatment related side effects were observed
Atrophic acne scar	Albalat, et al.	2022	24 Females 6 Males	Electric Pen	1.5mm	4 (1 month)	Subjects with acne scars, MN combined with platelet-rich plasma was applied to the right side of the face while MN combined with Botox was applied to the left side	Both sides observed of statistically significant improvement in the qualitative global scarring grading system	Neither group experienced unanticipated adverse events
Atrophic acne scars	Von Dalwig-Nolda	2020	56 Patients	Electric Pen	1.4mm	4 (1 month)	This single-center, open-label study involved subjects with facial atrophic acne scarring. The primary endpoint was to demonstrate a significant reduction in acne scarring severity according to the GBG scale	There was a significant improvement in acne scarring according to the Goodman and Baron grading scale, with 85.1% of subjects experiencing some reduction in scarring	Anticipated reactions were documented and 4 were unanticipated; three of the four were attributable to the device, including headache (n=2) and excessive bleeding of the treatment area two days post intervention (n=1). One event, fever and rigors was not attributable to the device

Scars and stretch marks									
Stretch marks	Saki, et al.	2021	38 Females 2 Males	Electric Pen	2.5mm	4 (1 month)	One side of the selected striae was treated with a CO2 fractional laser, while the other side was treated with microneedling using an electric pen	In the microneedling group, there was a significant decrease in the median cross-section of the largest striae from 1.9 cm to 1.4 cm (P-value <0.001)	No significant unanticipated events were documented
Stretch marks	El-Razek, et al.	2022	20 Patients	Not given	Not given	6 (2weeks)	The study involved a cohort of 20 patients with stretch marks, ranging from 17 to 45 years old	Most patients experienced a clinical improvement in texture pigmentation reduction, and a decrease in the length and width of stretch marks	No known adverse events recorded
Stretch marks	de Oliveira Costa, et al.	2019	18 Patients	Electric Pen	Not given	4	A three group study to determine the effectiveness of 5-FU alone, intralesional 5-FU or in combination with MN for treating white SM	Combination therapy resulted in 10% excellent improvement, 10% very good, and 60% mild improvement	Group treated with 5-FU had hyperpigmentation 30 days pots MN (100%) with complete resolution before the end of the study. In patients treated with microneedling 5-FU, 80% showed hyperpigmentation on day 30, 50% on day 90 and 10% maintained this adverse effect until the end of the study
Stretch marks	Mazzella et al.	2019	10 Females	Electric Pen	1mm	3 (4 weeks)	The study aimed to evaluate the effectiveness of MN alone and injecting HA treatment for SM	All patients demonstrated aesthetic improvements well documented by the photographs taken before and after both treatments	No adverse events were reported
Stretch marks	Naspolini, et al.	2019	20 Females	Dermaroller	2.5mm	5 (1 month)	A study to compare the effectiveness of a NAFL and MN for treating white SM	Both modalities showed improvement in the appearance of SM, with no significant difference between them	No unanticipated adverse events were reported
Stretch marks	Soliman, et al.	2019	28 Females 5 Males	Dermaroller	2mm	3 (1 month)	Compare the effectiveness of C02 laser and MN for treating SM	MN had 55% improvement, and laser had 76% improvement, but with post-inflammatory hyperpigmentation	PIH occurred in 11 subjects in the CO2 laser group, it resolved by the end of the study.

Pigment Disorder									
Melasma	Gupta, et al.	2018	24 Females 6 Male	Derma-roller	1.5mm	3 (1 month)	A prospective randomized study to compare how effective TA is when administered through microneedling	Although the oral TA group had a slightly higher MASI score reduction than the NN+TA group, the difference was not statistically significant	No significant adverse events were reported
Melasma	Menon, et al.	2019	30 Females	Derma-roller	1.5mm	2 (1 month)	This split-face study involved melasma patients who underwent MN + TA on the left side and MN+ Vitamin C on the right side	Both groups showed improvement in MASI. Improvement was slightly higher with MN+TA compared to MN+Vitamin C	No significant adverse events related to treatment were documented
Melasma	Ismail, et al.	2018	30 Females	Derma-roller	1.5mm	6 (2 weeks)	To assess the impact of microneedling with topical vitamin C on melasma treatment	The mean MASI score decreased from 8.61 ± 4.45 in the first session to 5.75 ± 4.16 in the last session ($P < 0.0001$)	No significant adverse events related to treatment were documented
Melasma	Cassiano, et al.	2019	10 Females	Derma-roller	1.5mm	1	An experimental trial included individuals with facial melasma who were assessed at the beginning and after 7 days of the treatment	A notable decrease in melanin density, pendulous melanocytes, and basement membrane damage was observed per histological field, indicating significant improvement	Not noted
Melasma	Saleh, et al.	2019	42 Females	Electric Pen	1.5mm	6 (2 weeks)	Patients were divided into two groups. Group I received an MN+TA application, while Group II received MN alone	The mean MASI score was significantly decreased in both groups, with statistically significant higher reduction scores in group I compared with group II	No unanticipated adverse events were documented
Melasma	Kaur, et al.	2020	32 Females 8 Males	Derma-roller	1mm	4 (2 weeks)	A split-face, prospective, randomized, open-label MN study was performed on both sides. One side received a 10% TA solution, while the other received distilled water as a control	The test side of the face exhibited a significant improvement in the mean mMASI score, with a 65.92% improvement compared to the control side	Systemic symptoms such as abdominal pain or discomfort, joint pains, muscle ache, fever, unusual bleeding, unusual tiredness, and menstrual cycle abnormality in women were noted

Pigment Disorder									
Melasma	Farag, et al.	2021	30 Females	Electric Pen	.25-.5mm	12 (weekly)	A split-face study involved patients with melasma receiving microneedling sessions followed by topical methimazole on the right side of the face and a placebo on the left side	Significant clinical and dermoscopic improvements were observed in patients who received methimazole treatment on the right side of their face, as indicated by decreased hemi-MASI scores ($p<0.001$)	PIH observed in one patient
Vitiligo	Ibrahim, et al.	2018	13 Females and 12 Males	Electric Pen	.25-.5mm	12 (6 months)	A study to assess the effectiveness of MN+tacrolimus compared to MN+calcipotriol and betamethasone for treating vitiligo	In the MN+calcipotriol and betamethasone group, 60% of the patients showed improvement, while 32% showed improvement in the second group	No significant adverse events were noted
Vitiligo	El-Zeftawy	2019	12 Females 8 Males	Electric Pen	.5-1mm	2 x week (3 months)	Compare the effectiveness of combined NB-UVB phototherapy + MN with NB-UVB phototherapy alone for vitiligo treatment	NB-UVB+MN showed a significantly higher mean percentage of improvement compared to NB-UVB alone.	Not noted
Vitiligo	Giorgio, et al.	2019	10 Patients	Derma-roller	.2-2mm	2 x week (3 months)	An open, randomized, double-arm study to investigate the effectiveness of microneedling and PDT for treating vitiligo	A notable percentage of patients in the MN group experienced complete repigmentation in the treated area	No adverse events reported
Vitiligo	Khashaba, et al.	2018	60 Patenits	Electric Pen	Not given	4x (3 months)	The study compares the effectiveness of MN+topical steroids alone or combined with NB-UVB versus NB-UVB alone as a standard treatment	MN alone resulted in a good-to-excellent response in 45% of cases while combining needling with NB-UVB increased this percentage to 70%	Not noted
Vitiligo	Feily, et al.	2020	10 Females 10 Males	Electric Pen	1.5 to 2mm	2 (1 month)	In this prospective pilot study, follicular grafts were taken from the scalp and transplanted in a grid pattern. The left-sided lesions were treated with fractional CO2 laser, while the right-sided lesions were treated with microneedling	Repigmentation measurements at different time points showed slightly greater results with hypofractionated CO2 laser than microneedling, but the differences were not statistically significant	No significant adverse events were observed
Vitiligo	Salem, et al.	2022	14 Femaels 11 Males	Electric Pen	.5-1mm	12 (6 months)	A prospective comparative clinical trial included patients with stable vitiligo and at least two patches. One patch was treated with MN alone, while the other received a combination of MN + topical cholecalciferol.	Repigmentation was observed in 52% of the patches treated with microneedling combined with topical cholecalciferol, compared to 40% of the patches treated with microneedling alone	No significant adverse events noted
Vitiligo	Ebrahim, et al.	2019	90 Patients	Electric Pen	1.5-2mm	12 (6 months)	Determine the effectiveness of combining MN with tacrolimus versus using MN alone or tacrolimus 0.1% ointment for treating localized and stable vitiligo	The combined group demonstrated a significantly higher overall improvement rate (76.6%) than the other groups	No unanticipated adverse reactions were recorded

Alopecia									
AA	Ali, et al.	2022	13 Females and 12 Males	Electric Pen	1.5-2mm	6 (1 month)	Determine the effectiveness of MN combined with topical vitamin D3 or bimatoprost, compared to MN alone, for treating AA	The vitamin D and bimatoprost groups showed significantly higher hair regrowth than the MN alone group	No unanticipated adverse reactions were recorded
AGA	Faghihi, et al.	2020	60 Patenits	Electric Pen	.6-1.2mm	12 (6 months)	The study examined the effects of microneedling with two different penetration depths on hair growth in AGA patients	All groups exhibited a significant increase in hair count and thickness compared to the baseline after treatment ($P < 0.05$)	Five patients in the control group and a total of three patients in both microneedling groups complained of scalp irritation. Facial hypertrichosis was reported by four women in the control group.
AGA	Starace, et al.	2019	14 Females 36 Males	Dermaroller	1.5mm	3 (1 month)	This study aimed to demonstrate the benefits of offering microneedling alongside existing treatments to patients with AGA	All patients experienced either a partial or complete reduction in hair loss	No significant adverse events were noted
MPA	Aggarwal, et al.	2020	200 Males	Dermaroller	1.5–2 mm	4 (4 months)	A triple-blinded cohort study was conducted to determine the efficacy of microneedling alone compared to microneedling with PRP	Both MN and MN + PRP groups significantly increased overall hair thickness	No significant adverse events were noted
AGA	Yepuri, et al.	2021	12 Females 48 Males	Dermaroller	1.5mm	4 to 6 (1 month)	The study aimed to evaluate the effectiveness of MN+PRP in treating patients with AGA and determine the number of sessions needed for each patient	This study demonstrates that PRP+MN is an effective treatment for AGA and reported that a minimum of four sessions are needed to achieve results	No adverse events reported
AGA	Sanchez-Meza, et al.	2022	34 Males	Electric Pen	2.5mm	3 (1 month)	A randomized placebo-controlled trial to investigate the efficacy of MN +topical dutasteride solution for treating AGA	A significant improvement was observed in the MN+dutasteride solution over the control group	None
AGA	Jia, et al.	2018	9 Females 9 Males	Dermaroller	1.5mm	6 (1 week)	A study to evaluate the effectiveness of MN combined with 5% minoxidil to treat AGA	The investigator reported significant improvement in hair appearance. Patients expressed satisfaction with the hair growth results	No significant adverse events reported
AGA	Kumar, et al.	2018	68 Males	Dermaroller	1.5mm	12 (1 week)	A study aimed to compare the effectiveness of MN+ topical minoxidil versus topical minoxidil alone for treating AGA	The combination treatment group showed a significantly greater increase in hair count compared to the minoxidil alone group	No significant adverse events reported

Table 1: A summary of publications from 2018 to 2023, encompassing study aims, outcomes, and reported adverse events for the indicated conditions. Abbreviation key- MN: Microneedling MPA: Male Pattern Alopecia, AGA: Androgenetic alopecia, AA: Alopecia Areata, PRP: Platelet-Rich Plasma, TA: tranexamic acid, MASI: Melasma area and severity index scores, PDT: Photodynamic therapy, NB-UVB: Narrowband UVB, CP: Chemical peel, HA: hyaluronic acid, NAFL: Nonablative fractional laser, TCA: Trichloroacetic acid, and GBGs: Goodman and Baron grading.

by the progressive insights of healthcare professionals**.** A significant advancement in microneedling is the discovery of its effectiveness as a therapeutic approach for treating inflammatory acneic lesions.

Acne vulgaris, a common skin disorder, affects the pilosebaceous unit and is experienced by nearly everyone at some point in their lives. Traditional treatment modalities for acne, such as antibiotics and sebum reduction methods, may have drawbacks and long-term adverse effects. There is a demand for new and efficient treatment alternatives that prioritize safety and effectiveness. While microneedling is contraindicated for active acne lesions due to concerns of exacerbating the condition and spreading bacteria, no published scientific literature supports this claim. A recent publication by Alqam, et al. challenged the prevailing perception by microneedling subjects with active acneic lesions [22]. The study demonstrated that microneedling, when performed on acne lesions does not cause post-treatment complications or worsen acne. Instead, it can significantly reduce inflammatory and non-inflammatory acne lesion counts. The authors proposed that microneedling could potentially target a different underlying cause of acne by addressing the issue of hyperkeratinization and blockage of sebaceous glands. Their study presented objective evidence that challenges the current contraindication of microneedling for acne treatment, indicating that microneedling could be a valuable and potentially safer alternative to conventional treatments. Their authors called for a reassessment of the current standard of care for acne vulgaris and highlighted the potential benefits of incorporating microneedling into treatment approaches.

The development of spider veins (telangiectasia) is attributed to intra-arteriolar vasodilation, although the specific cause can vary. They are a common benign vascular anomaly characterized by the presence of one or multiple lesions. However, when facial spider veins appear, they can have a negative impact on the patient's quality of life. A recent case study explores the use of microneedling as an effective approach for treating facial spider veins, achieving a clearance rate of over 50% after the initial treatment [23]. Microneedling outcomes appear to have the same level of efficacy as sclerotherapy and laser treatment, making it a compelling alternative. Notably, microneedling has demonstrated a remarkable safety profile, as no complications have been observed during the treatment, unlike other methods that carry potential risks and complications. The neovascularization that occurs during skin remodeling could also contribute to improving skin appearance.

Surgical scars can negatively impact a person's appearance, psychological well-being, and social interactions. Currently, it is advised to wait for a minimum of one year before considering any treatment to reduce the visibility of scars. In a recent study by Claytor, et al. researchers investigated whether initiating microneedling treatment at an earlier stage, before the scar matures, could improve clinical aesthetic outcomes for subjects [24]. The study included participants who had undergone surgery, and the treatments were initiated at different time points ranging from 6 to 16 weeks postoperatively. The results showed statistically significant improvements in scar appearance throughout the study. When comparing the data based on the timing of treatment initiation, it was observed that patients who received treatment at 6 to 7 weeks after the surgery showed significantly superior results compared to those who received treatment at 13 to 16 weeks postoperatively. The traditional approach to scar management has focused on conservative care during the inflammation and proliferation phases, with treatment options during the maturation phase. However, this investigator proposed a hypothesis that conservative care during the early maturation phase may miss an important time period for scar modulation. This suggests that delaying intervention may result in missing an optimal window of opportunity for effective scar management.

Gingival hyperpigmentation, characterized by a deep discoloration of the gums, can be influenced by various factors. These factors can be either exogenous or endogenous, including drug usage, genetic predisposition, hormonal imbalances, and smoking. Different techniques have been employed to treat gingival hyperpigmentation, such as scalpel scraping, electrosurgery, and lasers. These methods typically involve the removal of the pigmented epithelium to facilitate the regeneration of new gingival tissue without melanin. However, these techniques may have drawbacks, including higher costs, increased complications, prolonged healing time, and the requirement for a periodontal dressing. Laser and electrosurgery are effective but tend to be more expensive and complex. New research aimed to find an alternative treatment approach that addresses these limitations by offering lower costs, fewer complications, faster healing, and eliminating the need for periodontal dressing [25]. Their study enrolled 16 participants seeking treatment for their gingival hyperpigmentation and aimed to evaluate the effectiveness of combining microneedling and topical Ascorbic Acid (AA). Microneedling was utilized to create microchannels in the gingival tissue, enabling the topical application of AA to effectively inhibit melanin production. The results demonstrated that seven out of the 16 patients achieved complete depigmentation, while the remaining participants experienced reduced pigmentation. The healing process was relatively fast, taking only 7-10 days, quicker than other depigmentation methods. The investigator extended the application of microneedling from dermatology and found that combining microneedling with topical AA is a novel and non-invasive dental procedure that effectively treats gingival hyperpigmentation.

Conclusion

Our review highlights the rapid growth and expanding scope of microneedling beyond traditional dermatological applications, exploring its potential use in other therapeutic areas. In recent years, microneedling has emerged as a valuable tool in dermatology, providing a non-surgical option for addressing various aesthetic and medical concerns. Its applications have expanded beyond aesthetic indications to encompass the treatment of dermatological conditions such as pigmentation disorders and hair pathology, demonstrating high efficacy outcomes, a favorable safety profile, and minimal post-treatment recovery time.

The mechanisms of microneedling involve collagen induction, non-fibrotic skin remodeling, and the release of growth factors that promote fibroblast proliferation, neovascularization, and cellular turnover. It has shown effectiveness in improving various skin concerns, including wrinkles, scars, stretch marks, and pigmentation disorders. Microneedling combined with topical agents has yielded better treatment responses in pigmentation disorders than agents alone. Additionally, it has shown promise in hair growth stimulation and enhancing transdermal drug delivery.

The utilization of microneedling has expanded beyond dermatology, as demonstrated by its exploration in other medical disciplines. Recent studies challenge the conventional contraindication of microneedling for active acne lesions, suggesting that it may be a safe and effective alternative treatment option. Additionally,

microneedling has shown promise in treating facial spider veins, offering comparable efficacy to sclerotherapy and laser treatments while maintaining a remarkable safety profile. Early intervention with microneedling in the early maturation phase of surgical scars presents a novel approach to scar management, potentially improving aesthetic outcomes. Furthermore, microneedling combined with topical ascorbic acid has emerged as an innovative and non-invasive dental technique for effectively treating gingival hyperpigmentation.

Although our review underscores the promising potential of microneedling, it also serves as a purposeful cross examination of where we are with microneedling and to curiously question its innovative, prospective future. Microneedling has evolved into a versatile procedure with expanding applications in dermatology and other medical fields. Its ability to address various aesthetic and medical concerns, coupled with its high efficacy, safety, and minimal downtime, positions it as a valuable treatment option. However, further research is necessary to optimize protocols, establish guidelines, and explore new avenues for its use. The latest advancements discussed in this review pave the way for practitioners seeking to integrate microneedling into their practice and highlight the need for ongoing exploration and innovation in this field.

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Ethical Statement

Does not apply/Not needed.

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