Subdermal Minimal Surgery with Hyaluronic Acid as an Effective Treatment for Neck Wrinkles

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BACKGROUND Neck wrinkles are common, troublesome aesthetic deformities for which a limited number of treatments exist. Although previous study has demonstrated the safety and efficacy of subdermal minimal surgery technology in treatment of acne scarring, this technology has never been applied to treatment of wrinkles.

OBJECTIVE To evaluate the efficacy and safety of subdermal minimal surgery technology in the treatment of horizontal neck wrinkles.

MATERIALS AND METHODS All 12 enrolled participants were Koreans (Fitzpatrick skin types II–IV) with horizontal neck wrinkles. Participants underwent up to four sessions of treatment with subdermal minimal surgery technology at 4-week intervals. Wrinkle assessments were conducted at baseline and 2 months after the final treatment session. Participants and physicians evaluated improvement using pre- and post-treatment photographs.

RESULTS All participants completed the study. Improvement of wrinkling by at least 50% was observed at 6 months (2 months after the final treatment session) in more than half of the participants, as determined according to physician and participant evaluation.

CONCLUSION Findings from this preliminary study demonstrate that use of subdermal minimal surgery technology results in an effective decrease of the appearance of neck wrinkles.

The authors have indicated no significant interest with commercial supporters.

Senescent changes in the neck manifest in a variety of ways, most notably accumulation and herniation of adipose tissue, definition loss secondary to jowl formation, bone reabsorption, and laxity of the skin. Vertical muscle bands and horizontal neck rhytides also appear with age because of hyperkinetic activity and platysma muscle atrophy.[1,2] Although the appearance of vertical muscle bands can be lessened with surgical procedures (platysmaplasty) or botulinum toxin injections,[3,4] until recently, horizontal neck wrinkles have been a difficult to treat aspect of facial aging, with most therapies using some form of resurfacing. However, significantly delayed reepithelization and risk of morbidity resulting from fewer pilosebaceous glands in these regions limit application of such treatments to nonfacial skin.

Subdermal minimal surgery is a novel technology whereby a pneumatically accelerated jet of hyaluronic acid (HA) molecules penetrates the epidermis through a small entry point, spreading laterally in all directions at the level of the dermis. Heavy HA molecules are preloaded into the device and can also be directed sideways to allow for lateral dispersion.

Several previous clinical studies have proven that this novel technology can be used for effective treatment of scars resulting from acne, as well as herpes zoster, with minimal morbidity.[5,6] The system

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consists of a central console, an applicator, and a disposable kit. The central console contains a graphic user interface, through which the operator selects the treatment parameters of pressure and dose. The sterile disposable kit mounted on the applicator contains a fluid capsule, piston, and nozzle for driving the HA solution into the skin and an adjustable square spacer that sets the distance from the skin and the shape of the lateral fluid dispersion in the dermis. No studies have been published on specific evaluation of the effects of subdermal minimal surgery for treatment of neck wrinkles, so the present study was conceived and implemented for formal assessment of the safety and efficacy of this novel therapeutic modality in the treatment of horizontal neck wrinkles.

Materials and Methods

All enrolled participants were Koreans (Fitzpatrick skin types II–IV) with horizontal neck wrinkles who underwent treatment with a commercially available subdermal minimal surgery technology (Airgent, Perfection, Inc., Rehovot, Israel). Exclusion criteria included a history of keloid scar formation, pregnancy or lactation, a history of collagen vascular disease, and any ablative or nonablative laser skin resurfacing within the prior 3 months. The Institutional Review Board of Chung-Ang University Hospital approved this clinical study protocol, and none of the authors have any conflicts of interest. Enrolled participants were free to terminate their participation at any time during the study. Twelve participants (8 women, 4 men) with a mean age of 54.7 (range 45–62), with age-related neck degeneration categories II to IV were enrolled (Tables 1 and 2).

After obtaining informed consent, areas of skin to be treated were anesthetized using a topical anesthetic cream (EMLA, Astra Pharmaceuticals, Westborough, MA) applied under plastic wrap occlusion for 30 to 60 minutes before surgery. After removal of the cream using dry gauze, HA solution was shot gently onto the wrinkle sites using the hand piece. Treatment sessions consisted of anywhere from 20 to 50 shots, determined according to the number and length of wrinkling. Each shot contained 0.15 mL of HA and was administered at 70% pressure power using a 10- × 10-mm square-shaped tip. During treatment of the neck, a setting of 70% enabled penetration of HA particles into the reticular dermis. As the pressure was increased, the penetration depth also increased. Penetration of HA particles into the subcutis resulted in a reduction of the augmentation effect. Injections were made perpendicular to the wrinkle line for effective delivery of HA to the intended site, minimizing drug loss and preventing entry site laceration from the edge of the square-shaped tip (Figure 1). Participants received up to four subdermal minimal surgical treatments at 4-week intervals. Immediately after each treatment session, an antibacterial ointment was applied to the area of treatment for prevention of injection site skin infections. Histologic analysis was performed in one volunteer in whom a biopsy specimen was obtained from the treated neck area 2 weeks after the first injection.

TABLE 1. Categories of Age-Related Neck Degeneration

Category	*Description*
I	Platysmal bands only detectable with neck contraction
	Subtle horizontal neck rhytides
	No laxity of the skin
	No submental fat pads
II	Thin platysmal bands
	Minimal jowls
	Mild skin laxity
	Mild horizontal neck rhytides
III	Moderate platysmal bands
	Moderate jowls
	Moderate skin laxity
	Moderate horizontal rhytides
	Submental fat pads
IV	Severe hypertrophy of the platysmal bands
	Deep horizontal rhytides
	Prominent jowls and loss of mandibular contour
	Severe skin laxity
	Prominent submental fat pads/drooping of the chin

From Brandr FS, Bellman B. Cosmetic use of botulinum A exotoxin for the aging neck. Dermatol Surg 1998;24:1232–4.

TABLE 2. Summary of Patient Demographics

			Age-Related Neck Degeneration Categories				
Sex	N	*Age, Range (mean)*	*I*	*II*	*III*	*IV*	*V*
Female	8	45–58 (52.4)	—	3	3	2	—
Male	4	57–62 (59.5)	—	1	2	1	—
Total	12	45–62 (54.7)	—	4	5	3	—

Efficacy assessments were conducted 2 months after the final treatment (6 months from baseline). Standard photographs were obtained at baseline, before each treatment session, and 2 months after the last session. Using baseline photographs for comparison, two blinded dermatologists rated the final appearance of each participant's wrinkles at the 6-month follow-up visit according to the following grading scale: 75% to 100% improvement, 50% to 75% improvement, 25% to 50% improvement, and 0% to 25% improvement. At this time, each participant was also instructed to judge the level of improvement in wrinkle appearance by comparing pre- and post-treatment photographs. Throughout the study, participants were asked to report any adverse symptoms that they experienced.

Results

All participants completed the study. More than half of the participants experienced at least a 50% improvement in wrinkling, according to self and physician assessment at 6 months (2 months after the last treatment session). In addition, roughly 80% of participants showed at least 25% improvement in wrinkling appearance according to physician and self-assessment (Table 3). When stratified according to age-related neck degeneration category, grades II and III were found to be significantly improved, whereas grade IV showed slight improvement. Clinical photographs of representative treatment effects are shown in Figures 2 and 3. Histologic analysis showed HA particles in the reticular dermis and induced trauma to collagen fibers (Figure 4).

Figure 1. 57-year-old man; photograph taken immediately after the first session.

In all cases, participants tolerated the procedure well, reporting only minimal pain and discomfort during treatment sessions. All participants experienced some bruising of the treatment area, which lasted approximately 3 days after each session. A massage with ice relieved pain and swelling, and symptoms subsided within 2 days.

One individual reported an entry-site laceration after the final treatment session, which subsequently disappeared without scarring within 2 months. Two patients also developed some postinflammatory hyperpigmentation, which was also observed to have

TABLE 3. Patient and Physician Ratings of Wrinkle Appearance Improvement 2 Months After Final Treatment with Subdermal Minimal Surgery Technology

	n *(%)*			
Rater	*75–100*	*50–75*	*25–50*	*0–25*
Physician 1	2 (17)	5 (42)	4 (33)	1 (8)
Physician 2	1 (8)	6 (50)	3 (25)	2 (17)
Patient	1 (9)	5 (42)	4 (33)	2 (17)

Figure 2. 57-year-old man: (left) before the first treatment and (right) 2 months after the final treatment. Significant improvement was observed.

faded away by 2 months. No other severe adverse events (e.g., infection, crusting, hypopigmentation, scarring, itching, foreign body reaction) were reported. Only a few participants were available for long-term follow-up, although improvements in these participants were observed for as long as 12 months after treatment.

Discussion

The cutaneous aging process in the neck is in no way unique, clinically manifesting with laxity, atrophy, and loss of elasticity in the cervical skin. Formation of jowls can also occur because of ptosis of the facial portion of the platysma and the general downward pull of the entire platysma muscle complex, ultimately resulting in loss of definition of the chin and jaw line. By accentuating horizontal and radial neck lines, gravity also has a profound effect on the thin, lax, dehydrated skin of the aging neck.[4]

The resulting neck wrinkles are common, troublesome aesthetic deformities for which limited treatments exist. Until recently, the only treatment options for rejuvenation of neck skin were invasive surgery, botulinum toxin injection, and laser treatment.[3,4,7,8] Although such surgical techniques resulted in somewhat reduced platysma banding, they often had little effect on horizontal neck wrinkles, had a high degree of risk, and required prolonged recovery times. Botulinum toxin treatments were also associated with a substantial risk of morbidity, because the higher doses (50–200 U) required for treatment of neck wrinkles can result in hoarseness and difficulty swallowing.[9,10] In addition, significant delays in re-epithelization and risk of morbidity due to the paucity of pilosebaceous glands in the area have limited attempts to use ablative laser therapy on nonfacial skin.

The present study is the first to report on subdermal minimal surgery as a safe and effective technology for the treatment of neck wrinkles. Our results demonstrate that subdermal minimal surgery can achieve markedly decreased neck wrinkling without significant adverse effects, with all participants

Figure 3. 52-year-old woman: (left) before the first treatment and (right) 2 months after the final treatment. Significant improvement was observed.

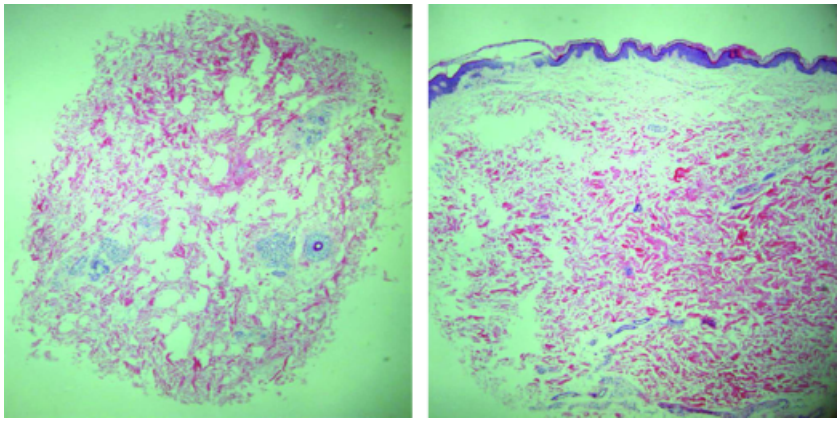

Figure 4. Histologic analysis of treated skin from the neck of a 47-year-old man 2 weeks after the first injection; hyaluronic acid particles in the reticular dermis and induced trauma to collagen fibers. (Left) transverse view (right) longitudinal view (hematoxylin and eosin stain; original magnification $\times 40$).

experiencing noticeable clinical improvements in neck wrinkles according to physician and participant assessment.

Mechanistically, the effect of subdermal minimal surgery on wrinkles is probably similar to that on acne scarring.[6] Specifically, HA particles have the ability to augment any tissue, and HA-based fillers are now the most commonly used dermal fillers. HA is not species specific; it occurs in all tissues of vertebrates and is highly prevalent in human skin; therefore, there is theoretically no need to test patients for allergenicity before use. HA is believed to exist in significantly smaller quantities in intrinsically aged skin and to undergo alteration through photoaging. Two specific properties make HA an effective and practical filler: its capacity for hydrophilic binding to many times its weight in water and the substantial cross-linkage that occurs in HA polysaccharide chains, which results in slow degradation times.[11,12] HA has also been used in subdermal surgical technologies as a bacterial-derived, 2.5-mg/mL, cross-linked solution (10% non-cross-linked, 90% cross-linked), with butanediol diglycidyl ether. It is specially formulated for use in an Airgent device. In addition, when applied at a high velocity to the dermal layer, HA particles induce controlled trauma, augmenting the skin by initiation of natural healing processes. These high-velocity HA particles act as "nano-bullets" and agitate regional dermal cells. Through this process, the wound-healing process is also initiated, presumably resulting in collagen remodeling. This wound-healing process may also involve greater collagen synthesis, which is believed to be responsible for the gradual replacement of HA's immediate aesthetic response.

In conclusion, our results indicate that subdermal minimal surgery can be used safely in the treatment of neck wrinkles and has several advantages over present therapeutic modalities: rapid results, high success rates, predictable outcomes, minimal morbidity, and little patient discomfort. Furthermore, unlike filler injections or botulinum toxin, subdermal minimal surgery technology is less dependent on physician technique; because the device relies on a computerized system, treatment does not affect normal skin, and the operator can specifically target areas of skin to be treated. Postinflammatory hyperpigmentation and laceration were identified as two rare complications of this modality. Except for transient spot bleeding and slight edema, no side effects were reported in previous trials using subdermal minimal surgery for treatment of facial acne scarring. Consequently, further studies are needed for determination of the optimal HA volume and pressure power for use in treatment of nonfacial skin. In addition, more data are needed to determine the optimal intertreatment interval length and longevity of the clinical results.

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