Microdermabrasion: An Evidence-Based Review

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Summary: Microdermabrasion is a popular technique used in the treatment of several skin problems, including acne, acne scarring, striae distensae, and photoaging. This article will review the relevant literature and use an evidence-based approach to evaluate the clinical efficacy of microdermabrasion in skin care. In summary, microdermabrasion appears to be a procedure that can produce changes in dermal matrix constituents and result in improvement in skin contour irregularities. It may also be beneficial in improving transepidermal delivery of certain medications. Its role in the treatment of dyschromias and acne vulgaris is limited. (*Plast. Reconstr. Surg.* 125: 372, 2010.)

Microdermabrasion ranks as one of the top five minimally invasive cosmetic procedures performed in the United States, with almost 900,000 cases performed in 2007 (American Society of Plastic Surgeons). It is also one of the most highly questioned procedures in discussions of efficacy. Many physicians believe that the procedure has minimal clinical effect. This article will serve as an evidence-based review of the clinical uses for microdermabrasion and the science behind the procedure to define its role in the cosmetic surgeon's armamentarium.

Microdermabrasion or particle resurfacing is a minimally invasive procedure that relies on an abrasive component, usually aluminum oxide crystals, and a vacuum component. Microdermabrasion has evolved since it was initially described for scar camouflaging by Monteleone in 1985. Today, there are various microdermabrasion systems that differ based on the source of the abrasive component. Most systems use an inert crystal, such as aluminum oxide or sodium chloride, that is propelled at the skin through a handpiece. In other systems, the abrasive stimulus is a handpiece with coarse crystals (e.g., diamonds) embedded on the handpiece's contact point with the skin. Regardless of the abrasive stimulus, microdermabrasion devices are basically a closed-loop system. In systems that use aluminum oxide or sodium chloride as an abrasive stimulus, there is a receptacle of unused crystals attached to a compressed air source that propels the crystals through tubing and then through a handpiece. The handpiece is either disposable or sterilizable. Vacuum suction is simultaneously used to collect spent crystals and skin debris that has resulted from the crystals' abrasive action. This refuse is transferred through a distinct set of collection tubing into a waste receptacle, which is then disposed of as medical waste. This closed-loop system ideally prevents cross-contamination between patients. As mentioned previously, crystal-free systems with diamond-studded handpieces differ because they do not propel inert crystals on the skin. Instead, these systems rely on the abrasiveness of the handpiece, much like a diamond fraise in mechanical dermabrasion, to disrupt the skin surface and promote exfoliation. Otherwise, the crystal-free systems are very similar to standard microdermabrasion systems in their components (Fig. 1). Many manufacturers produce aesthetician units that create lower levels of abrasion.

PATIENT SELECTION

Microdermabrasion is used to treat a variety of predominantly cosmetic maladies of the skin. Reports of microdermabrasion to treat signs of photoaging (wrinkles, mottled dyspigmentation),

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Fig. 1. A standard aluminum oxide microdermabrasion system.

acne, acne scars, and striae distensae can be found in the medical literature.[1–3] Many physicians also advocate its use to treat enlarged pores. Microdermabrasion has been used to enhance drug delivery into the skin by removing the stratum corneum.[4] Microdermabrasion appears to have a high safety profile with minimal risk of adverse events. Unlike laser procedures, it is safe in almost all skin types, with a very minimal risk of scarring or pigmentary alteration of the skin.

TECHNIQUE

It is difficult to define a standard technique for microdermabrasion. The procedure likely differs depending on who is providing the treatment. It can be performed by a physician, nurse, or licensed aesthetician. The procedure usually begins by having the patient remove makeup with soap and water. The face is degreased with isopropyl alcohol. Patients are instructed to close their eyes, or moist gauze pads may be placed over the eyes to avoid crystal contact with the conjunctiva. The patient lies supine on the examination room table. The operator grasps the handpiece in his or her dominant hand and holds tension on the skin to be treated to provide as flat a surface as possible. The handpiece is placed on the skin; the occlusion of the handpiece aperture will stimulate crystal flow. Most practitioners will then perform three passes in different directions (vertical, horizontal, and oblique) over the treated skin. The degree of abrasion depends on several factors, including the strength of the flow of crystals, the roughness of the handpiece (particularly with crystal-free systems) and the rate at which it moves over the skin, and the number of passes performed (more passes leads to more abrasion). In our clinic, for facial microdermabrasion, we perform our passes sequentially over the different aesthetic subunits of the face. We begin on one half of the forehead and, after three passes, proceed to the contralateral half of the forehead. This is done for all subunits. We believe that high levels of abrasion generally tend to provide better results, so crystal outflow pressures are maximized. We do, however, decrease suction and crystal outflow pressures in areas of thin skin (e.g., the eyelid) to avoid purpura. The procedure is well tolerated and is described by some patients as the sensation of a "cat's tongue licking them." After treatment, the crystals are wiped away with a mild soap on a warm washcloth. A cool washcloth is placed over the patient's face to soothe any erythema or burning sensation after treatment. A moisturizer is applied to the treated skin, and the procedure is repeated in 1 to 2 weeks. Patients are often told to plan on having at least six treatments on a weekly or biweekly basis and that, after the initial six treatments, they may desire touch-up treatments on an as-needed basis.

RISKS AND COMPLICATIONS

The risks associated with the microdermabrasion procedure are minimal. Most patients will experience erythema and mild pain with the procedure. Minor abrasions may occur if the procedure is performed aggressively. Patients may also develop petechiae if they have thin, photodamaged skin or are taking antiplatelet agents. The petechiae are usually short-lived, lasting about 1 week. Microdermabrasion appears safe in all skin types, and the risk of postinflammatory pigmentary alteration appears to be minimal. Scarring has not been reported; however, it could potentially result if the procedure were performed aggressively. Ocular complications, such as corneal irritation, may occur in crystal-based systems. There is also a risk for autoinoculation of certain viral diseases, such as warts or molluscum contagiosum. These diseases can be spread within an individual by moving the microdermabrasion handpiece across affected skin and then delivering the virus to unaffected skin. Linear groupings of lesions might occur in this situation. Reactivation of latent herpes simplex virus in an orofacial distribution is also a possibility. Some authors have noted the importance of sterilization of microdermabrasion equipment, especially when performing aggressive microdermabrasion, to avoid infectious disease transmission.[5] The most serious adverse effect reported thus far appears to be urticaria in a patient who was allergic to latex and had a history of dermatographism. In this case, there did not ap-

pear to be any latex in the microdermabrasion system, and prick tests with aluminum oxide crystals run through the system were negative. This case may represent a pressure-induced urticaria.[6] Finally, some have suggested that the use of aluminum oxide crystals may increase either operator or patient risk of developing of pulmonary fibrosis or Alzheimer's-type dementia.[7,8] At this time, however, there is no substantiated supporting evidence for this concern in patients or providers of microdermabrasion.

EVIDENCE FOR EFFICACY

Contour Deformities: Acne Scars and Wrinkles

Frequently, patients complain about contour irregularities of their skin. Certain acne scars, rhytides caused by photoaging, and striae distensae may all be looked upon as atrophic scars.[9,10] In fact, fragmentation of collagen fibrils with resulting impairment of their structural integrity is characteristic of photoaged skin and chronologically aged skin.[10,11] Similarly, atrophic acne scars and striae distensae are characterized by disorganized collagen and decreased elastic tissue.[9] An ideal treatment for these conditions would result in generation of new organized collagen and other dermal matrix constituents. Several studies have evaluated the effects of microdermabrasion on contour irregularities. Early studies demonstrated a clinical benefit for aggressive microdermabrasion in the treatment of acne scars.[2] Coimbra et al.[1] demonstrated that weekly facial microdermabrasion performed for 8 weeks resulted in improvement in fine wrinkles, as noted by lay observers looking at patient photographs. This same observation was not made by medical professionals observing the same photographs. Subjects in this study also reported improved texture of their skin, which might speak to improved collagen content, flattening of wrinkles, or decreased roughness caused by hyperkeratosis. These investigators also demonstrated histologic changes in the skin of treated subjects. In biopsy specimens taken after the last treatment, they noted a thickening of the epidermis with concomitant increases in collagen content by Masson's trichome staining. The newly deposited collagen also demonstrated greater organization than seen with control samples of untreated skin.[1] In another study, Shim et al.[12] performed facial microdermabrasion on subjects with skin problems ranging from acne scarring to photodamage. Subjects underwent treatment every 2 weeks for a total of six treatments. Subjects were surveyed to determine their impressions of the treatment. Subjects noted the most improvement in roughness, textural irregularities, and mottled pigmentation and had overall satisfaction in their complexion. Subjects felt there was no change in fine rhytides and acne lesions. In a separate histology study, subjects received aluminum oxide microdermabrasion treatment to dorsal forearm skin every 2 weeks for six treatments. Observers noted an increased thickness of the epidermis and an increase in elastin content. Subjects also demonstrated "inconsistent" increases in collagen content.[12] Other clinicopathologic studies have failed to demonstrate beneficial increases in dermal collagen based on histology, despite evidence suggestive of wrinkle improvement.[13]

Karimipour et al.[14] performed a molecular study to evaluate the effects of a single microdermabrasion study on dermal remodeling and collagen generation. These investigators performed a single aluminum oxide microdermabrasion treatment on photo-protected buttock skin and looked at molecules known to be involved in dermal remodeling and wound healing. The highly sensitive and specific modalities of real-time reverse transcriptase polymerase chain reaction and immunohistochemistry were used to quantify any molecular changes noted after treatment. They found that a single microdermabrasion treatment resulted in statistically significant elevations of proinflammatory transcription factors (AP-1 and nuclear factor-kappa binding) and cytokines (interleukin-1-beta and tumor necrosis factor-alpha). These molecules are well-known regulators of matrix-degrading enzymes known as matrix metalloproteinases that serve to degrade collagen and other dermal matrix components. Matrix metalloproteinases were similarly elevated, and these enzymes were presumed to be important in the removal of damaged collagen, hence, setting the stage for new collagen replacement. Approximately 20 percent of the subjects in this study demonstrated increased type I collagen deposition by immunohistochemical staining (Fig. 2). Interestingly, these investigators did not notice significant disruption of the stratum corneum, suggesting that a minimally invasive resurfacing technique with little effect on the epidermis might have significant effects on the dermis.[14] Recently, we discovered that the microdermabrasion procedure can be optimized to result in consistent collagen elevation if a more aggressive, yet still nonablative, technique is used (publication pending). This may result in improvement in rhytides and other contour irregularities (Fig. 3). In summary, microdermabrasion appears capable of gen-

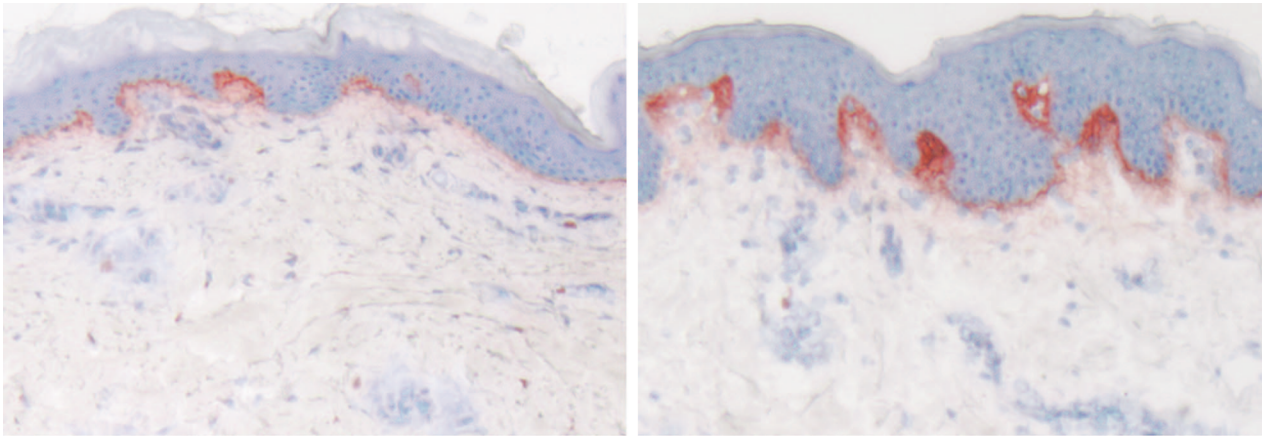

Fig. 2. Immunohistology demonstrating increased type I procollagen production 14 days after a single microdermabrasion treatment. (*Left*) No treatment; (*right*) day 14 after microdermabrasion. (Reprinted from Karimipour DJ, Kang S, Johnson TM, et al. Microdermabrasion: A molecular analysis following a single treatment. *J Am Acad Dermatol.* 2005;52:215–223, with permission from Elsevier.)

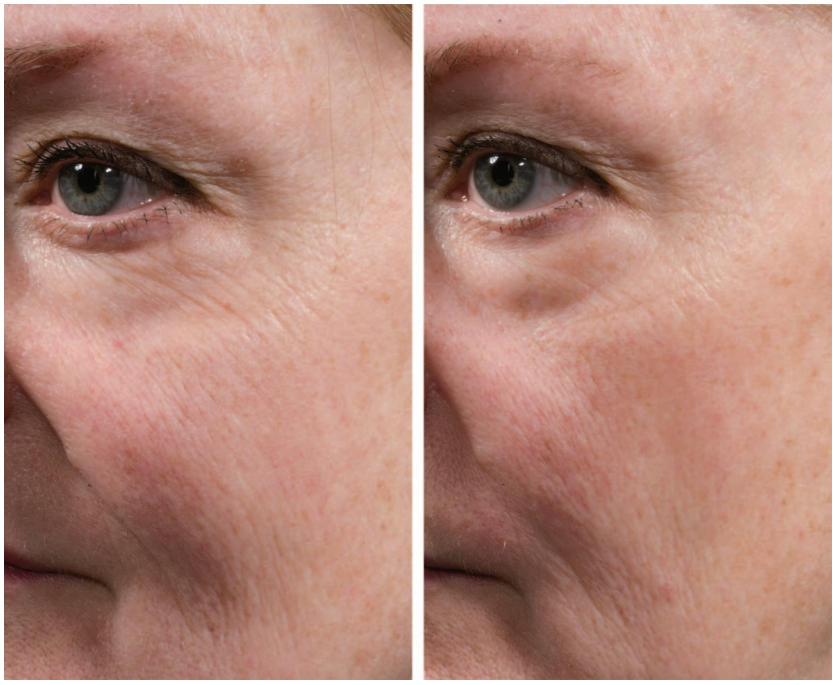

Fig. 3. (*Left*) Subject with periorbital and cheek rhytides before aluminum oxide microdermabrasion. (*Right*) Subject 1 month after six weekly aluminum oxide microdermabrasion treatments. Note improvement in rhytides and pigmentation.

erating collagen and other dermal matrix components, which may "fill in" superficial contour deformities as are seen with fine wrinkles, acne scars, and striae distensae.

Acne

Acne is a common disease of adolescence characterized by comedones, pustules, and nodulocystic lesions that may result in scarring. The pathogenesis of acne is multifactorial, but it is generally accepted that the sebaceous gland plays a key role in the disorder. The sebaceous gland is affected by several pathogenic factors, including follicular hyperkeratosis, androgens, and *Propionibacterium acnes*. Because the sebaceous gland extrudes its contents through the ostium of a hair follicle, it is felt that follicular hyperkeratosis can result in distention and rupture of the sebaceous duct, resulting in an

inflammatory acne lesion. Comedolytic agents, such as tretinoin, are a mainstay of acne therapy due to their ability to "unclog" the hair follicle and allow for better sebum flow.[15] It is felt by many that the controlled abrasion and vacuum components of microdermabrasion might improve acne by removing follicular plugs and hyperkeratosis. Lloyd[3] treated 25 acne patients with microdermabrasion on a weekly basis for a total of eight treatments and demonstrated significant improvements in treated subjects' acne. Unfortunately, as the author noted, this was not a rigorously designed study, as it included no randomization or control group. In addition, subjects were allowed to stay on their acne medications throughout the course of the study. All subjects were taking an oral antibiotic for their acne, and 96 percent of subjects were also using a topical retinoid.[3] Hence, there are many problems with this study, and we believe it has given microdermabrasion an unwarranted designation as a possible treatment for acne. Anecdotally, most patients whom we have treated with microdermabrasion for acne have worsened with the treatment and have done much better when a medical acne regimen was instituted. We have recently completed a split-face randomized controlled study that should debunk microdermabrasion as a possible treatment for this common condition (Karimipour DJ, unpublished).

Dyspigmentation

The role of microdermabrasion in disorders of dyspigmentation (i.e., melasma, lentigines, mottled hyperpigmentation of photoaging) has been evaluated by several authors. Most authors report some improvement in pigmentary changes associated with photoaging.[1,12] Shim et al.[12] also demonstrated possible histologic correlates to the improvement noted by her group in mottled skin pigmentation associated with photoaging. In the histologic portion of her study, she demonstrated more regular distribution of melanosomes within the epidermis, as well as decreased melanization of the epidermis.[12] On the contrary, other investigators have found microdermabrasion to be of little benefit in disorders characterized by hyperpigmentation. Its effects on melasma were minimal in one study.[16] Alam et al., in a study comparing microdermabrasion to glycolic acid peels for efficacy, demonstrated that microdermabrasion performed poorly when patients were surveyed regarding their impression of microdermabrasion's effects on pigmentation.[17] The subjects in this study were nurses in Dr. Alam's practice, so these results could be complicated by selection bias.

Given the available evidence, the role of microdermabrasion for the treatment of dyspigmentation is uncertain. In our practice, we generally prefer to use other modalities in the treatment of dyspigmentation.

Drug Delivery

The stratum corneum provides a barrier to the percutaneous absorption of compounds.[18] There has been significant interest in enhancing the permeability of certain substances into the skin for therapeutic purposes. By increasing permeability, transdermal delivery could prove more effective as a therapeutic alternative. Increasing the permeability of the barrier is important to dermatologists and plastic surgeons who might advocate topical cosmetic preparations to their patients. Photodynamic therapy is a treatment modality that is used to treat acne, nonmelanoma skin cancer, actinic keratoses, and photoaging. It depends on the absorption of a drug precursor, 5-aminolevulanic acid, which is converted into protoporphyrin IX in vivo. 5-Aminolevulanic acid is a hydrophilic molecule that is poorly absorbed across the lipophilic stratum corneum. In high concentrations, it can be used to enhance absorption; however, this can create skin irritation. Microdermabrasion has been shown to enhance absorption of the acid. This could enhance the efficacy of the procedure and allow lower concentrations of 5-aminolevulinic acid to be used, which might be less irritating to patients.[19] Microdermabrasion before application of 5-aminolevulinic acid also appears to speed up the acid's absorption, shortening incubation times from hours to potentially minutes.[20] This could greatly enhance a physician's productivity and be more convenient for patients, as they could thus avoid prolonged application and waiting times in the physician's office. Some studies have demonstrated that the duration and aggressiveness of microdermabrasion treatment may enhance drug absorption.[4] Similar findings have been demonstrated with the application of hydrophilic vitamin C, a potential cosmeceutical.[21] Most investigators suggest that microdermabrasion facilitates this increased permeability by altering the architecture of the stratum corneum.[4,21] In short, microdermabrasion appears to enhance the absorption of hydrophilic substances across the lipophilic epidermal barrier.

CONCLUSIONS

Microdermabrasion is a safe procedure that has indications in the realm of dermatology and plastic surgery. It should also be noted that it has several limitations in terms of efficacy for certain diseases. Several authors have illustrated that microdermabrasion may play a role in the improvement of skin contour irregularities, including rhytides and acne scars. Although microdermabrasion can improve certain dyschromias, it may be less effective than glycolic acid chemical peels. The role of microdermabrasion in the treatment of acne vulgaris is dubious, as there are no well-designed, randomized, controlled clinical trials reported to date. It also appears helpful in enhancing transdermal drug delivery.

It is our practice to perform microdermabrasion for conditions characterized by contour irregularity and mottled dyspigmentation caused by photoaging in patients who prefer minimal downtime. Our experience with microdermabrasion for the treatment of acne has been lackluster, and it is never recommended in our clinic. There is a wide range of clinical outcomes when performing this procedure. Optimizing the microdermabrasion procedure likely depends on being aggressive—that is, using prolonged applications of high-pressure settings that may potentially result in bruising or pinpoint bleeding.

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