Treatment of Acne Scars Using Subdermal Minimal Surgery Technology

Jin Woong Lee, MD,* Beom Joon Kim, MD, PhD,* Myeung Nam Kim, MD, PhD,* and Chang Kyun Lee, MD†

BACKGROUND Acne is a common condition, seen in up to 80% of people aged 11 to 30. In some patients, it can result in permanent scars that are surprisingly difficult to treat, with current treatments for acne scars having limited efficacy. Recently, subdermal minimal surgery technology has been introduced as a novel therapeutic modality for acne scars.

OBJECTIVE To evaluate the clinical efficacy and safety of subdermal minimal surgery technology for treating acne scars.

MATERIALS AND METHODS Ten Korean patients (Fitzpatrick skin type II-V) with acne scars were enrolled in this study. They received three sessions of subdermal minimal surgery technology at 4-week intervals. The treatment parameters were a one-shot 0.15-mL volume of hyaluronic acid (HA) and 70% pressure power with a 10- × 10-mm square-shaped tip. Two independent dermatologists evaluated clinical improvement using a quartile grading scale by comparing digital photographs taken before treatment (baseline) and 3 months after the last treatment. The patients also evaluated any side effects at each visit. At the end of the study, the patients documented pain severity (none, mild, moderate, or severe) during the procedure and degree of satisfaction (worse, no change, mild, moderate, or strong improvement).

RESULTS All volunteers completed the three treatment sessions and were satisfied with the procedure. Three months after the last treatment session, according to the physicians' assessments, two patients had improvement of greater than 75% in acne scars, six had 50% to 75% improvement, and two had 25% to 50% improvement. Patient degree of satisfaction was similar to the physicians' assessment. There were no side effects except transient spot bleeding at entry points and slight edema that resolved within 48 hours.

CONCLUSION Subdermal minimal surgery technology is an effective and safe method for improving acne scars.

The authors have indicated no significant interest with commercial supporters.

Acne scars, a well-known and often permanent sequela of acne, are a common dermatologic condition that is difficult to treat.[1] They result in underlying loss of collagen and elastic fibers during a dermal inflammatory process in patients with acne.[2] They lead not only to cosmetic problems, but also to psychological effects such as emotional debilitation, embarrassment, poor self-esteem, and social isolation.[3,4] A variety of modalities have been advocated to treat acne scarring, including surgical techniques (punch grafts, punch excision, subcision), dermabrasion, chemical peels, traditional ablative, and nonablative laser treatments,[5–12] but these techniques have limited efficacy and different risks, so a combination of different modalities is typically required to achieve successful results.

Recently, subdermal minimal surgery technology has been introduced as a novel treatment for acne scars. The system consists of a central console, an applicator and a disposable kit (Figures 1 and 2). The central console contains the graphic user interface, through which the operator selects the treatment parameters of pressure and dose. The sterile

*Department of Dermatology, Chung-Ang University College of Medicine, Seoul, Korea; †Department of Dermatology, Chungdam Gowoonsesang Dermatologic Clinic, Seoul, Korea

ISSN: 1076-0512 • Dermatol Surg 2010;36:1281–1287 • DOI: 10.1111/j.1524-4725.2010.01623.x

Figure 1. Diagram of subdermal minimal surgery technology.

Figure 2. Diagram of Airgent handpiece.

disposable kit mounted on the applicator contains the fluid capsule, piston, and nozzle for driving the hyaluronic acid (HA) solution into the skin and an adjustable square spacer that sets the distance to the skin and the shape of the lateral fluid dispersion in the dermis. It is performed by pneumatically accelerating a carrier fluid jet containing high-mass molecules of HA. The accelerated jet penetrates the epidermis through a tiny entry point. Upon reaching the dermal layer, the jet immediately spreads laterally in all directions, filling a 10- × 10-mm area. HA spreads inside the dermis with high momentum and creates a lateral dispersion. To the authors' knowledge, no study has been reported using the novel therapeutic modality subdermal minimal surgery technology. Therefore, we evaluated the clinical efficacy and safety of subdermal minimal surgery technology for the treatment of acne scars.

Materials and Methods

The Institutional Review Board of Chung-Ang University Hospital approved this clinical study protocol. There were no conflicts of interest in this study. Written informed consent was obtained from all patients before treatment.

Ten Korean patients (Fitzpatrick skin type II-V) with acne scars were enrolled. All subtypes of acne scar (ice pick, boxcar, and rolling scars) were treated

using subdermal minimal surgery technology (Airgent, PerfAction, Inc., Rehovot, Israel). Exclusion criteria were history of keloid scar formation, active inflammation, oral isotretinoin use within the preceding 3 months, diabetes, pregnancy or lactation, history of collagen vascular disease, and ablative or nonablative laser skin resurfacing within the preceding 3 months. The mean age of the patients enrolled in this study was 29.2 (range 21–40). The patient group consisted of four women and six men. Table 1 summarizes the patient data.

Before treatment, the treatment areas (all subtypes of acne scars) were gently cleansed using a mild cleanser, and a topical anesthetic cream (EMLA, AstraZeneca, Wilmington, DE) was applied for 30 minutes with occlusion. After 30 minutes, the cream was wiped off and with the handpiece the HA solution was shot gently on the acne scar sites but not directly on the inflamed lesions. According to patients' scar conditions, 20 to 50 shots were penetrated into the skin in each treatment session.

Three treatments were performed at 4-week intervals with subdermal minimal surgery technology using 0.15-mL volume of HA per shot and 70% pressure power with a 10- × 10-mm square-shaped tip. After the procedure, an anti-inflammatory cream was applied to the treated area to prevent skin infection. The Food and Drug Administration has approved this therapeutic modality, which is commercially available, for use in dermatological procedures.

A photograph of each patient was taken at baseline, before each treatment session, and 3 months after the last treatment. The same photographer photographed subjects in the same position using identical camera settings and lighting. Two blinded dermatologists evaluated clinical improvement by comparing digital photographs taken before treatment (baseline) and 3 months after the last treatment using a quartile grading scale (Grade 1, <25%; Grade 2, 25–50%; Grade 3, 51–75%; and Grade 4, >75% improvement). During the study, patients were asked to report any adverse symptoms that they experienced. At the end of the study, subjects documented pain severity during the procedure (none, mild, moderate, or severe) and degree of satisfaction (−1 = worse, 0 = no change, 1 = mild improvement, 2 = moderate improvement, 3 = strong improvement).

Results

All patients completed the study. Three months after the last treatment session, according to the physicians' assessments, two patients had improvement of greater than 75% in acne scars, six had 50% to 75% improvement, and two had 25% to 50% improvement (Table 2). The mean grade of clinical improvement achieved, based on the dermatologists' clinical assessment, was 3. According to subtypes of acne scar, ice pick scars were greatly improved, and boxcar and rolling scars were moderately improved. Repeated procedures achieved better results.

The patients were asked to complete a subjective self-assessment using a 5-point scale; two felt that they achieved mild improvement in two patients, five achieved moderate improvement, and three achieved strong improvement (Table 2). Comparison of before and after photographs shows clear improvement of acne scars (Figures 3 and 4). The slight discrepancy

TABLE 1. Summary of Patient Demographics

Sex	N	*Age, Range (Mean)*	*Fitzpatrick Skin Type*					
			I	*II*	*III*	*IV*	*V*	*VI*
Female	4	22–36 (27.7)	—	1	1	2	—	—
Male	6	21–40 (30.2)	—	1	2	2	1	—
Total	10	21–40 (29.2)	—	2	3	4	1	—

TABLE 2. Summary of Patient Outcomes

Patient	*Physician Assessment*	*Patient Self-Assessment*	*Pain Severity*	*Significant Adverse Effect*
1	3	2	Mild	None
2	3	2	None	None
3	4	3	Mild	None
4	3	2	None	None
5	3	3	Mild	None
6	2	1	None	None
7	3	2	None	None
8	3	2	Mild	None
9	2	1	None	None
10	4	3	None	None
Mean score	3	2.1	—	—

between the patient self assessment and the physician assessments might be based on the subjectivity of self-evaluation after most cosmetic procedures. Six patients reported no pain, and four reported mild pain during the procedure (Table 2). Side effects observed were transient spot bleeding at entry points and slight edema that resolved within 48 hours. Other severe adverse events (e.g., infection, long-standing erythema, hyperpigmentation, hypopigmentation, crusting, itching, scarring, and foreign body reaction) were not encountered (Table 2). Six months after the last treatment, there were marked improvements in acne scars and skin texture, and improvement was well maintained (Figure 4).

Discussion

Acne scars are common but surprisingly difficult to treat.[1] They occur because of impaired resolution or healing of damage caused in and around pilosebaceous follicles during active inflammation. The enzymatic activity and inflammatory mediators released from acne follicles also destroy the deeper structures and contribute to the production of

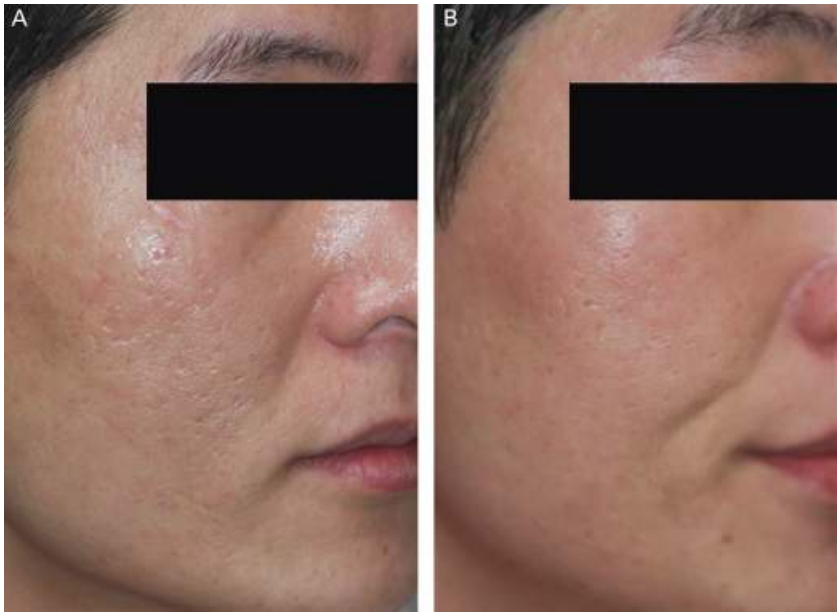

Figure 3. 32-year-old man: (A) before first treatment and (B) 3 months after last treatment. Significant improvement was observed.

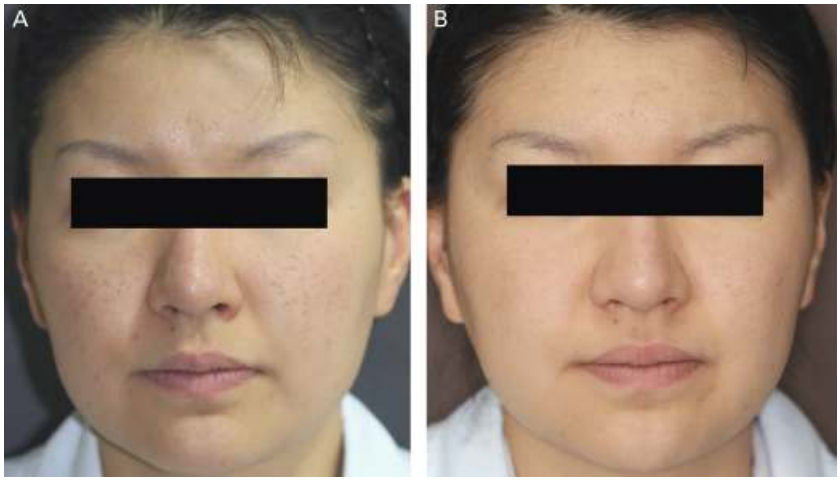

Figure 4. 29-year-old woman: (A) before first treatment and (B) 6 months after the last treatment. Significant improvement was observed.

atrophic acne scars.[2] Acne scars create not only cosmetic problems, but also psychological effects such as emotional debilitation, embarrassment, poor self-esteem, and social isolation.[3,4] Because of these physical and psychological effects, there remains an ongoing need for medical resources to resolve the scarring. Many therapies have been employed to treat acne scars (medical management, surgical management, procedural management, tissue augmentation, light, energy and laser therapy), but most of these modalities result in incomplete improvement and varying degrees of adverse effects.[5–12]

Subdermal minimal surgery technology has been introduced to overcome the therapeutic weaknesses of other treatments. Subdermal minimal surgery technology uses a high-speed jet containing HA molecules, pneumatically accelerated to penetrate the skin through tiny entry points in the epidermis. Sophisticated control precisely spreads the jet laterally within the dermis so that each application uniformly treats a 10- × 10-mm tissue area. These high-mass particles spread inside the dermis with great momentum.

In our study, all participants experienced clinical improvement of acne scars in the physicians' assessments, and all patients were satisfied with the procedure according to their self-assessments. There were no specific adverse effects except for mild pain, transient spot bleeding at entry points, and slight edema that resolved within 48 hours. We achieved good results because of the following mechanisms of this therapeutic modality. First, the HA particles augment the tissue. HA is a highly hydrophilic, natural, linear polysaccharide component of connective tissue in all mammals, so it is not tissue or species specific. Its biocompatibility and non-immunogenicity allow us to use it without pretesting for sensitivity. In addition, it displays isovolemic degradation, in which molecules of HA degrade, allowing those remaining to absorb more water. Thus, it hydrates the skin, and the total volume of gel remains stable.[13–15] HA used in subdermal minimal surgery technology is a cross-linked solution (10% non-cross-linked, 90% cross-linked) with butanediol diglycidyl ether. Deep penetration is achieved because of its low viscosity, unlike the high viscosity of fillers. It works for 6 to 8 weeks in the dermis on the average.

Second, the high-velocity HA particles induce a controlled trauma, like subcision. They act as "nano-bullets" and disturb the dermal cells in their passages, initiating a wound-healing process. The triggered healing process stimulates growth factors

and promotes the formation of new collagen fibers, providing long-term skin remodeling.[16–19] Collagen synthesis gradually replaces the HA's immediate aesthetic contribution.

A variety of approaches are available for treatment of acne scars. The treatment of postacne scars needs multimodal approaches according to scar type (ice pick, boxcar, and rolling) for best clinical outcomes. Several good reviews of these scar treatment modalities have been published.[5,20–23] Of the variety of treatment modalities available, punch excision or chemical reconstruction of skin scars (CROSS) are the most reliable and effective procedures for ice pick scars, subcision for rolling scars, punch excision or elevation for boxcar scars, and laser skin resurfacing for all type of scars.[5,22,23] Because this study is not a comparison study, it is impossible to compare the efficacy of subdermal minimal surgery technology with that of other treatment modalities (e.g., trichloroacetic acid CROSS, subcision, laser resurfacing) directly, but subdermal minimal surgery technology has some advantages over other treatment modalities. The CROSS technique, punch excision, or elevation and subcision are effective and cost-effective for the treatment of acne scars, but these techniques take a long time to heal, and the clinical results of the methods depend on the physician's skill.[23–25] Subdermal minimal surgery technology has short downtimes and is less dependent on physician technique because of the computerized system. Unlike with laser skin resurfacing, subdermal minimal surgery technology does not affect normal skin and operators specifically target the treatment lesion, but post-treatment transient bruising and a loud shooting noise from the machine should be improved in the near future.

In conclusion, our results show that subdermal minimal surgery technology is clinically effective and is associated with minimal complications when used to treat atrophic acne scars. Although few studies have reported on this system, we think that subdermal minimal surgery technology is another effective treatment modality for the treatment of atrophic acne scars in addition to the CROSS technique, punch excision or elevation, subcision, and laser skin resurfacing. One limitation of this study is that all subtypes of acne scar were treated using the same parameters. Better clinical results might be achieved by modulating HA volume and pressure power according to scar type (e.g., high pressure power in deep scars, greater volume of HA in extensive scars). Additional controlled trials including multiple patients, longer follow-up, and different parameters will be necessary to determine the optimal settings for maximum clinical effects.

Acknowledgments This research was supported by Chung-Ang University Research Grants in 2010.

References

1. Alam M, Dover JS. Treatment of acne scarring. Skin Ther Lett 2006;11:7–9.
2. Goodman GJ. Postacne scarring: a review of its pathophysiology and treatment. Dermatol Surg 2000;26:857–71.
3. Cho SB, Lee JH, Choi MJ, et al. Efficacy of the fractional photothermolysis system with dynamic operating mode on acne scars and enlarged facial pores. Dermatol Surg 2009;35:108–14.
4. Hu S, Chen MC, Lee MC, et al. Fractional resurfacing for the treatment of atrophic facial acne scars in Asian skin. Dermatol Surg 2009;35:826–32.
5. Rivera AE. Acne scarring: a review and current treatment modalities. J Am Acad Dermatol 2008;59:659–76.
6. Goodman GJ, Baron JA. The management of postacne scarring. Dermatol Surg 2007;33:1175–88.
7. Garg VK, Sinha S, Sarkar R. Glycolic acid peels versus salicylic-mandelic acid peels in active acne vulgaris and post-acne scarring and hyperpigmentation: a comparative study. Dermatol Surg 2009;35:59–65.
8. Chrastil B, Glaich AS, Goldberg LH, Friedman PM. Second-generation 1,550-nm fractional photothermolysis for the treatment of acne scars. Dermatol Surg 2008;34:1327–32.
9. Chapas AM, Brightman L, Sukal S, et al. Successful treatment of acneiform scarring with CO2 ablative fractional resurfacing. Lasers Surg Med 2008;40:381–6.
10. Tay YK, Kwok C. Minimally ablative erbium: YAG laser resurfacing of facial atrophic acne scars in Asian skin: a pilot study. Dermatol Surg 2008;34:681–5.
11. Gonzalez MJ, Sturgill WH, Ross EV, Uebelhoer NS. Treatment of acne scars using the plasma skin regeneration (PSR) system. Lasers Surg Med 2008;40:124–7.

12. Bhalla M, Thami GP. Microdermabrasion: reappraisal and brief review of literature. Dermatol Surg 2006;32:809–14.

13. Romagnoli M, Belmontesi M. Hyaluronic acid-based fillers: theory and practice. Clin Dermatol 2008;26:123–59.

14. Beasley KL, Weiss MA, Weiss RA. Hyaluronic acid fillers: a comprehensive review. Facial Plast Surg 2009;25:86–94.

15. Bentkover SH. The biology of facial fillers. Facial Plast Surg 2009;25:73–85.

16. Iocono JA, Ehrlich HP, Keefer KA, Krummel TM. Hyaluronan induces scarless repair in mouse limb organ culture. J Pediatr Surg 1998;33:564–7.

17. Fernandes D, Signorini M. Combating photoaging with percutaneous collagen induction. Clin Dermatol 2008;26: 192–9.

18. Fabbrocini G, Cacciapuoti S, Fardella N, et al. CROSS technique: chemical reconstruction of skin scars method. Dermatol Ther 2008;21:29–32.

19. Fabbrocini G, Fardella N, Monfrecola A, et al. Acne scarring treatment using skin needling. Clin Exp Dermatol 2009;21: 1–6.

20. Alster TS, West TB. Treatment of scars: a review. Ann Plast Surg 1997;39:418–32.

21. Solish N, Raman M, Pollack SV. Approaches to acne scarring: a review. J Cutan Med Surg 1998;2(Suppl 3):24–32.

22. Jacob CI, Dover JS, Kaminer MS. Acne scarring: a classification system and review of treatment options. J Am Acad Dermatol 2001;45:109–17.

23. Khunger N. Standard guidelines of care for acne surgery. Indian J Dermatol Venereol Leprol 2008;74:28–36.

24. Alam M, Omura N, Kaminer MS. Subcision for acne scarring: technique and outcomes in 40 patients. Dermatol Surg 2005;31:310–7.

25. Kim HJ, Kim TG, Kwon YS, et al. Comparison of a 1,550 nm Erbium: glass fractional laser and a chemical reconstruction of skin scars (CROSS) method in the treatment of acne scars: a simultaneous split-face trial. Lasers Surg Med 2009;41:545–9.

Address correspondence and reprint requests to: Prof. Beom Joon Kim, MD, PhD, Department of Dermatology, Chung-Ang University Yongsan Hospital, 65-207 Hangangro-3ka, Yongsan-gu, Seoul 140-757, South Korea, or e-mail: beomjoon@unitel.co.kr