Microneedling: Advances and widening horizons

Aashim Singh, Savita Yadav

ABSTRACT

Microneedling is a very simple, safe, effective, and minimally invasive therapeutic technique. It was initially introduced for skin rejuvenation, however, now it is being used for a very wide range of indications including acne scar, acne, post-traumatic/burn scar, alopecia, skin rejuvenation, drug delivery, hyperhidrosis, stretch marks, and many more. Moreover, during the last 10 years, many new innovations have been made to the initial instrument, which was used for microneedling. This technique can be combined with other surgical techniques to provide better results. In particular, it is a very safe technique for dark skin types, where risk of postinflammatory pigmentation is very high with other techniques that damage the epidermis. In this review article, we are updating on the different instruments now available for this procedure, and its efficacy when performed alone or in combination with other techniques for various indications.

Key words: Dermaroller, dermatosurgery, microneedling, percutaneous collagen induction

INTRODUCTION

Microneedling is a relatively new minimally invasive procedure involving superficial and controlled puncturing of the skin by rolling with miniature fine needles. Over a short period of time, it has gained mass popularity and acceptance as it is a simple, cheap, safe, and effective technique requiring minimal training. Traditionally used as a collagen induction therapy for facial scars and skin rejuvenation, it is also widely used now as a transdermal delivery system for therapeutic drugs and vaccines. In this review, we highlight the constantly evolving research and developments in microneedling techniques, instruments, and its applications in dermatology.

THE INVENTION

The advent of the concept of microneedling dates back to 1995 when Orentreich and Orentreich described dermal needling in the form of subcision for scar treatment and then independently in 1997 by a plastic surgeon Camirand who used tattoo guns without ink to take-off tension from postsurgical scars. Microneedling technique was given further shape by a German inventor Liebl in 2000 and a plastic surgeon Fernandes in 2006 who self-designed a drum-shaped device with multiple fine protruding needles and used it for percutaneous collagen induction.

BASIC INSTRUMENT

The standard medical dermaroller has a 12 cm long handle with a 2 × 2 cm wide drum-shaped cylinder at one end studded with 8 rows and 24 circular arrays of 192 fine microneedles, usually 0.5–3 mm in length and 0.1–0.25 mm in diameter. These single use microneedles are synthesized by reactive ion etching techniques on silicon or medical-grade stainless steel. The instrument is presterilized by gamma irradiation. Rolling with a standard dermaroller containing 192 needles of 2 mm length and 0.07 mm diameter over an area of skin for 15 times results in approximately 250
quickly to −100 mV. This triggers increased cell activity and
near the membrane, the inner electrical potential increases
of cells is approximately −70 mV, and when needles come
microneedling works.

Liebl et al. have proposed another hypothesis to explain how microneedling works.11 Resting electrical membrane potential
of cells is approximately −70 mV, and when needles come
near the membrane, the inner electrical potential increases
quickly to −100 mV. This triggers increased cell activity and
the release of various proteins, potassium, and growth factors
from the cells into the exterior leading to the migration of
fibroblasts to the site of injury, and hence, collagen induction.
Thus, the needles do not create a wound in a real sense, but
rather body cells are fooled into believing that the injury has
occurred.9,11-13

The expression of matrix metalloproteinases induced by
microneedling is speculated in reduction of hyperpigmentation.11 In addition, the hyperproliferation of
keratinocytes is downregulated by microneedling in acne
patients because it overall balances out the cell equilibrium.11
However, more research needs to be done to elucidate the
chain of events clearly.

Microneedling enhances the delivery of various drugs across
the skin barrier as it bypasses the stratum corneum and
deposits the drug directly up to the vascularized dermis. It has
also been shown to cause significant widening of the follicular
infundibulum by 47%, which may partly explain the increased
penetration of the medication across the skin barrier. In addition,
removes the scales and sebum residues in the neighbourhood
of the infundibulum.14

Hence, this procedure extrapolates the body’s own physiology
of wound healing and the new collagen deposition results in
skin tightening and filling-up of atrophic scars with an overall
better aesthetic appeal since overlying epidermis is not
ablated.

**PROCEDURE**

Microneedling is a simple office-based procedure lasting
10 to 20 minutes depending on the area to be treated.
The patients must be counselled prior to the procedure
explaining the expected outcomes, delayed response, and
need for multiple sittings. The skin should preferably be
prepared preoperatively for at least a month with vitamin A
and C formulations twice a day to maximize dermal collagen
production. Vitamin A influences 400–1000 genes that control
proliferation and differentiation of all major cells in epidermis
and dermis, and Vitamin C is essential for production of
normal collagen.10

The procedure is performed under topical anesthesia
containing eutectic mixture of lignocaine and prilocaine/
tetracaine for 45 minutes to 1 hour. After preparation of
the area with antiseptic and saline, the skin is stretched with
10 to 20 minutes depending on the area to be treated.

The patients must be counselled prior to the procedure
explaining the expected outcomes, delayed response, and
need for multiple sittings. The skin should preferably be
prepared preoperatively for at least a month with vitamin A
and C formulations twice a day to maximize dermal collagen
formation. Vitamin A influences 400–1000 genes that control
proliferation and differentiation of all major cells in epidermis
and dermis, and Vitamin C is essential for production of
normal collagen.10

The expression of matrix metalloproteinases induced by
microneedling is speculated in reduction of hyperpigmentation.11 In addition, the hyperproliferation of
keratinocytes is downregulated by microneedling in acne
patients because it overall balances out the cell equilibrium.11
However, more research needs to be done to elucidate the
chain of events clearly.

Microneedling enhances the delivery of various drugs across
the skin barrier as it bypasses the stratum corneum and
deposits the drug directly up to the vascularized dermis. It has
also been shown to cause significant widening of the follicular
infundibulum by 47%, which may partly explain the increased
penetration of the medication across the skin barrier. In addition,
removes the scales and sebum residues in the neighbourhood
of the infundibulum.14

Hence, this procedure extrapolates the body’s own physiology
of wound healing and the new collagen deposition results in
skin tightening and filling-up of atrophic scars with an overall
better aesthetic appeal since overlying epidermis is not
ablated.

**PROCEDURE**

Microneedling is a simple office-based procedure lasting
10 to 20 minutes depending on the area to be treated.
The patients must be counselled prior to the procedure
explaining the expected outcomes, delayed response, and
need for multiple sittings. The skin should preferably be
prepared preoperatively for at least a month with vitamin A
and C formulations twice a day to maximize dermal collagen
formation. Vitamin A influences 400–1000 genes that control
proliferation and differentiation of all major cells in epidermis
and dermis, and Vitamin C is essential for production of
normal collagen.10

The procedure is performed under topical anesthesia
containing eutectic mixture of lignocaine and prilocaine/
tetracaine for 45 minutes to 1 hour. After preparation of
the area with antiseptic and saline, the skin is stretched with
1 hand, and perpendicularly, rolling is done 5 times each
in the horizontal, vertical, and oblique directions with the
other hand [Figure 2]. The treatment endpoint is identified
as uniform pin-point bleeding which is easily controllable.
Post-procedure, the area is made wet with saline, or ice

---

**Figure 1**: Different variety of Dermarollers: (a) Dermaroller with narrow width of drum meant for smaller areas such as eyelids and nose; (b) Dermaroller with 540 needles; (c) Standard dermaroller with 192 needles holes per square cm up to the papillary dermis depending on
the pressure applied.[9] Each pass produces 16 micropunctures
in the stratum corneum per square cm without damaging the
epidermis significantly.[6]

**Principle and mechanism of action**

Micropunctures are created using microneedles which produce
a controlled skin injury without actually damaging the epidermis.
These microinjuries lead to minimal superficial bleeding and
set up a wound healing cascade with release of various
growth factors such as platelet derived growth factor (PGF),
transforming growth factor alpha and beta (TGF-α and TGF-β),
connective tissue activating protein, connective tissue growth
factor, and fibroblast growth factor (FGF).[7] The needles
also breakdown the old hardened scar strands and allow it
to revascularize. Neovascularization and neocollagenesis is
initiated by migration and proliferation of fibroblasts and laying
down of intercellular matrix.[8,9] A fibronectin matrix forms after
5 days of injury that determines the deposition of collagen
resulting in skin tightening persisting for 5–7 years in the form
of collagen III. The depth of neocollagenesis has been found
to be 5–600 µm with a 1.5 mm length needle. Histological
examination of the skin treated with 4 microneedling sessions
1 month apart shows up to 400% increase in collagen
and elastin deposition at 6 months postoperatively, with
a thickened stratum spinosum and normal rete ridges at
1 year postoperatively.[10] Collagen fibre bundles appear to
have a normal lattice pattern rather than parallel bundles as
in scar tissue.[9]
VARIOUS INSTRUMENTS AND TECHNIQUES

A simple dermaroller has evolved over the past decade through a variety of advancements. The current market is booming with an assortment of devices based on needle length, drum size, and automation [Figure 1].

The most important is the diversity of needle lengths. High ratio of tip length versus diameter of 13:1 is an important property of good needles.[8] The length of needle selected for an individual patient depends upon the indication for microneedling. For treating acne and other scars as a routine, a needle length of 1.5–2 mm is usually used. When microneedling is used as a procedure to treat ageing skin and wrinkles, the needle length of 0.5 mm or 1.0 mm is usually recommended.[8] When the needles are only up to 0.5 mm long, the procedure is essentially painless, and the perception of pain increases as the depth of needle penetration increases. It also depends on the thickness of epidermis and dermis of the skin.

The minimum time interval between two sittings of microneedling depends upon the indication for which the procedure is being done as well as the needle length of the dermaroller being used. More is the needle length, greater should be the interval between two sittings of microneedling. When using 1.5 mm dermaroller, at least 3 weeks gap should be there between two procedures.

Five basic types of medical dermarollers, which are registered with the FDA, have been described in the dermaroller series by Konstantinos, and most dermarolling devices are adopted from these elementary types:[16]

- **C-8** (Cosmetic type), is the basic dermaroller as described above with a needle length of only 0.13 mm (130 µm) used for enhancing penetration of topical agents. It is completely painless.
- **C-8HE** (Cosmetic type for hair-bearing surfaces, scalp) has a needle length of 0.2 mm (200 µm). Even this length is below the pain threshold.
- **CIT-8** (CIT: Collagen Induction Therapy, Medical type) has a needle length of 0.5 mm (500 µm) and helps in collagen induction and skin remodelling.
- **MF-8** type has a needle length of 1.5 mm (1500 µm). This creates deeper microchannels on the whole epidermis and dermis and at the same time destroys scar collagen bundles.
- **MS-4** is the only dermaroller that has a smaller cylinder, 1 cm length, 2 cm diameter, and subsequently 4 circular arrays of needles (total 96 needles) that have 1.5 mm length. It is used on areas where better precision and deeper penetration is required. It is mostly used on facial acne scars.
- Devices similar to MS-4 are available with needle lengths of 0.5–0.75 mm, which are used for thin-skinned areas such as the periorbital and perioral regions.

**Home care dermaroller**

Home-care dermarollers (C-8) are used by patients themselves as they are of needle length less than 0.15 mm and are available for reduction of pore size, fine lines, and sebum production, as well as for transdermal delivery of substances such as lipopeptides and other antiaging products. They can be used twice or thrice a week for up to 100 times. After use, the rollers should be cleaned in hot tap water and shaken dry.[3,17] Beauty Mouse is another approved device intended for home use. It contains a total of 480 needles of approximately 0.2 mm size on 3 separate drums strategically placed inside a computer mouse shaped device. It has been developed to ensure coverage of larger skin surface areas, such as the arms, legs, and buttocks for the treatment of stomach or thigh stretch marks and cellulite.[18]
Derma-stamp

These are miniature versions of the dermaroller available in different needle lengths (0.2–3 mm) and a diameter of 0.12 mm that are used for localized scars such as varicella scars. Advantage over the dermaroller is that a more focussed treatment of individual scars is possible. It causes vertical penetration to create infusion channels in the skin and is considered ideal for use on isolated scars and wrinkles.[3,5,17,18]

Dermapen

Dermapen [Figure 3] is an automated microneedling device which looks like a pen. This ergonomic device makes use of disposable needles and guides to adjust needle length for fractional mechanical resurfacing. The tip has 9–12 needles arranged in rows. It makes use of a rechargeable battery to operate in two modes, namely, the high speed mode (700 cycles/min) and the low speed mode (412 cycles/min) in a vibrating stamp-like manner.[19] It has the advantage of being reusable in different patients as the needles are disposable, safe as the needle tips are hidden inside the guide, and more convenient to treat narrow areas such as the nose, around the eyes and lips without damaging the adjoining skin. It makes the procedure less painful and more economical as there is no need to buy a new instrument every time.[20] This technology has been designed to overcome the issues of varying pressure application and the subsequent depth of penetration achieved.[19]

DermaFrac

DermaFrac treatment is a newer modification of microneedling combining microdermabrasion, microneedling, simultaneous deep tissue serum infusion, and light emitting diode (LED) therapy. DermaFrac treatments target aging and sun damaged skin, acne, enlarged pores, uneven skin tone, wrinkles, fine lines, hyperpigmentation, and superficial scars. It takes approximately 45 min to complete full face treatment when all four modalities are used. This noninvasive, cost-effective treatment carries the advantage of having no downtime with individualized selection of serums for infusion.[20,21]

Microneedle delivery systems

Microneedle delivery systems offer a minimally invasive and painless method of transdermal drug administration, especially useful for vaccines.[22] The various types of microneedles available for this purpose can be solid, coated, dissolving, hollow, and swellable polymer microneedles synthesized by microfabrication technique.[18] Silicon, metals such as titanium, natural and synthetic polymers, and polysaccharides are the various materials used to fabricate these microneedles. Solid-coated microneedles are used to pierce the superficial skin followed by topical application and delivery of the drug, whereas dissolvable or biodegradable and hollow needles deliver drugs directly into the dermis.[23]

Fractional radiofrequency microneedling

The amalgamation of microneedling with radiofrequency has further expanded the prospects of application of this technology. Insulated needles are used to penetrate the skin and release radiofrequency currents from the needle tips producing thermal zones in the dermal structural components and accessory glands without damaging the overlying epidermis.[22] This triggers long-term dermal remodelling, neocollagenesis, and neocollagenesis. The depth of the needles can be adjusted from 0.5 mm to 3.5 mm allowing us to target different layers of the dermis discretely.[24] Operating person can exercise a good control over tissue damage by adjusting the power level and duration of energy pulse. The main energy delivery system has a disposable tip with 49 gold plated needles. Microneedling radiofrequency (MNRF) technology does not damage the epidermis, and is therefore, safe in darker skin types. Its indications include scar treatment, hyperhidrosis, skin tightening, rejuvenation, and many more.

Light emitting microneedling device

LED microneedling rollers have been recently launched. These incorporate titanium microneedles and LED light to combat wrinkles and scarring.[19] These devices have not yet been explored and no published data is available regarding its efficacy.

APPLICATIONS OF MICRONEEDLING IN DERMATOLOGY

Dermarolling has been used for a wide range of indications with many trials supporting evidence for its usefulness.[5,6,17,23] It has been tried alone as well as in combination with other treatment modalities such as chemical peeling, platelet rich
plasma, radiofrequency, subcision, punch elevation, and lasers. It is often used in conjunction with a topical formulation, and hence, enhances its penetration and action.

Skin rejuvenation

Microneedling leads to reorganization of old collagen fibres and laying down of new collagen, elastin, and capillaries leading to the effect of skin tightening. A significant increase in level of collagen type I, III, and VII, newly synthesized collagen and tropoelastin from baseline was observed after 6 microneedling sessions at 2-week intervals by El-Domyati et al. This percutaneous collagen induction leads to an overall youthful appearance of the skin by reducing fine lines and wrinkles, reducing pore size, more suppleness, and elasticity.

The effects are enhanced when the procedure is combined with topical antiaging vitamin C serum and tretinoin application. Microneedling has also been combined with human embryonic stem cells derived endothelial precursor cell conditioned medium and has shown significant reduction in wrinkles and pigmentation. Fractional microneedling radiofrequency has been studied in a large multicentre trial and has found to be effective in reducing wrinkles [Table 1].

Scars

Acne scars

The most frequently used indication of microneedling is post-acne facial atrophic scars [Figure 4], and a large number of trials have been conducted to evaluate the same alone as well as in combination with chemical peels, platelet-rich plasma, subcision, cryotherapy, and CROSS technique. Microneedling has been found to be more effective for rolling and boxcar scars, and relatively less effective in ice-pick scars. It is safe for all skin types with minimal downtime. Only the affected area needs to be treated and there is minimal risk of post-inflammatory dyschromia. However, a minimum of 4–6 sessions are required for a significant improvement [Table 2].

Nonacne scars

Post-burn, post-traumatic scar, hypertrophic scars, varicella scars [Table 3].

Post-surgical scars were the first to be studied by Camirand who used tattoo gun needles to reduce the scars. Since then, microneedling has been used for almost all types of surgical scars and are to be found useful. Microneedling has been found to be effective in reducing even burn scars [Figure 5] by up to 80% in a study on 16 patients by Aust et al. It was stipulated that there is normalization of collagen-elastin matrix in the dermis at 1 year. Microneedling is also effective for varicella scars [Figure 6] and post-traumatic scars [Figure 7].

Acne vulgaris

The advent of fractional microneedling radiofrequency has expanded the application of microneedling to acne vulgaris as well. It directly targets the sebaceous glands and helps in reducing the sebum production. It is also known to reduce the hyperproliferation of keratinocytes [Table 4].

Androgenic alopecia and alopecia areata

Use of microneedling over scalp for alopecia is one of its recent advances. It has been compared with minoxidil alone and has been found to be better in combination. Home-use dermarollers are prescribed to patients who are using minoxidil, and a better hair growth is observed. However, when topical minoxidil was compared with Platelet Rich Plasma (PRP) and microneedling therapy in a recent study, minoxidil alone continued to remain better. Microneedling has also been combined with topical triamcinolone acetonide application in alopecia areata and better response has been observed [Table 5].

Pigmentation—Melasma and periorbital hypermelanosis

The introduction of Dermafrac technique and smaller drums with needles sizes approximately 0.5 mm has made the microneedling to periorcular skin amenable. Microneedling

---

Table 1: Microneedling trials for skin rejuvenation (literature search after year 2010)

| Author          | Year | No. of patients | Objective                                                                 | Outcome                                                                 |
|-----------------|------|-----------------|---------------------------------------------------------------------------|-------------------------------------------------------------------------|
| Clementoni et al | 2010 | 21              | Photodynamic photorejuvenation of the face with a combination of microneedling, 1 hour ALA incubation followed by red light and broadband-pulsed light | 90% of patients judged clinical improvement to be greater than 50% at 6 months compared to baseline photography |
| Calderhead et al | 2013 | 499             | Multicentre study to evaluate efficacy of microneedling fractional radiofrequency | 80-89% overall improvement, 30-36% decrease in wrinkle size, 25-29% decrease in wrinkle depth after 2-3 sessions |
| Seo et al        | 2013 | 15              | Comparison of FMRF with and without stem cell medium                       | Combination found to be better                                           |
| Lee et al        | 2014 | 25              | To study efficacy of microneedling with human stem cell conditioned medium | Combination better than microneedling alone (P<0.05)                     |
| El-Domyati et al | 2015 | 10              | To study objective and histological efficacy of microneedling              | Increased collagen I, III, VII, and tropoelastin (P<0.05)                |
has been combined with various skin lightening agents and chemical peels to reduce melasma as well as periorbital hypermelanosis [Table 6].

Miscellaneous conditions
Extended applications of microneedling include stretch marks, axillary hyperhidrosis, and actinic keratosis in photodamaged skin. MNRF has been used even in patients with rosacea and post-acne erythema with favorable results [Table 7].
Table 2: Studies using microneedling for facial post acne atrophic scars (literature search after year 2010)

| Author               | Year | No. of patients | Objective                                                                 | Outcome                                                                 |
|----------------------|------|-----------------|----------------------------------------------------------------------------|------------------------------------------------------------------------|
| Sharad et al.        | 2011 | 60              | Comparison of microneedling with and without glycolic acid peels           | Combination found to be better                                         |
| Dogra et al.         | 2014 | 36              | To study efficacy in atrophic facial acne scars                           | Mean improvement of 50-75% from baseline                                |
| Chawla et al.        | 2014 | 30              | Microneedling with PRP vs Microneedling with vitamin C                    | PRP combination found better (P=0.01)                                   |
| Chandashekar et al.  | 2014 | 31              | Evaluation of Microneedling Fractional Radiofrequency Device              | Improvement-58% moderate and 29% minimal                               |
| Gadkari et al.       | 2014 | 30              | Comparison of subcision with dermaroller vs. subcision with cryoroller    | Cryorolling better than microneedling                                   |
| Fabbrocini et al.    | 2014 | 60              | To analyze efficacy in different skin phototypes                           | Significant reduction in scars (P<0.05) in all phototypes without dyspigmentation in any, 31% reduction in skin irregularity |
| Hassan               | 2015 | 70              | Comparison of microneedling with and without subcision                     | 100% efficacy with combination, 77% with microneedling alone            |
| El-Domyati et al.    | 2015 | 10              | To assess objective and histological efficacy                            | Improvement seen, increased collagen (P<0.05)                           |
| Pandey et al.        | 2015 | 30              | To assess efficacy of microneedling alone                                 | Mean 80% improvement                                                   |
| Puri et al.          | 2015 | 30              | Comparison of microneedling with TCA CROSS                                | Comparable results                                                     |
| Cachafeiro et al.    | 2016 | 46              | Comparison of Nonablative Fractional Erbium Laser 1340 nm and Microneedling |                                                                        |

Table 3: Microneedling for non-acne scar treatment (literature search after year 2010)

| Indication    | Author               | Year | No. of patients | Objective                                                                 | Outcome                                                                 |
|---------------|----------------------|------|-----------------|----------------------------------------------------------------------------|------------------------------------------------------------------------|
| Burn scars    | Kim et al.           | 2010 | 25              | To study the effectiveness of Dermastamp                                    | Improvement seen (P<0.05)                                               |
| Burn scars    | Aust et al.          | 2010 | 16              | To study efficacy of microneedling in reducing post-burn scars without damaging epidermis | 80% improvement in scarring, 45% thickened stratum spinosum, normal rete ridges after 1 year |
| Burn scars    | Sofanov              | 2011 | 1               | Assessment of efficacy                                                     | Good improvement                                                        |
| Varicella scars | Costa et al.       | 2014 | 1               |                                                                           | Significant improvement                                                 |

Table 4: Fractional microneedling radiofrequency trials for acne vulgaris (literature search after year 2010)

| Indication      | Author               | Year | No. of patients | Objective                                                                 | Outcome                                                                 |
|-----------------|----------------------|------|-----------------|----------------------------------------------------------------------------|------------------------------------------------------------------------|
| Acne vulgaris   | Lee et al.           | 2012 | 18              | To assess the efficacy of FMRF                                           | Reduced number of lesions                                               |
| Acne vulgaris   | Lee et al.           | 2013 | 20              | To assess the efficacy of FMRF                                           | 70-80% reduced sebum                                                   |
| Acne vulgaris   | Kim et al.           | 2014 | 25              | Treatment of acne vulgaris with FMRF                                     | 76% reduction in acne, 37% reduction in sebum (P<0.05)                  |
| Acne and acne scars | Min et al.        | 2015 | 20              | Comparison of FMRF with bipolar radiofrequency                           | Superior efficacy of FMRF                                               |

Table 5: Microneedling trials for alopecia (literature search after year 2010)

| Indication          | Author               | Year | No. of patients | Objective                                                                 | Outcome                                                                 |
|---------------------|----------------------|------|-----------------|----------------------------------------------------------------------------|------------------------------------------------------------------------|
| Androgenic alopecia | Dhurat et al.        | 2013 | 100             | Comparison of topical minoxidil with and without microneedling            | Combination better (P=0.039)                                            |
| Alopecia areata     | Chandashekar et al.  | 2014 | 2               | To study the efficacy of microneedling with topical triamcinolone acetone | Response seen                                                           |
| Androgenic alopecia | Dhurat et al.        | 2015 | 4               | To study efficacy in patients not responding to minoxidil and finasteride | Up to 75% improvement                                                  |
| Patterned hair loss | Farid et al.         | 2016 | 40              | Comparison of PRP microneedling with topical 5% minoxid                   | Minoxidil remains better                                                |
**TRANSDERMAL DELIVERY OF DRUGS**

The technique of microneedling has been well-exploited to increase penetration of drugs across the skin barrier. This has been proven in *in-vitro* skin models where enhanced absorption of larger molecules such as calcinein has been observed. Microneedles cover a range of activity between that of a transdermal patch and a hypodermic needle attempting to gain the advantages of both and eliminate the disadvantages of each one of them. Microneedling has been used for the transdermal delivery of various types of drugs including macromolecular biopharmaceuticals such as insulin, growth hormone, heparin, and albumin; immunobiologicals such as hepatitis B, tetanus toxoid, and influenza vaccines; proteins, peptides and drugs such as aspirin, minoxidil, tretinoin, and L-ascorbic acid. Microneedling has also been combined with other advanced techniques such as micropumps, sonophoresis, iontophoresis, and electroporation for better drug penetration.

**CONTRAINDICATIONS**

1. Active acne
2. Herpes labialis or any other local infection such as warts
3. Moderate to severe chronic skin disease such as eczema and psoriasis
4. Blood dyscrasias, patients on anticoagulant therapy
5. Extreme keloidal tendency
6. Patient on chemo/radiotherapy.

**LIMITATIONS AND ADVERSE EFFECTS**

Dermarolling has its own set of limitations despite its assembly of effective uses and advantages over other procedures. It is

---

**Table 6: Microneedling trials for pigmentation (melasma and periorbital hypermelanosis) (literature search after year 2010)**

| Indication                      | Author                  | Year | No. of patients | Objective                                                                 | Outcome                                                                 |
|--------------------------------|-------------------------|------|-----------------|--------------------------------------------------------------------------|-------------------------------------------------------------------------|
| Melasma                        | Fabbrocini et al.       | 2011 | 20              | Comparison of combined skin needling with depigmenting serum and depigmenting serum alone | Reduction in MASI score more on combination side compared to serum alone (P<0.001) |
| Periorbital hypermelanosis     | Sahni et al.            | 2013 | 1               | To study the efficacy of Dermafrac                                          | 75-90% improvement                                                       |
| Melasma                        | Budamakuntla et al.     | 2013 | 60              | Comparison of tranexamic acid microinjections against tranexamic acid with microneedling | 44.41% reduction in MASI score in microneedling group compared to 35.72% reduction with microinjections |
| Melasma                        | Limas                  | 2015 | 22              | To evaluate efficacy in recalcitrant cases                                  | Improvement seen                                                          |
| Periorbital hypermelanosis     | Markantoni et al.       | 2015 | 13              | Combination of microneedling and 10% TCA peels                             | Improvement in 92.3% patients                                            |
| Periorbital hypermelanosis     | Kontochistopoulos et al | 2016 | 13              | Combination of microneedling and 10% TCA peels                             | Improvement seen                                                          |

**Table 7: Microneedling trials for miscellaneous indications (literature search after year 2010)**

| Indication                  | Author                  | Year | No. of patients | Objective                                                                 | Outcome                                                                 |
|-----------------------------|-------------------------|------|-----------------|--------------------------------------------------------------------------|-------------------------------------------------------------------------|
| Actinic keratosis           | Bencini et al.          | 2012 | 12              | To study efficacy of microneedling with topical PDT                      | 83% showed complete response                                           |
| Acinic keratosis and photodamage | Torezan et al.       | 2013 | 10              | Comparison of PDT with and without microneedling                        | Combination better (P=0.004)                                            |
| Primary axillary hyperhidrosis | Kim et al.             | 2013 | 20              | To study efficacy of FMRF                                                | Reduced number and size of sweat glands                                 |
| Striae rubra                | Sanad et al.           | 2015 | 30              | Comparison of microneedling with and without trichloroacetic acid peeling | Combination better (P<0.05)                                             |
| Rosacea                     | Park et al.            | 2015 |                 | To study efficacy of microneedling fractional radiofrequency            | 25-58% improvement                                                      |
| Post-acne erythema          | Min et al.             | 2015 | 25              | FMRF in post inflammatory acne erythema                                  | Improvement seen (P<0.05)                                               |

**Skin laxity**

a. Lax skin on arms, abdomen, neck, thighs, areas between breast and buttocks

b. To tighten skin after liposuction

With respect to dermatology, microneedling is often combined with topical tretinoin and vitamin C for the treatment of acne scarring and skin rejuvenation, as described above. Penetration enhancement of minoxidil and platelet-rich plasma for androgenic alopecia is another application. Microneedling enhances the effect of 5-aminolevulinic acid for more efficacious photodynamic therapy. They have been used in combination for the treatment of actinic keratosis and photosaging.
less efficacious in some types of scars such as pitted scars, linear scars, and deep boxcar scars. However, combining other surgical procedures to microneedling can improve its results.

Certain adverse events are also known with the procedure, the common ones being potential erythema and irritation which usually subside within a few hours. Other events noted are post-inflammatory hyperpigmentation, aggravation of acne and reactivation of herpes, systemic hypersensitivity, allergic granulomatous reactions and local infections following the use of a nonsterile instrument.[6,9,17,22] Allergic contact dermatitis to materials used in the needles has also been observed.[67] Tram-track effect after two sessions of microneedling has been reported in a patient with acne scars who developed regularly placed linear popular scars over bony prominences of the face.[68] This can be avoided by using less pressure and smaller needles over these areas.

Microneedling is relatively safe to use in Indian skin because it rarely leads to hyperpigmentation unlike other ablative and resurfacing procedures.[23] It carries a better safety profile with regards to risk of dyspigmentation in all skin types.[34]

**FUTURE PROSPECTS**

Because skin is an easily accessible tissue, has a good regenerative capacity, and is easily scrutinized directly, it serves as a potential organ for the development of therapeutic and prophylactic genetic medicines. It was demonstrated by Chabri et al. that microneedling can be used for intradermal delivery of a nonviral vector which can be exploited for localized treatment of genetic diseases such as epidermolysis bullosa.[69]

Dermarolling may be useful to dye poorly pigmented hairs and improving laser hair removal because it has been shown that it dilates the follicular infundibulum and increases the transfollicular absorption of melanin.[70]

**CONCLUSION**

Microneedling is an effective modality of treatment, especially in patients with Fitzpatrick’s IV and V skin types because it overcomes the side effects of scarring and hyperpigmentation resulting from other procedures in which the epidermis is compromised. It certainly promises to be a valuable technique with its numerous applications and its ever-expanding modifications as well as feasibility of home use.

**Declaration of patient consent**

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

There are no conflicts of interest.

**REFERENCES**

1. Orentreich DS, Orentreich N. Subcutaneous incisionless (subcision) surgery for the correction of depressed scars and wrinkles. Dermatol Surg 1995;21:543-9.
2. Camirand A, Doucet J. Needle dermabrasion. Aesthet Plast Surg 1997;21:48-51.
3. Bahuguna A. Micro needleing—Facts and Fictions. Asian J Med Sci 2013;4:1-4.
4. Fernandes D. Minimally invasive percutaneous collagen induction. Oral Maxillofac Surg Clin North Am 2006;17:51-63.
5. Bhardwaj D. Collagen induction therapy with dermaroller. Community Based Med J 2013;1:35-7.
6. Nair PA, Arora TH. Microneedling using dermaroller: A means of collagen induction therapy. GMJ 2014;69:24-7.
7. Falabella AF, Falanga V. Wound healing. In: Freinkel RK, Woodley DT, editors. The Biology of the Skin. New York: Parethenon; 2001. p. 281-99.
8. Fabbrocini G, Fardella N, Monfrecola A, Proietti I, Innocenzi D. Acne scarring treatment using skin needling. Clin Exp Dermatol 2009;34:874-9.
9. Majid I, Sheikh G, September PI. Microneedling and its applications in dermatology. InPrime 2014 Sep 15 (Vol. 4, No. 7, pp. 44-49). London: Informa Healthcare.
10. Aust MC, Fernandes D, Kolokythas P, Kaplan HM, Vogt PM. Percutaneous collagen induction therapy: An alternative treatment for scars, wrinkles, and skin laxity. Plast Reconstr Surg 2008;121:1421-9.
11. Liebl H, Kloth LC. Skin cell proliferation stimulated by microneedles. J Am Coll Clin Wound Spec 2012;4:2-6.
12. Jaffe L. Control of development by steady ionic currents. Fed Proc 1981;40:125-7.
13. Kloth LC. Electrical stimulation for wound healing: A review of evidence from in vitro studies, animal experiments, and clinical trials. Int J Low Extrem Wounds 2005;4:23-44.
14. Serrano G, Almudéver P, Serrano JM, Cortijo J, Faus C, Reyes M, et al. Microneedling dilates the follicular infundibulum and increases transfollicular absorption of liposomal sepal melanin. Clin Cosmet Investig Dermatol 2015;8:313-8.
15. Aust MC1, Knobloch K, Reimers K, Redeker J, Ipakchi R, Altintas MA, et al. Percutaneous collagen induction therapy: An alternative treatment for burn scars. Burns 2010;36:836-43.
16. Anastassakis K. The Dermaroller Series. http://www.mtoimportadora.com.br/site_novo/wp-content/uploads/2014/04/Dr.-Anastassakis-Kostas.pdf. [Last accessed on 2016 Jun 22].
17. Doddaballapur S. Microneedling with dermaroller. J Cutan Aesthet Surg 2009;2:110-1.
18. McCrudden MT, McAlister E, Courtenay AJ, González–Vázquez P, Singh TR, Donnelly RF. Microneedle applications in improving skin appearance. Exp Dermatol 2015;24:561-6.
19. Arora S, Gupta BP. Automated microneedling device–A new tool in dermatologist’s kit–A review. J Pak Med Assoc 2012;22:354-7.
Percutaneous collagen induction: An effective and safe treatment for acnes scars. J Cutan Aesthet Surg 2014;7:93-7.

El-Domyati M, Barakat M, Awad S, Medhat W, El-Fakahany H, Hassan R. Comparison of efficacy of combined subcision and dermaroller against combined subcision and cryoroller in treatment of acne scars. J Cosmet Dermatol 2014;13:94-8.

Costa IM, Costa MC. Microneedling for varicella scars in a dark-skinned teenager. Dermatol Surg 2014;40:333-4.

Lee SJ, Goo JW, Shin J, Chung WS, Kang JM, Kim YK, et al. Use of fractionated microneedle radiofrequency for the treatment of inflammatory acne vulgaris in 18 Korean patients. Dermatol Surg 2012;38:400-5.

Lee KR, Lee EG, Lee HJ, Yoon MS. Assessment of treatment efficacy and sebaceous suppressive effect of fractional radiofrequency microneedle on acne vulgaris. Lasers Surg Med 2013;45:639-47.

Kim ST, Lee KH, Sim HJ, Suh KS, Jang MS. Treatment of acne vulgaris with fractional radiofrequency microneedling. J Dermatol 2014;41:586-9.

Min S, Park SY, Yoon JY, Suh DH. Comparison of fractional microneedle radiofrequency and bipolar radiofrequency on acne and acne scar and investigation of mechanism: Comparative randomized controlled clinical trial. Arch Dermatol Res 2015;307:897-904.

Dhurat R1, Sukesh M, Avhad G, Dandale A, Pal A, Pund P. A randomized evaluator blinded study of effect of microneedling in androgenic alopecia: A pilot study. Int J Trichol 2013;5:611.

Dhurat R, Mathapati S. Response to microneedling treatment in men with androgenic alopecia who failed to respond to conventional therapy. Indian J Dermatol 2015;60:260-3.

Farid CI, Abdelmaksoud RA. Platelet-rich plasma microneedling versus 5% topical minoxidil in the treatment of patterned hair loss. J Egyptian Women’s Dermatol Soc 2016;13:29-36.

Chandrashekar B, Yepuri V, Mysore V. Alopecia areata-successful outcome with microneedling and triamcinolone acetionate. J Cutan Aesthet Surg 2014;7:63-64.

Fabbrocini G, De Vita V, Fardella N, Pastore F, Anunziata MC, Mauriello MC, et al. Skin needling to enhance depigmenting serum penetration in the treatment of melasma. Plast Surg Int 2011;2011:158241.

Budamakuntla L, Loganathan E, Suresh DH, Shanmugam S, Suryanarayana S, Dongare A, et al. A Randomised, Open-label, Comparative Study of Tranexamic Acid Microinjections and Tranexamic Acid with Microneedling in Patients with Melasma. J Cutan Aesthet Surg 2013;6:139-43.

Lima Ede A. Microneedling in facial recalcitrant melasma: Report of a series of 22 cases. An Bras Dermatol 2015;90:919-21.

Markantoni V, Kouris A, Vavouli C, Armyma K, Plesou N, Antoniou C, Kontochristopoulos G. Combination of microneedling and trichloroacetic acid 10% peels in the management of infraorbital dark circles. J Am Acad Dermatol 2015;72:15.

Kontochristopoulos G, Kouris A, Platsidaki E, Markantoni V, Gerodimou M, Antoniou C. Combination of microneedling and 10% trichloroacetic acid peels in the management of infraorbital dark circles. J Cosmet Laser Ther 2016;15:1-4.

Bencini PL, Galimberti MG, Pellacani G, Longo C. Application of photodynamic therapy combined with pre-illumination microneedling in the treatment of actinic keratosis in organ transplant recipients. Br J Dermatol 2012;167:1193-4.

Torezan L, Chaves Y, Niwa A, Sanches JA, Festa-Neto C, Szeimies RM. A Pilot Split-Face Study Comparing Conventional Methyl Aminolevulinate-Photodynamic Therapy (PDT) With Microneedling-Assisted PDT on Actinically Damaged Skin. Dermatol Surg 2013;39:1197-201.

Kim M, Shin JY, Lee J, Kim JY, Oh SH. Efficacy of fractional microneedle radiofrequency device in the treatment of primary axillary hyperhidrosis: A pilot study. Dermatology 2013;227:243-9.
59. Sanad EM, Aginaa HA, Sorour NE. Microneedling system alone versus microneedling system with trichloroacetic acid in the management of abdominal striae rubra: A clinical and histopathological study. J Egyptian Women’s Dermatol Soc 2015;12:96-101.

60. Park SY, Min S, Suh DH. P102: Clinical and histological effect of fractional microneedling radiofrequency treatment on rosacea. Program book (formerly proceedings). 2015;67:439-40.

61. Seonguk MI, Park SY, Yoon JY, Kwon HH, Dae Hun SU. Fractional Microneedling Radiofrequency Treatment for Acne-related Post-inflammatory Erythema. Acta Derm Venereol 2016;96:87-91.

62. Oh JH, Park HH, Do KY, Han M, Hyun DH, Kim CG, et al. Influence of the delivery systems using a microneedle array on the permeation of a hydrophilic molecule, calcein. Eur J Pharm Biopharm 2008;69:1040-5.

63. Badran MM, Kuntsche J, Fahr A. Skin penetration enhancement by a microneedle device (Dermaroller®) in vitro: Dependency on needle size and applied formulation. Eur J Pharm Sci 2009;36:511-23.

64. Kolli CS. Microneedles: Bench to bedside. Ther Deliv 2015;6:1081-8.

65. Kim YC. Park JH, Prausnitz MR. Microneedles for drug and vaccine delivery. Adv Drug Deliv Rev 2012;64:1547-68.

66. Donnelly RF, Morrow DI, McCarron PA, Woolfson AD, Morrissey A, Juzenas P, et al. Microneedle-mediated intradermal delivery of 5-aminolevulinic acid: Potential for enhanced topical photodynamic therapy. J Control Release 2008;129:154-62.

67. Yadav S, Dogra S. A Cutaneous Reaction to Microneedling for Postacne Scarring Caused by Nickel Hypersensitivity. Aesthet Surg J 2016;36:168-70.

68. Pahwa M, Pahwa P, Zaheer A. “Tram track effect” after treatment of acne scars using a microneedling device. Dermatol Surg 2012;38 (7pt1):1107-8.

69. Chabri F, Bouris K, Jones T, Barrow D, Hann A, Allender C, et al. Microfabricated silicon microneedles for nonviral cutaneous gene delivery. Br J Dermatol 2004;150:869-77.