

REVIEW ARTICLE

Microneedling for the treatment of hair loss?

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Abstract

Microneedling is a minimally invasive dermatological procedure in which fine needles are rolled over the skin to puncture the stratum corneum. This therapy is used to induce collagen formation, neovascularization and growth factor production of treated areas. It has been used in a wide range of dermatologic conditions, including androgenetic alopecia (AGA) and alopecia areata, among others. While there are a limited number of studies examining this therapy in the use of hair loss, microneedling has been successfully paired with other hair growth promoting therapies, such as minoxidil, platelet-rich plasma and topical steroids, and shown to stimulate hair follicle growth. It is thought that microneedling facilitates penetration of such first-line medications, and this is one mechanism by which it promotes hair growth. To date, the area most studied and with the most success has been microneedling treatment of AGA. While the current evidence does not allow one to conclude superiority of microneedling over existing standard therapies for hair loss, microneedling shows some promise in improving hair growth, especially in combination with existing techniques. This review summarizes the current literature regarding microneedling in the treatment of alopecia and calls for further studies to define a standard treatment protocol.

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Conflicts of interest

Dr. Antonella Tosti received honoraria as a consultant, advisory board participant, speaker or book author from the following companies: Aclaris, Incyte (Consultant and PI), Kythera, P&G, DS Laboratories, Merck (Consultant and Speaker over 3 years ago), Taylor & Francis (Author), Springer & Verlag (Author) and National Alopecia Areata Foundation (Scientific Board Member). Raymond M. Fertig, A. Caresse Gamret, Jessica Cervantes have no conflict of interest to report.

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Introduction

Microneedling is a minimally invasive procedure that utilizes multiple fine needles to create micropunctures in the skin.¹ The act of creating these two to four cell-wide puncture holes triggers neovascularization, the release of growth factors, and stimulates the expression of Wnt proteins.² This process was first used cosmetically because it initiates an increase in collagen and elastin formation, which gives rise to its alternative name, percutaneous collagen induction (PIC).^{3,4} Microneedling therapy is performed with a roller, which is a barrel-shaped roller instrument studded with fine needles ranging from 0.5 to 2.5 mm in length, that is repeatedly rolled over the skin.^{5,6} The principle of this therapy dates back to 1995 when Orentreich and Orentreich first used dermal needling to treat scars in the form of subcision. This

reduced the appearance of scars by inserting needles and manoeuvring them under the skin to make subcuticular cuts.¹ The application of microneedling has since broadened to a more medicinal use, as opposed to purely cosmetic, and it is now used to augment transdermal drug delivery.⁷ In addition, microneedling therapy has been utilized in the treatment of a wide range of dermatological conditions, which include active acne vulgaris, acne scars, burn scars, striae distensae, rhytides, melasma, melanos, hyperhidrosis and alopecia.^{8–11}

Microneedling has specifically been demonstrated to increase hair regrowth in alopecia via the release of platelet-derived growth factor, epidermal growth factors and activation of the hair bulge, all of which are triggered by the wound healing response.² Increased expression of Wnt proteins, namely Wnt3a and Wnt10b, is also evident following microneedling. These particular proteins have been demonstrated to stimulate dermal papillae stem cells and hair growth.²

Raymond M. Fertig and A. Caresse Gamret made equal contributions to this manuscript.

Methods and materials

A PubMed search (1995–2017) was used to identify documented cases of microneedling treatment of alopecia in the literature. The search terms used were: ‘microneedling’, ‘microneedling therapy’, ‘microneedling alopecia’, ‘microneedling hair’, ‘microneedling review’, ‘percutaneous collagen induction’ and ‘percutaneous collagen induction alopecia’. Any review articles, randomized clinical trials, case reports and case series found were included, which were few in number (Table 1). In addition to the PubMed search results, references of included resources

were examined, and sources which were not identified in the initial search were incorporated.

Instruments used in microneedling

For general use, the typical medical roller is a handheld instrument with a 2-cm-wide cylinder containing 192 evenly spaced medical grade stainless steel or silicon needles which is rolled over the skin in multiple directions to produce micropunctures.^{3,12} These skin punctures trigger a wound healing reaction composed of platelet-derived growth factor, transforming

Table 1 Overview of studies analysing microneedling for the treatment of hair loss

Alopecia type	Author	Year	N	Treatment Group	Control	Results	Study design
Androgenic alopecia	Dhurat <i>et al.</i> ²	2013	100	Weekly microneedling with twice daily 1 mL 5% minoxidil cream	Twice daily 1 mL 5% minoxidil cream	Treatment hair count 91.4 vs. control hair count 22.2 ($P = 0.039$)	12-week, randomized, evaluator blinded controlled study
Androgenic alopecia	Dhurat <i>et al.</i> ²⁰	2015	4	Fifteen microneedling sessions in 6 months on four treatment resistant men in addition to their existing finasteride and minoxidil therapy	N/A	Microneedling in addition to existing finasteride and minoxidil therapy improved new hair growth by more the 75% in three of four patients and by more than 50% in one of four patients	6-month, four-subject, case series
Androgenic alopecia	Farid <i>et al.</i> ²¹	2016	40	Platelet-rich plasma (PRP) was applied in conjunction with microneedling once monthly for 6 months	Twice daily 1 mL 5% minoxidil cream	Both treatments equally improved hair growth, and patients were equally satisfied but minoxidil worked significantly quicker	28-week, randomized, evaluator-blinded, controlled study
Androgenic alopecia	Sasaki ²²	2017	10	PRP treatment to patients with androgenic alopecia	N/A	Average hair count was 88.3 ± 22.5 prior to treatment, and after PRP microneedling, it was 133.6 ± 13.8 in a 10-mm spot	Case series
Androgenic alopecia	Lee <i>et al.</i> ²³	2013	11	Half of the scalp of each subject was treated with growth factors followed by microneedling	Half of the scalp of each subject was treated with saline and followed by microneedling	Average hair count was 52.91 ± 10.85 on the treated side of the scalp compared to 45.91 ± 9.98 on the control side of the scalp	5-week, scalp-split, single-blinded, placebo-controlled study
Alopecia areata	Lee <i>et al.</i> ²⁴	2009	6	Microneedling was performed on half the scalp prior to application of a photosensitizer used in photodynamic therapy	Photosensitizer without prior microneedling was applied to half the scalp before photodynamic therapy	There was no hair regrowth in treatment or control group	12-week, scalp-split, single-blinded, placebo-controlled study
Alopecia areata	Chandrashekar <i>et al.</i> ²⁵	2014	2	Topical triamcinolone was applied before and after microneedling for three sessions each 3 weeks apart	N/A	Excellent restoration of hair growth	9-week assessment of two person case series

growth factor alpha and beta, vascular endothelial growth factor, fibroblast growth factor, epidermal growth factor and Wnt proteins, among others, without significantly damaging the epidermis.⁵ Essentially, these vertical channels of injury break down existing scars and lead to neocollagenesis, which is of particular importance cosmetically in reducing the appearance of wrinkles and scars and revascularization of the skin, which is a mechanism which stimulates hair growth.^{13–16} There are currently five prototype roller instruments registered with the FDA. The C-8, a cosmetic roller, has a needle length of 0.13 mm and is primarily used to enhance the efficacy of topical drugs. This instrument is painless and is often used by patients at home to increase transdermal delivery of medications and reduce pore size, sebum production and small wrinkles. The C-8HE is also a cosmetic roller but has a needle length of 0.2 mm and is used for the scalp and areas of skin with hair. The C-8HE roller is also painless. The CIT-8 is a medical type of roller with 0.5-mm needles and is primarily used to initiate skin remodelling and collagen induction. The MF-8 roller will penetrate the epidermis and dermis with its 1.5-mm needle length and will break down existing collagen scars effectively. Finally, the MS-4 roller has 1.5-mm needles but is narrower, with a 1-cm-wide cylinder. The MS-4 instrument gives deep penetration with better control and is primarily used for acne scars on the face.³ There are variations of these devices, and shorter-length needle rollers (0.5–0.75 mm in width) can be used in conjunction with a narrower cylinder. These shorter needle rollers are of particular use for areas circumventing the mouth and eyes. High-quality instruments are of utmost importance to ensure that needles do not break off in the skin, causing injury.¹⁷ The time interval between successive uses is based on the needle length, with longer needles requiring more recovery time.¹²

In addition to rollers, there are smaller microneedling devices such as the stamp and pen which are useful for treating small, localized areas of skin and hair.¹⁷ The pen is a narrow instrument that utilizes 33 gauge needles that vibrate and punch vertically into the skin at speeds of up to 25+ times/s.

Microneedling procedure for alopecia

Depending on anticipated pain tolerance, a topical anaesthetic cream, typically a mixture of lignocaine and prilocaine/tetracaine, can be applied to the area to be treated 15–45 min prior to an in-office microneedling procedure.¹² Once the anaesthetic has become effective, the area to be treated is washed using saline and ethanol or betadine to ensure an aseptic field. For the treatment of hair loss, a pen or roller can be used. The pen, which has adjustable speeds and depth of penetration, should be moved over the treatment area in linear passes, lifting the device between each stroke. Up to three passes can be made over the skin when using the pen. If a roller were to be utilized for treatment, a 0.5- to 1.5-mm-length microneedle would be

manoeuvred over the appropriate area in a vertical, horizontal and diagonal direction approximately 15–20 times, which should produce roughly 250 holes per square centimetre.³ Pinpoint bleeding or mild erythema from the covered area is the desired endpoint and is achieved with minimal pressure.¹⁸ After the resultant blood is washed off with saline solution, an antibiotic cream should then be applied to the treatment area.¹² Following antibiotic application, a hair growth promoting topical solution can be applied at this time [in the case of platelet-rich plasma (PRP)] or 24 h after the microneedling session has terminated (if minoxidil therapy will be used in conjunction). As treatment of hair loss with microneedling is still a relatively new procedure, a best practice has yet to be definitively determined.² It is worth mentioning that this lack of standard procedure has a bearing on success of treatment. As demonstrated in Kim *et al.*'s Murine model study of microneedling, hair growth varied based on the size of the needle and the number of times the skin was rolled over. Mice demonstrated greatest hair growth with both 0.25-mm needles and 0.5-mm needles rolled over the skin in a back-and-forth movement 10 times (0.15-, 0.25-, 0.5- and 1-mm needles were all tested).¹⁹ To derive greatest therapeutic success in human subjects, a standard optimal protocol needs to be determined. No side-effects have been reported so far in the literature, and microneedling appears to be quite safe. Possible side-effects due to topical anaesthetics and infections should, however, be considered.

Microneedling and androgenetic alopecia

The use of microneedling has been most extensively studied in AGA and has been found to have positive therapeutic results, particularly when combined with topical minoxidil. In the first randomized, evaluator-blinded, comparator control trial in humans on the subject, Dhurat *et al.*² compared the results of weekly microneedling sessions used in conjunction with 5% minoxidil solution applied twice a day for 12 weeks to the twice-daily application of 5% minoxidil alone. One hundred men with mild-to-moderate AGA, ages 20–35, were randomly assigned to the microneedling group ($N = 50$) or the control group ($N = 50$).² All subjects had their heads shaved prior to treatment to ensure the same length of hair at baseline. The scalp of microneedling patients who had weekly sessions was prepared with betadine and saline solution, and a 1.5-mm roller was used. The areas of hair loss were rolled over in a vertical, horizontal and oblique direction until mild erythema was evident. Minoxidil was not applied until 24 h after the roller procedure for each of these sessions for subjects in the microneedling group. Three outcome measures were utilized in assessing treatment success: hair count after 12 weeks in a predefined area with 1 cm diameter, blinded evaluator assessment of hair growth on a seven-point scale and a subjective patient assessment of hair growth (ranked from no improvement, 1–25% improvement, 26–50%

improvement, 51–75% improvement, 76–100% improvement). After 12 weeks of treatment, the microneedling group showed significantly higher hair count (91.4 hairs per cm^2) than the control group (22.2 hairs per cm^2) ($P = 0.039$). Additionally, both the evaluator and subjects assessed the microneedling group to have greater improvement compared to the control group. Based on the blinded evaluator assessment, 80% of the microneedling group showed the highest two levels of improvement (six or seven on the blinded evaluator seven-point scale) compared to none of the controls as assessed by professionals. Based on the subjective patient assessment, 82% of the patients in the microneedling group self-ranked improvement above the 50% level, compared to only 4.5% in the control group that self-ranked improvement above the 50% level.² It was also noted that new hair growth was evident by week 6 in the microneedling group compared to week 10 for the minoxidil-only control group. Subjects in the microneedling group reported sustained results 8 months after the final treatment session. No adverse events were reported in either group.

In a subsequent case series by Dhurat *et al.*,²⁰ four men with AGA (ages 28, 30, 35 and 40) who had been resistant to finasteride and minoxidil 5% therapy received 6 months of microneedling therapy in addition to their existing treatment of finasteride and minoxidil. The study subjects received four weekly sessions, followed by 11 more sessions occurring once every 2 weeks, for a total of 15 sessions in addition to the continuation of their finasteride and minoxidil therapy. The results were assessed by the evaluators, with 50% of patients obtaining the highest evaluator ranking on the seven-point scale and 50% obtaining the second highest ranking which is 6 of 7 on the scoring scale. In addition, results were assessed by the patients. Three patients felt there was greater than a 75% improvements, and one patient felt that there was more than a 50% improvement.²⁰ These results persisted after 18 months of follow-up. The authors of this study considered microneedling to be an effective, inexpensive and novel tool in the treatment of AGA warranting further study.

In a 2016 study of 40 female AGA patients by Farid *et al.*,²¹ hair growth following microneedling combined with PRP mesotherapy was compared to 5% minoxidil monotherapy. PRP mesotherapy is thought to stimulate the release of growth factors such as VEGF, epidermal growth factor, IGF, fibroblast growth factors and PDGF by injecting activated platelets into the scalp. These growth factors stimulate vascularization and growth of dermal papillary cells which spur replication of epithelial cells while preventing apoptosis. The desired effect of this therapy is to increase follicular growth and lead to new hair production.²¹ PRP therapy is applied topically following microneedling treatment to allow for more widespread and better penetration, in addition to capturing the wound healing benefits of microneedling. In the randomized, 28-week evaluator-blinded, controlled study, the microneedling/PRP group

received once monthly treatments for 6 months. The scalp was prepared with 70% ethyl alcohol and 1 mL PRP was injected along vertical paths along the scalp. A microneedling roller with 0.5-mm needles was then used over the area until mild erythema was observed. Another 1 mL PRP solution was then sprayed on the area followed by a final roller pass. The control group used 5% minoxidil twice daily for 6 months. Hair growth was assessed at 12 and 28 weeks after treatment initiation. Both groups showed a significant increase in hair count following therapy. Hair counts were 5.05 ± 27.95 per cm^2 for the microneedling/PRP group, compared to 16.05 ± 11.83 per cm^2 for the minoxidil group, but this difference was not significant ($P = 0.239$).²¹ Blind evaluators rated a 45% improvement in hair density for the microneedling/PRP group compared to 65% improvement in the minoxidil treatment group ($P = 0.34$). Finally, hair growth occurred faster with minoxidil therapy alone, and statistically significant improvements in hair growth were evident after 12 weeks of therapy with minoxidil while it took 28 weeks for the same result with combined microneedling/PRP therapy. The authors concluded minoxidil monotherapy was more effective and should remain the first treatment option based on greater hair counts and faster hair growth time. These findings led the authors to recommend microneedling in combination with PRP therapy as a second-line therapy in those who cannot tolerate or who fail minoxidil treatment.²¹

Another recent paper by Sasaki examined the effect of treatment with microneedling combined with PRP for AGA. It was found that based on a total of 10 treatments with an average of 5 mL of PRP used per session (needle depth ranged from 0.5 to 2.5 mm) there was a significant improvement in hair growth at the 12-month mark.²² The average hair count in a 10-mm area on the scalp increased from 88.3 ± 22.5 prior to treatment to 133.6 ± 13.8 . The authors considered these results promising and felt microneedling in combination with PRP therapy was effective in stimulating hair growth.²²

A pilot study conducted by Lee *et al.* included 11 women with an average age of 41.4 years who had female pattern hair loss. The study subjects were treated with two different methods, one on each half of their scalp. One half of the scalp was treated with five weekly sessions with a proprietary topical growth factor application followed by 0.5-mm microneedling treatment to increase drug penetration. The other half of the scalp served as the control and received a treatment with saline solution followed by microneedling.²³ The topical growth factor solution was made of fibroblast growth factor, vascular endothelial growth factor, insulin-like growth factor, keratinocyte growth factor, stem cell factor, superoxide dismutase and Noggin.²³ The growth factor-treated side of the scalp had more than a 10% increase in hair count by the fifth week compared to the control side of the scalp (52.91 ± 10.85 vs. 45.91 ± 9.98 , respectively, $P = 0.0001$). It was additionally noted that there were no adverse

reactions to the treatment, and pain scores were at the marginal level.²³

The results from these studies therefore suggest a role of microneedling in combination with other established treatments of AGA and particularly topical minoxidil.

Microneedling and alopecia areata

Alopecia areata (AA) is an autoimmune condition in which hair is lost in circular patches. AA is a non-scarring, inflammatory-mediated process.²⁴ Data on efficacy of microneedling in treating AA are scarce. Lee *et al.* proposed that the ineffectiveness of photodynamic therapy in AA was due to the lack of absorption of the photosensitizer, methyl 5-aminolevulinic acid (MAL). In his 2009 study, he combined photodynamic therapy (PDT) with microneedling to increase the absorption of the MAL to treat six treatment-resistant patients with alopecia areata.²⁴ Half of the affected alopecia areas were given the microneedling treatment, with the other half serving as the control. Next, MAL was applied to the entire area. After 3 h, the patients received red light (630 nm) PDT for 7.5 min.²⁴ This was performed a total of three times with 4-week intervals between subsequent treatments. It was found that neither the microneedling nor the control regions experienced hair regrowth.

Chandrashekar *et al.* described the first successful treatment of two alopecia areata patients utilizing microneedling and topical application of triamcinolone.^{3,25} The patients had previously been treated with injections of triamcinolone, topical steroids and minoxidil 5% with no improvement and had a 6-month and 1-year history of patchy hair loss, respectively. After aseptic preparation, topical triamcinolone acetonide (0.1 mL of 10 mg/mL solution) was applied to the affected areas, followed by use of a microneedling roller (1.5-mm-length needles) and then followed by triamcinolone application once more.²⁵ This procedure was performed three times with 3 weeks in between each treatment session. Both patients (one male and one female) showed improved hair growth after each session, and the authors categorized the end result as excellent following the last therapy session. After 3 months of follow-up, these results were maintained.²⁵

Microneedling for the treatment of alopecia areata does not have enough evidence to conclude efficacy; however, the use of needling to improve penetration of topical steroids is of interest and shows the most promise.

Conclusion

Microneedling is a relatively new treatment modality that is believed to stimulate the deposition of collagen and release of growth factors in the skin to enhance healing in a multitude of conditions ranging from scarring to hyperhidrosis. Microneedling is performed using a variety of instruments such as a pen, which uses vertical punctures on the skin or scalp, or the cylindrical roller, studded with fine needles of varying lengths. Due to

the novelty of this therapy for hair loss, there is no standard procedure for pretreatment of the skin; however, the technique has been shown to be particularly effective in combination with minoxidil therapy or topical steroids. In general, microneedling can facilitate penetration of medications such as minoxidil, topical steroids and PRP medium.^{2,21,25} The ease, inexpensiveness and safety of microneedling make it a potentially appealing therapy for future treatment of hair loss conditions. However, based on the limited available evidence, there is a need for further RCTs to refine a standard treatment protocol.¹

Compliance with ethical standards

Raymond Fertig, A. Caresse Gamret, Jessica Cervantes and Antonella Tosti declare that they have no conflict of interest and no commercial associations with any product or device described in the article. No funding was received for this manuscript.

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