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Treatment of atrophic acne scars by subcision and other modalities

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Abstract
Acne scars are the most common sequelae of the severe inflammatory process of acne. Subcision is used for scars which are adherent and do not flatten on skin stretching. Calcium hydroxylapatite injections have proved to be safe and effective in improving the quality of the extracellular matrix and treatment Atrophic Acne Scars. Caustic peels like trichloroacetic acid peels are beneficial to most types of acne scars. While treating with a full-face peel for acne scars, it is important to achieve mid depth peeling.

Keywords: Atrophic acne scars, calcium hydroxylapatite, cross TCA technique, subcision

Introduction
Acne vulgaris (AV) is a chronic skin inflammation as a result of a complex pathophysiology process. AV has a prevalence of almost 95% in adolescents and will be persistent in adults. 1, 2. The cause of AV is multifactorial, related to genetics, race, hormonal, stress, climate/temperature/humidity, diet, and immune response [1].
Subcision is a surgical technique for treating atrophic scars, wrinkles, and contours using a 23- 26G gauge tri-beveled hypodermic needle inserted through a puncture [2].
Calcium hydroxylapatite (CaHA) monotherapy is safety and effective and its association with high intensity microfocused ultrasound for treating moderate-to-severe atrophic acne scars [3]. A variety of therapeutic modalities can be used to improve acne scars. Chemical reconstruction of skin scars (CROSS) applies high-concentration trichloroacetic acid (TCA) on acne scars with an applicator, usually with a wooden-made pointed tip. TCA is applied for a few seconds until the “white frost” appears on the scar [4].

Post Acne atrophic scars
Acne vulgaris is a disease of the pilosebaceous unit that results in non-inflammatory lesions, such as open and closed comedones, inflammatory lesions, such as papules, pustules, and nodules, as well as scarring of varied degrees [5]. Atrophic acne scarring is very common, with reports indicating some degree of scarring in up to >87% of patients with mild to moderate acne but severe or very severe acne was most likely to develop scarring [6].

Treatment of Atrophic Acne Scars
1. Resurfacing Modalities
- **Microdermabrasion:** It is a minimally invasive technique with a textural benefit. It is superior to chemical peeling, because of more control over exfoliation depth, comparably less discomfort, and little "downtime" [7].
- **Dermabrasion:** With this technique, the epidermis is removed together with or without a portion of the dermis. Neocollagenesis, greater dermal thickness, and improved hydration and epidermal barrier are the consequences of the subsequent wound remodeling [8].
- **Chemical Peeling:** Atrophic scarring can be efficiently treated with deep chemical peels like phenol, but their use is constrained by their increased risk of side effects, particularly post-inflammatory hyperpigmentation (PIH) and prolonged erythema [9].

- **Laser Resurfacing:** Fractional and non-ablative lasers have safer safety profiles than conventional ablative lasers. Pitted acne scars can be successfully treated with the long-pulsed Erbium: Yttrium Aluminum Garnet (Er: YAG) laser in skin phototypes III–V. All Er: YAG lasers are effective at reducing acne scars [7].

2. Volume-Related Modalities

- **Soft Tissue Augmentation:** Fillers are used to boost the soft tissue, and they work best on soft boxcar or rolling scars. Fillers can be used alone or in conjunction with subcision to enhance atrophic acne scars appearance [10].
- **Fat Transplant:** This approach is recommended for severely atrophic scars where deeper tissues have been destroyed. The fat obtained during liposuction is then injected into the atrophic scar from a viable donor site. Subcision should be carried out first. Although there is barely little downtime necessary for the process, it depends on the operator so, the lifespan of correction is doubtful [11].
- **Platelet-Rich Plasma (PRP):** Numerous desirable growth factors found in PRP promote the regeneration of collagen and elastin. It works well on rolling and boxcar scars but is ineffective on icepick scars [12].
- **Human Adipose Tissue Stem Cell- derived Exosomes (ASCE):** In fact, a variety of applications for ASCE have been suggested as novel cell-free therapeutic strategies in regenerative and aesthetic medicine including atrophic acne scars treatment [13, 14].

3. Skin-Tightening Modalities

- **Lasers:** Fractional lasers were created to achieve a balance between the unfavorable side effects of ablative lasers and the limited efficacy of nonablative lasers. By producing columns of thermal injury, known as microthermal zones, this technology only treats small areas of skin but allows for column-like denaturation of the epidermis and dermis (ablative lasers) or dermis only (nonablative lasers). With the reproduction of epidermal stem cells and the repopulation of the ablated columns of tissue with fibroblast-derived neocollagenogenesis, the intervening sections of unharmed skin quickly begin the process of repair [15].
- **Fractional Radiofrequency (FRF):** Fractional Radiofrequency (FRF) uses a variety of electrodes to inflict micro-thermal dermal injuries with intervening zones of unaffected skin. This promotes dermal remodeling with neocollagenesis and neoelastogenesis, as seen by elevated levels of procollagen types I and III and elastin. The elasticity and melanin/erythema index both significantly enhance acne scars in a noticeable way [16].

4. Lifting-Related Modalities

Subcision

Subcision is a procedure in which a needle is put under the acne scar to cut the fibrous tissue (tethers) holding the scar down. This causes the fibrous tissue to loosen, elevating the scar [17]. Furthermore, the produced dermal damage causes clot formation and neocollagenesis, which fills the area left behind and increases scar elevation [8]. Although cannulas have also been used [18], most frequently an 18- or 20-gauge tri-beveled hypodermic needle or an 18-gauge Nokor needle with a triangle tip is used. Bi-level subcision is a refinement of the operation that involves cutting at the upper dermis and subcutaneous tissue levels [19].

Subcision works primarily in rolling and other tethered scars. Boxcar scars improve considerably less than rolling scars, and deeper, wider, and more prominent rolling scars improve more dramatically following subcision than scars that were initially small or shallow. It can be combined with the majority of other procedures like Chemical peeling, PRP, Lasers, Filler, etc. [20]. Infection, bleeding, bruising, and acne flare up are all potential adverse outcomes of the operation, which may call for the use of intralesional corticosteroids [7]. Regular suctioning of the scar significantly improves the subcision effectiveness and prevents depression of the scar from recurring [17].

Calcium hydroxylapatite filler

Calcium hydroxylapatite (CaHA) is a bioceramic with exceptionally high biocompatibility that, when injected, drives the regeneration of collagens I and III, elastin, and proteoglycans, and de novo formation of tissue and vasculature [21].

- **Mechanism of action**

Radiesse is a biodegradable filler made up of 30% synthetic CaHA microspheres (25-45m in diameter) contained in a 70% aqueous carboxymethylcellulose gel carrier. The soluble carrier gel distributes the Radiesse CaHA microspheres evenly, enabling 1:1 correction, and progressively fades, leaving the microspheres at the injection site, where they promote neocollagenesis by fibroblast activation [22], Radiesse provides both immediate (replacement volume) and long-term (collagen biostimulation) volume increase in this manner [23].

Fibroblasts are prevalent in all connective tissues, and whether Radiesse is injected intradermally or at the dermal-subdermal junction, the CaHA microspheres are assumed to activate them and cause collagen formation. Animal studies have revealed that this new collagen development begins four weeks after injection and lasts at least 12 months [24].

A clinical study demonstrated the longevity of collagen stimulation by Radiesse, in which the immediate volume correction, as well as the encouragement of long-term deposition of new collagen surrounding the microspheres, contribute to an average duration of the impact of 12 to 18 months, however, some outcomes have been observed 24 months after injection [25].

CaHA is a soft tissue filler that is biodegradable. Phagocytes degrade the CaHA microspheres into calcium and phosphate ions over time. Because soft tissue lacks progenitor cells for osteogenesis, no calcification or osteogenesis has been recorded in the literature reporting the use of CaHA in a range of soft tissue applications [26].

- **Calcium hydroxylapatite filler in atrophic acne scars**

Soft-tissue augmentation is the basis for the injection of dermal fillers to treat acne scars. Collagen synthesis is stimulated by hyaluronic acid fillers (HAFs). Semipermanent or bio-stimulatory fillers, such as poly-lactic acid (PLL) and calcium hydroxylapatite (CaHA), and permanent fillers stimulate collagen formation more strongly [27].

CaHA's composition is intended to give both quick correction and long-term biostimulatory neocollagenesis. The gel is absorbed over time, fibroblasts emerge, and the process of neocollagenesis begins, stimulating the patient's collagen to grow gradually. The carboxymethylcellulose gel carrier fills the 'missing' space and functions as replacement filler; the microspheres induce neocollagenesis, causing the

spheres to anchor into the soft tissue as the gel dissipates. They act as a scaffold for new collagen development as early as 4 weeks after injection and persist for at least 12 months [27].

CaHA, on the other hand, is not permanent. Over 24 months, the CaHA microspheres are metabolized into calcium and phosphate ions by regular metabolic processes. CaHA does not stimulate osteogenesis in soft tissues, migrate, or obscure diagnostic x-rays. Open trials demonstrated improvement in boxcar scars but failure in icepick scars, implying that combining CaHA with subcision may result in a better outcome [27].

Trichloroacetic Acid (TCA)

Trichloroacetic acid (TCA) is still the go-to medium-depth peeling agent because of its proven safety record. As it penetrates the skin, TCA causes protein coagulation and denaturation. It coagulates proteins found in epidermal and dermal cells, as well as blood vessels. It cannot be neutralized once it has penetrated the skin. Instead, it self-neutralizes when a specific amount of protein has been coagulated. As a result, subsequent applications will force the peel deeper until it is depleted by coagulating proteins deeper in the skin [28].

- **Mechanism of Action of TCA**

Peels are frequently referred to as "light" or "deep" depending on the type or concentration of acid utilized. However, peel depth is affected by several factors other than concentration or acid type. The key variables are the acid concentration, the number of coats applied, skin thickness, percentage of body surface area, and in rare situations, the duration of acid contact with the skin. The qualified physician understands that peeling agents should be evaluated based on their mode of action, either keratolytic agents or protein denaturants, rather than the concentration utilized. TCA, one of the protein denaturants can be employed for both superficial and deeper peels. The mechanism by which TCA causes protein denaturation is not understood yet [29].

- **CROSS Technique**

Chemical reconstruction of skin scars (CROSS) is the treatment of atrophic post-acne scars, particularly ice-pick scars, by the targeted application of greater trichloroacetic acid (TCA) concentrations, which induce dermal collagen remodeling [30].

- **Materials of CROSS**

Materials to perform CROSS included are brushes and the TCA solution [30]:

a. **Brushes:** Use natural hair brushes. They allow more scars per treatment, while synthetic ones are rapidly dissolved by the TCA. The brush hair should be cut with scissors to a length of 3–5 mm.
b. **Trichloroacetic Acid (TCA):** The TCA damage stimulates dermal collagen remodeling for several months which fills and improves the scars' appearance [31].

Trichloroacetic acid (TCA) is applied with a toothpick in Chemical Reconstruction of Skin Scars (CROSS). Despite precautions in CROSS technique, TCA may contact the surrounding skin, resulting in dyspigmentation and decreased patient satisfaction. Failure to reach the base of tapering ice pick scars can result in a suboptimal response [32].

Instead of using a toothpick in CROSS technique for applying TCA, A technique modification by using a blunted tip of an insulin syringe needle (after cutting the sharp tip with scissors) as an applicator. TCA solution is dipped into the needle (TCA is not aspirated). Capillary action on dipping the needle in TCA solution creates a TCA reservoir replacing imbibition as the mechanism of creation of TCA reservoir in a wooden toothpick [33].

Vishwanath *et al*., [32] used this technique on three patients, applying TCA to one half of the face with a toothpick and the other half with a blunted insulin needle (separate needle for each patient). Non-polarized dermatoscopy (Dinolite) was used to magnify frosted areas to precisely determine TCA delivery. When magnified images were compared, the needle showed more precise drug deposition into the depth of the scar and less onto the surrounding skin than the toothpick [32].

Furthermore, despite immersing the needle in 100% TCA for one minute, there were no visible changes in the needle's physical properties. Dedicated applicators with technological assistance that accurately distribute TCA to the base of ice-pick scars would be beneficial in ice-pick scar therapy [32].

It has been used painting CROSS TCA technique for the treartment of atrophic acne scars similar to Vishwanath *et al.* with further modification in 2021. He described the use of 0.3 ml insulin syringe with a 30-gauge needle filled with 0.05 ml of 85% TCA solution, the needle was pressed slowly to apply small amount of the solution to the scar with the bevel pointed downward in a 45° angle. Slight pressure was applied while moving the needle through the base of scar (painting) until frosting was achieved [32].

It has been applied this modified technique on 31 difficult-to-treat acne scars of six different patients. Each patient had 2–7 scars treated using this method once. The average volume of the scars assessed in the study was 2.71 mm^3 before treatment and 1.96 mm3 after treatment. There was a 26.3% average decrease in the volume of the scars after a single treatment using this method**.** The study reported better control of the scar edges with better selectivity to the scars with higher success rates and less dyspigmentation [32].

Conclusion

Effective management of atrophic acne scars involves a combination of innovative treatment modalities, including laser resurfacing, soft tissue augmentation, and chemical peels. Fractional lasers and calcium hydroxylapatite fillers enhance skin texture and stimulate collagen production. Subcision effectively releases tethered scars, and the CROSS technique with TCA offers targeted collagen remodeling for ice-pick scars. Emerging methods, such as PRP and adipose-derived stem cell therapies, show promise for further improvement. Overall, individualized treatment plans tailored to scar types and patient needs can significantly enhance outcomes in scar reduction and skin rejuvenation.

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