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Acne scarring: A classification system and review of treatment options
[Clinical Review]

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Abstract

Acne is a common condition experienced by up to 80% of people between 11 and 30 years of age and by up to 5% of older adults. In some patients, the severe inflammatory response to Propionibacterium acnes results in permanent, disfiguring scars. Over the past several decades, numerous descriptive terms and surgical techniques have been used to diagnose the types, and improve the appearance, of scarring in those persons with acne. We propose a descriptive, simple, universally applicable acne scar classification system that includes 3 scar types: icepick, rolling, and boxcar. We also have developed an effective treatment algorithm for reconstructing and improving the appearance of acne scars including punch excision, punch elevation, subcutaneous incision (Subcision), and laser skin resurfacing. This new classification system for acne scars enables the physician to more precisely identify scar subtypes. Once the scar type has been defined, appropriate and effective treatment protocols can be developed. (J Am Acad Dermatol 2001;45:109-17.)

Acne is a common disorder experienced by up to 80% of people between 11 and 30 years of age and by up to 5% of older adults.[1,2] It is caused by several factors including increased sebum production, follicular hypercornification, colonization with Propionibacterium acnes, and a lymphocytic and neutrophilic inflammatory response.[3-5] For most patients acne remains a nuisance with occasional flares of unsightly comedones, pustules, and nodules. For other less fortunate persons, the severe inflammatory response to P acnes results in permanent disfiguring scars. Stigmata of severe acne can lead to social ostracism, withdrawal from society, and severe psychologic depression.[6] Patients dislike the appearance of acne, and prevention of acne scarring is often a key motivation behind treatment. Aggressive treatment of acne that is prone to scarring occasionally prevents this outcome. Once scarring has occurred, patients and physicians are left to struggle with the options available for improving the appearance of the skin.

Several reviews of acne scar treatment exist in the literature, but there has been no previously accepted standard classification system for the types of acne scarring.[7-12] Terms such as narrow, wide, deep, shallow, icepick, pitted, crater-like, saucer-shaped, diffusely depressed, and severe atrophic have all been used to describe acne scars. Most physicians agree on the concept of icepick scars, but the other terms can be vague and confusing. To consistently discuss treatment options, it is important to use the same defining language in the description of scars.

THE ACNE SCAR CLASSIFICATION SYSTEM

We have devised a simple classification system that is universally applicable. Acne scarring can be divided into 3 basic types: icepick scars, rolling scars, and boxcar scars (Fig 1). Boxcar scars can be further subdivided into shallow or deep. Although many scar types have been described for acne, the lack of consistency in scar description precludes accurate comparison among studies. There are certainly subtle variations within each subtype, but we have found remarkable consistency within this new simple classification system when categorizing scars and most acne scars can be classified in this way.

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Fig 1. A novel classification system: 3 basic scar types—icepick, rolling, and boxcar

(superficial and deep). Yellow reference line denotes depth of ablation and resurfacing capability of the CO_2 laser. Green line represents superficial musculoaponeurotic system to which fibrous bands adhere, creating rolling scars.

The general principle guiding this classification system is that scar subtype classification must be done with therapeutic options in mind. Specifically, any useful classification system for acne scars must take into account the ultimate treatment options. Because scars have both a natural biology as well as distinctive physical characteristics, these attributes, when taken together, allow acne scars to fall into 3 general categories: icepick, boxcar, and rolling. The important determining features of scar subtypes are their width, depth, and 3-dimensional architecture. Although the characteristics of icepick, boxcar, and rolling scars may be seen histologically, physical examination alone can and should be used to distinguish these entities.

Current treatments allow the surgeon to treat the surface, depth, or entirety of a scar. This new classification system marries scar anatomy with the available effective treatment options, facilitating precise identity and classification of acne scar types. Ultimately this will enhance treatment outcomes by making the choice of treatment options less random and more reproducible from patient to patient.

Icepick scars

Icepick scars are narrow (<2 mm), deep, sharply marginated epithelial tracts that extend vertically to the deep dermis or subcutaneous tissue. The surface opening is usually, but not always, wider than the deeper infundibulum as the scar tapers from the surface to its deepest apex (Fig 2). Their depth is below that reached with conventional skin resurfacing options.

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Fig 2. Icepick scars scattered on the cheek.

Rolling scars

Rolling scars occur from dermal tethering of otherwise relatively normal-appearing skin and are usually wider than 4 to 5 mm. Abnormal fibrous anchoring of the dermis to the subcutis leads to superficial shadowing and a rolling or undulating appearance to the overlying skin (Fig 3). Although they tend to be shallow, the subdermal tether precludes treatment from the surface above. Correction of the subdermal component is essential for treatment success.

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Fig 3. Numerous rolling scars along the chin and cheeks.

Boxcar scars

Boxcar scars are round to oval depressions with sharply demarcated vertical edges, similar to varicella scars. They are clinically wider at the surface than icepick scars and do not taper to a point at the base. They may be shallow (0.1-0.5 mm) or deep (>=0.5 mm) and are most often 1.5 to 4.0 mm in diameter (Fig 4). Shallow boxcar scars are within the dermal reach of skin resurfacing treatments (such as laser skin resurfacing), but deeper boxcar scars are resistant to improvement in the absence of full-thickness treatment of the scar.

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Fig 4. Arrows highlight small, medium-depth boxcar scars on the cheek.

Other less common scars such as sinus tracts, hypertrophic scars, and keloidal scars may occur after acne treatment. Their treatment options include excision, cryosurgery, pulsed dye laser treatment, compression with silicone sheeting, and various other modalities. These scars and treatment techniques have been reviewed elsewhere.[10]

TREATMENT OPTIONS

Treatment of acne scars must be individually directed for each patient depending on the types of scars present. Where needed, several surgical sessions are performed a minimum of 4 weeks apart. It is important that the patient with acne scarring understand that the scar revision process may require more than one surgical procedure for maximum results. Patient history is essential to obtain with evaluation of recent isotretinoin (Accutane, Hoffmann-LaRoche, Nutley, NJ) use and history of keloid or hypertrophic scar formation. For many patients, we have observed that facial or truncal acne scars suggest a tendency to poor wound healing. It is essential for the surgeon to consider this when planning the treatment protocols. Dermabrasion within 6 months of the discontinuation of isotretinoin has been reported to have a high risk of hypertrophic scarring.[13] On the basis of this information, we do not surgically treat patients who have used isotretinoin within the previous 12 months.

A variety of approaches are available for revision of each of the 3 scar types. Nonsurgical methods include subcutaneous or dermal fillers such as autologous fat, Fibrel (Mentor Corp, Goleta, Calif), bovine collagen (Zyderm I and II, Zyplast, Collagen Corp, Palo Alto, Calif), human collagen (Dermalogen, Collagenesis, Inc, Beverly, Mass), hyaluronic acid derivatives (Restylane, Q-Med, Inc, Uppsala, Sweden, and Hyalaform gel, Biomatrix, Inc, Ridgefield, NJ),[14] and polymethyl-methacrylate microspheres with collagen (Artecoll, Rofil Medical USA, Inc, Laguna Hills, Calif).[15,16] Topical approaches include chemical peels (glycolic acid, trichloroacetic acid, phenol) and microdermabrasion or particulate resurfacing. Surgical modalities include primary elliptical excision, punch excision, punch elevation, punch autografting, dermal grafting, dermal planing, subcutaneous incision (Subcision), dermabrasion, and laser skin resurfacing.[9,12,17-20] Simple surgical procedures often produce the best and most reproducible results. We have found this to be especially true with punch excision, punch elevation, Subcision, and laser skin resurfacing, our 4 treatments of choice. Each type of scar has an optimal method by which it can be improved. Icepick scars with deep bases are treated with punch excision. This modality can also be used to treat narrow (<3 mm), deep boxcar scars. Wider (>=3 mm) deep boxcar scars with normal bases can be treated with either punch excision or punch elevation. Shallow boxcar scars are best treated with laser resurfacing. Before the advent of Subcision, filler substances were predominantly used for rolling scars. We have found them to be less effective for these types of scars because their benefits are temporary. Rolling scars are therefore treated preferentially with Subcision, although some may improve slightly with laser skin resurfacing alone. We have found that acne scars further improve when surgical revision is followed by laser skin resurfacing, and we prefer to use this combination approach for most types of scars (Table I).

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Table I. Acne scar subtypes and corrective surgical treatment options

Punch excision

Punch excision of icepick and deep boxcar scars can easily be combined during the same procedure. We recommend that these scars should be at least 4 to 5 mm apart because suturing closely spaced defects can

lead to excess traction and lack of proper wound eversion. If scars are closer together, at least a 4-week interval between the procedures is optimal. Any scar requiring a punch larger than 3.5 mm is repaired by elliptical excision or punch elevation because these larger defects lend to "dog ear" formation on the face. A marker is used to delineate the scars to be excised, and the patient's skin is cleansed with povidone iodine. The tissue is infiltrated subcutaneously with 1% lidocaine plus epinephrine (1:100,000). Ten to 15 minutes later, after adequate anesthesia and vasoconstriction are obtained, the scars including the walls are excised down to fat by the use of appropriate diameters of disposable punch biopsy instruments (1.5-3.5 mm). The punch biopsy instrument should match the diameter of the scar, including its walls. Disposable biopsy instruments are chosen because they tend to be sharper than reusable ones. The scars are easily removed when the punch extends to the fatty layer unless there is a large amount of deep dermal and subcutaneous fibrous tissue. In that event, the punched tissue and any visible fibrous bands can be gently excised with iris scissors and Bishop-Harmon forceps (Skylar Corp, West Chester, Pa). Care must be taken to avoid traction on the newly created walls. Punch excision sites 2 mm or smaller are sutured with one or two 6-0 polypropylene (Prolene, Ethicon, Inc, Somerville, NJ) simple interrupted sutures, with care taken to evert the wound edges. Larger excisions (>=2.5 mm) require 3 or more simple interrupted sutures for best edge approximation. We have found that placing a single buried 6-0 polyglactin 910 (Vicryl, Ethicon, Inc, Somerville, NJ) deep suture for punch holes 2.5 mm or more facilitates good wound healing and scar improvement. The sutures are covered with bacitracin, and a sterile bandage is applied. Sutures are removed 7 days later to prevent track-mark formation. Newly produced linear pink scars fade with time and are less noticeable than the previous deep scars.

Some authors have advocated punch excision with full-thickness graft replacement as a means for improving deep icepick acne scars.[12] The postauricular skin is most often used to create these grafts. Unfortunately, the thickness and color of the postauricular skin often creates a color and textural mismatch leading to unnatural-appearing circles on the face. Dermabrasion or laser skin resurfacing 4 to 6 weeks after graft replacement can be performed to improve the appearance of the graft-filled sites.[21] We have found punch excision to be easier to perform, and results are superior to punch grafting for our patients with icepick scars.

Punch elevation

Punch elevation combines the techniques of punch excision and grafting without the risk of skin color or texture mismatch. It is essential that the scars chosen for this technique have sharp edges and normal-appearing bases. This limits its use to shallow and deep boxcar scars. The punch biopsy tool is first sized to exactly match the inner diameter of the scar. Preparation of the skin is similar to that for punch excision, and disposable biopsy instruments are again used to excise the scar and walls down to fat. Careful elevation of the tissue is performed so that it sits slightly higher than the surrounding skin. Retraction of the grafted tissue occurs during the healing phase, resulting in a leveled surface. The "floating" punched specimen is affixed to the surrounding tissue. This is routinely performed with either sutures or Steri-Strips (3M, St Paul, Minn).[12] We have found that placing a small drop of 2-octyl cyanoacrylate glue (Dermabond, Ethicon, Inc, Somerville, NJ) on the surface of the elevated tissue causes immediate adherence of the tissue into its position and alleviates the need for cumbersome suturing. The areas are then covered with Steri-Strips, bacitracin, gauze, and tape (Hypafix Dressing Retention Sheet, Smith & Nephew, Largo, Fla). The patient is given instructions to gently clean the areas with soap and water twice daily and to apply bacitracin.

Subcision

The technique of subcutaneous incision, or Subcision, was initially described by Orentreich and Orentreich [18] in 1995. It is used to free the tethering fibrous bands that cause rolling scars (Fig 5). They used a tribeveled hypodermic needle to cut the adherent bands beneath the skin. We have found that excellent results can be achieved by using an 18-gauge, 1½-inch NoKor Admix needle (Becton Dickinson and Co, Franklin Lakes, NJ) (Fig 6). The triangular tip (similar to a No. 11 blade) allows smooth and thorough separation of the fibrous

cords.

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Fig 5. Schematic depicting subcision with the NoKor needle. Fibrous bands extend from underside of the dermis (depicted in red) to the superficial musculoaponeurotic system.

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Fig 6. The triangular tipped NoKor needle.

For this procedure, the entire area to be subcised is marked and subcutaneous anesthetic (1% lidocaine with epinephrine 1:100,000) is administered. Once maximal vasoconstriction and anesthesia are obtained, the needle is inserted with the blade facing upwards, at the periphery of the scarred area. It is then turned so that the tip is in a horizontal orientation (parallel to the skin surface) just below the dermal-subcutaneous junction plane, and gently swept across the site (Fig 7). A gentle pistonlike motion is also used to advance the needle through the fibrous bands to release them (Fig 8). The use of 3 insertion sites allows a triangulated approach to heavily fibrous areas and thorough release of the bands. Afterwards, bacitracin and a compression bandage are applied. Risks of Subcision include bleeding (which is uncommon with proper anesthesia and pressure bandages) and excessive fibroplasia leading to subdermal nodule formation. This rare outcome can be improved with low-dose intralesional steroid injections, but often resolves without treatment in 2 to 3 months. Bruising from the procedure fades within 1 week. Patients generally have great improvement of rolling scars (Fig 9), but deeper boxcar scars are not eliminated by Subcision (Fig 10). Some rolling scars, especially those on the chin and upper lip, may require more than one Subcision session for optimal improvement. The use of filler substances (Fibrel, autologous fat, and lipocytic dermal augmentation) in conjunction with Subcision can be performed, but we have found this to be unnecessary.[22,23]

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Fig 7. The horizontal direction of NoKor needle incision.

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Fig 8. A piston-like motion is used to release the fibrous bands with the skin elevated to improve skin traction and facilitate needle motion.

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Fig 9. Patient 1. A, Pre-Subcision. Arrows denote rolling scars on the medial cheek. B, Twelve months post-Subcision with leveling of the skin.

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Fig 10. Patient 2. A, Pre-Subcision with rolling and boxcar scars on the chin. B, Six months post-Subcision. Note persistence of deeper boxcar scars on lateral aspect of the left side of the chin.

Laser skin resurfacing

For those patients with residual scars from excisions, as well as for those with shallow boxcar scars, full-face laser skin resurfacing with the carbon dioxide (CO_2) and/or erbium:YAG (Er:YAG) laser is often helpful. It improves overall texture, thereby producing a more homogeneous appearance to the skin. We recommend waiting a minimum of 6 to 8 weeks before resurfacing to allow the first phase of healing to be complete. Although each person is treated somewhat uniquely, we follow a relatively standard approach to resurfacing patients with acne scarring. We begin with an initial pass over the entire face with the CO_2 laser (Coherent Ultrapulse 5000C, Coherent, Palo Alto, Calif) using the computer pattern generator (CPG) at 300 mJ/pulse, 60 W, and CPG pattern settings of 2 (parallelogram), 9 (the largest size), and a density of 5. The lower edge of the face from the angle of the jaw under the mandibular ramus is feathered at a setting of 250 mJ/pulse and 50 W. Additional passes are then performed over the scarred areas until adequate dermal tightening and effacement of the scars is observed (usually 2-4 additional passes). These are done with either 250 or 300 mJ/pulse and either 50 or 60 W, depending on the depth of the scars, with CPG settings of 2, 9, and a density of 5. One pass of the Er:YAG laser (CB Erbium/2.94, Continuum Biomedical, Dublin, Calif) is then used over the full face with a fluence of 5.2 J/cm^2 (7 mm handpiece, 2 J), overlapping 50% with each spot. This removes some of the residual thermal damage left behind by the CO_2 laser, thereby allowing faster re-epithelialization, less crusting, and less and shorter lasting erythema. In addition, the Er:YAG laser can be used to sculpt the edges of shallow boxcar scars. A different approach is to start with the Er:YAG laser to sculpt the scar edges, then to follow with the pulsed or scanned CO_2 laser to resurface the rest of the face, yielding a homogeneous result. The Er:YAG laser ablates approximately 4 µm of tissue per joule per square centimeter, thus producing reproducible, highly precise skin sculpting.[24]

Dressings consisting of silicone sheeting (Silon-Temporary Skin Replacement, Bio Med Sciences, Inc, Bethlehem, Pa), gauze, and tube netting are placed for 24 hours. The gauze and netting are then removed, and the silicone sheeting is left in place for another 48 hours. The patient is given instructions to soak the exposed areas with cold water for 20 minutes every 2 to 4 hours while awake. Each soak is followed by application of a thick layer of occlusive ointment (Aquaphor Healing Ointment, Beiersdorf, Inc, Wilton, Conn). Seventy-two hours after the procedure the silicone sheeting is removed and patients continue soaks followed by ointment application every 4 hours for 3 to 5 more days. As re-epithelialization progresses, soaks are performed less frequently, and the ointment is substituted with a moisturizer containing sunscreen. Re-epithelialization is usually complete within 7 to 10 days, and most patients are able to resume daily activities 2 weeks after the procedure (Fig 11). Postoperative erythema lasts 6 to 12 weeks on average. Although improvement is seen at the 2-week follow up visit, the patients continue to improve for up to 18 months after laser skin resurfacing for acne scarring.[25]

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Fig 11. Patient 3. A, Before punch excision and laser skin resurfacing of boxcar scars. B, Three months after punch excision and laser skin resurfacing.

Combining treatments

The 3 surgical procedures (punch excision, punch elevation, and Subcision) can be combined in one treatment session if necessary. We usually perform Subcision along with excisions or elevations (or both) if the lesions are not in overlapping areas. Otherwise, Subcision can be performed, with excision or elevation, or both, scheduled 4 to 8 weeks later. Patients return after 4 weeks for re-evaluation and, if necessary, further surgical procedures. Most patients who have had punch excision or elevation will undergo laser resurfacing approximately 6 months later for further textural refinement (Fig 12).

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Fig 12. Patient 4. A, Before excision, Subcision, and laser skin resurfacing. B,

[Help with image viewing] Twelve months after excision, Subcision, and laser skin resurfacing.

DISCUSSION

As far back as 1905, surgical methods have been used to improve the skin that has been scarred by facial acne.[26] Mechanisms used to resurface the epidermis and tighten the dermal collagen have included dermaplaning,[17] dermabrasion, and laser skin resurfacing. Removal or leveling (or both) of individual scars has been achieved via excision, punch excision, punch elevation, dermal grafting, punch grafting, and Subcision. Several excellent reviews of these scar revision modalities have been published.[7-11] Of the variety of choices available, we have found punch excision or elevation (or both), Subcision, and laser skin resurfacing to be the most reliable procedures, resulting in the best clinical outcomes.

Dermabrasion was once the main treatment modality for skin resurfacing.[13] Postoperative complications including alteration in pigment, hypertrophic or keloidal scarring, and milia formation are not uncommon with the procedure.[8] In addition, dermabrasion does not improve icepick or deep boxcar scars optimally. Clinical results from dermabrasion are technique dependent with a steep learning curve, making it less attractive than laser skin resurfacing as a treatment option. A recent study by Walia and Alster [25] evaluated 60 patients with moderate to severe "atrophic" facial scars treated with laser skin resurfacing alone. They demonstrated a subjective 75% clinical improvement in "atrophic" acne scars 18 months after CO_2 laser skin resurfacing.

Other combination approaches to acne scar revisions have been proposed. A small study was performed by Whang and Lee [12] on the combination of chemical peeling with trichloroacetic acid, followed by CO_2 laser skin resurfacing, excision, punch grafting or elevations, and then dermabrasion 6 to 8 weeks later. "Excellent" improvement was noted in 3 of 4 patients who were treated with peels, excisions, scar edge CO_2 laser skin resurfacing, and dermabrasion. We have found our techniques to be as effective and simpler to perform.

Table I is a guide for determining the ideal surgical procedure to correct each type of scar. Icepick and narrow, deep boxcar scars require punch excision because other modalities, including laser resurfacing, do not reach far enough into the dermis to treat the scar base. After excision, patients are left with small linear, nondepressed scars that are much less noticeable. Wide, deep boxcar scars require punch excision or elevation. Rolling scars are best treated with Subcision. Laser skin resurfacing can be used after Subcision, but is not always necessary. Laser skin resurfacing alone is not as effective for rolling scars because it does not release the fibrous tethers. Small shallow boxcar scars can be effectively treated by laser skin resurfacing. Large shallow boxcar scars may also be improved with laser skin resurfacing, although some require punch elevation beforehand. Those patients with surgical scars made via punch excision or elevation with remaining superficial changes after surgical treatment can then undergo CO_2 or Er:YAG laser skin resurfacing. Patients must be reminded that collagen remodeling can take several months to occur, and maximum benefit from resurfacing may not be evident until that time.[25]

The described methods of punch excision, punch elevation, Subcision, and laser skin resurfacing are exceptional tools for acne scar revision. Combinations of surgical and laser options can be used to tailor the treatment to each person. The ability to correctly identify types of scars and perform these straightforward procedures for reducing the appearance of scars can lead to substantial cosmetic improvement for the patient. Each of the procedures will produce improvement when used alone. However, it is the proper identification of scar subtypes and the use of multiple complimentary techniques that produces optimal results.

Acne scarring can cause a tremendous loss of self-esteem and remains a difficult burden for affected patients. Developing a simple classification system using the terms icepick, boxcar, and rolling to describe the 3 major scar types allows physicians to easily assess patients with acne scarring and determine the best approach to treatment.

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