

# Kinetic energy–assisted delivery of hyaluronic acid for skin remodeling in middle and lower face

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## Abstract

**Background:** Kinetic energy of a liquid jet has been demonstrated to achieve clinical efficacy by injecting hyaluronic acid for skin thickening and improving facial sagging. A pneumatically accelerated jet penetrates the epidermis leaving HA particles spherically spread in the dermis and initiating microtraumatic wound healing.

**Method:** We reported retrospective analysis of our successful experience in improving rhytidosis and skin remodeling in the middle and lower facial regions by pneumatically administered HA filler. Subjects seeking correction of facial wrinkles in middle and lower face were treated in 3 monthly sessions with computerized jet-injection device and assessed 6 months thereafter for perception of the wrinkles, rhytidosis burden, and treatment satisfaction.

**Results:** Thirty-four female patients (average age 42 years) with age-related rhytidosis in perioral, cheek, and neck areas received the treatment. The treatments had short downtime, minimal pain, and no side effects. Mean Lemperle Rating Scale score decreased in all treated areas by one full degree and was maintained for 6 months after the treatments. Patients and investigators independently scored the wrinkles as “improved” per Global Aesthetic Improvement Scale. Mean treatment satisfactory score was  $4.0 \pm 1.4$  (out of 5).

**Conclusion:** Retrospective data showed successful implementation of liquid jet injections of HA in correction of aging middle and lower facial regions.

## KEYWORDS

AirGent, hyaluronic acid, jet injection, kinetic energy, skin remodeling

## 1 | INTRODUCTION

Aging is associated with internal processes that visibly change the appearance of the skin. Wrinkles, dryness, laxity, thinning, and loss of elasticity are associated with a synergistic process of photoaging and chronological aging.

Histology studies demonstrate progressing degeneration and lysis of collagen along with reduced density of retinacula cutis ligaments and lowered vascularity.<sup>1,2</sup> Combined with loss of volume and bone atrophy, facial skin ages with visible thinning, rhytidosis

and laxity. Therefore, the main objective for anti-aging treatments is to stimulate dermal collagen, correct skin thickening, and improve facial sagging.

Dermal fillers containing hyaluronan or other biodegradable materials, botulinum toxin, and various sources of energy (laser, light, and radio frequency) have been utilized for age correction therapy. Contrary to classic surgical face lifting, all of these methods have less risks for scarring, infection, nerve damage, and risks associated with anesthesia.<sup>3,4</sup> Their effects on immediate collagen contraction, and tightening and stimulation of collagen synthesis have been proven to be effective for wrinkle reduction and a tightening effect. The

most widely used hyaluronan-based injectable gels fill wrinkles and compensate for volume loss.

As an alternative to traditional correction methods, the needless drug delivery utilizes the kinetic energy of a liquid jet for intradermal administration of drugs. A pneumatically accelerated jet penetrates the epidermis leaving the drug particles spherically spread in the dermis (Figure 1). The depth of penetration is directly related to the injection pressure which was validated clinically<sup>5</sup> and *ex vivo* (Figure 2). The multidirectional dispersion of the material creates microtrauma to the surrounding tissues and initiates wound-healing processes leading to dermal augmentation and remodeling over time.<sup>6,7</sup>

A number of publications demonstrated clinical efficacy of jet-injected hyaluronic acid (HA) for skin thickening, rejuvenation, and nonsurgical face lifting.<sup>5,8,9</sup> This paper reports our own successful experience in improving rhytidosis and skin remodeling in the middle and lower facial regions by pneumatically administered hyaluronic acid in more than 90 treatment procedures.

## 2 | METHOD

The data were collected on the jet treatments performed between August 2017 and September 2018 in a well-established aesthetic clinic in the east coast, USA. Subjects seeking correction of facial wrinkles in middle and lower face were identified and after signing the informed consent undergone the treatment. Pregnant and lactating females, as well as patients with uncontrolled diabetes, history of vascular and autoimmune diseases, recent energy-based aesthetic treatments, and chronic use of anti-coagulants, were excluded. Indicated group with perioral, accordion, marionette wrinkles, and neck lines was treated in 3 monthly sessions with computerized jet-injection device (AirGent 2.0, PerfAction Technologies) and followed during a 6-month period thereafter. At each session, Juvederm Vollure (Allergan) was intradermally injected by the AirGent system in series of consecutive injections.

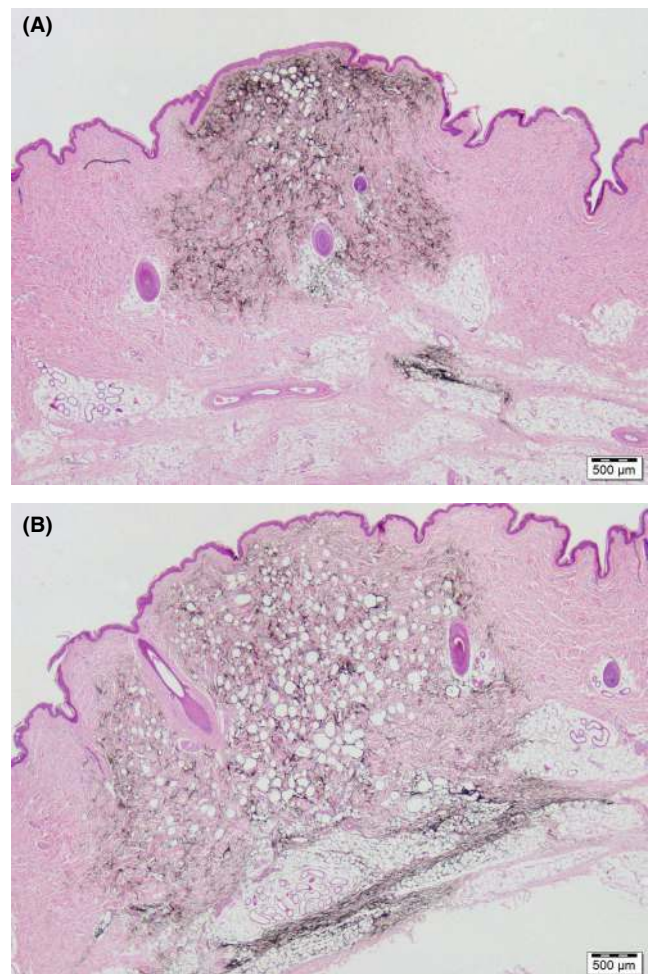
Each injection was set by two parameters— injection volume and pressure. The injection volume was constant at 90  $\mu$ L for all areas; injection pressure varied in order to address variability of regional dermis thickness and to avoid damage to subcutaneous blood vessels. The endpoint of the pressure adjustment was



**FIGURE 1** Multidirectional dispersion of the colored HA jet injected into polyacrylamide gel vial (Courtesy of PerfAction)

appearance of the skin papule, which indicated intradermal deposition of hyaluronan. No local anesthesia was applied before the treatments. The injections were spaced out 1 cm apart along the wrinkle line, with no overlap. After the treatment, patients were recommended to avoid sun exposure and to prevent contamination of the treated area.

Results were evaluated 6 months after the treatments and compared with baseline. Appearance and perception of the wrinkle were assessed by the 4-grade Lemperle Rating Scale (LRS) and the 7-grade Global Aesthetic Improvement Scale (GAIS). Additionally, patients evaluated the rhytidosis burden using 5-grade scoring: 1—“does not bother me”, 2—“slightly bothers me”, 3—“I think of it from time to time”, 4—“I am self-conscious about it”, and 5—“I don't like this area of my body at all.” They also rated their satisfaction with the treatment results per 1-5 scale, ranging from “not satisfied” to



**FIGURE 2** Histological examination of jet-injected Indian ink (porcine model): (A) Injected at pressure 2.52 bar and locally dispersed within dermis at 4.6 mm deep; (B) Injected at pressure 3.57 bar and dispersed in dermis and subcutaneous layers at 7.7 mm deep. Lateral dispersion of ink, absence of mechanical separation between epidermis and dermis, and intact dermal and subdermal blood vessels are observed in both cases (H&E,  $\times 1.25$ ). (Courtesy of Dr A-M. Botero-Anug)

**TABLE 1** Changes in wrinkle severity score (LRS), mean ± SD

Treated area	No. patients	Average treatments per patient	Pretreatment	Posttreatment
Perioral area	13	2.8	2.0 ± 0.7	1.0 ± 0.9
Marionette lines	7	3	3.0 ± 0.5	2.0 ± 0.9
Neck lines	14	2.5	3.0 ± 0.5	2.0 ± 0.9
Total	34	2.7	2.0 ± 0.6	1.5 ± 0.9

Note: 0—no wrinkles, 1—just perceptible wrinkle, 2—shallow wrinkle, 3—deep wrinkle, well-defined edges, and 4—very deep wrinkle redundant fold.

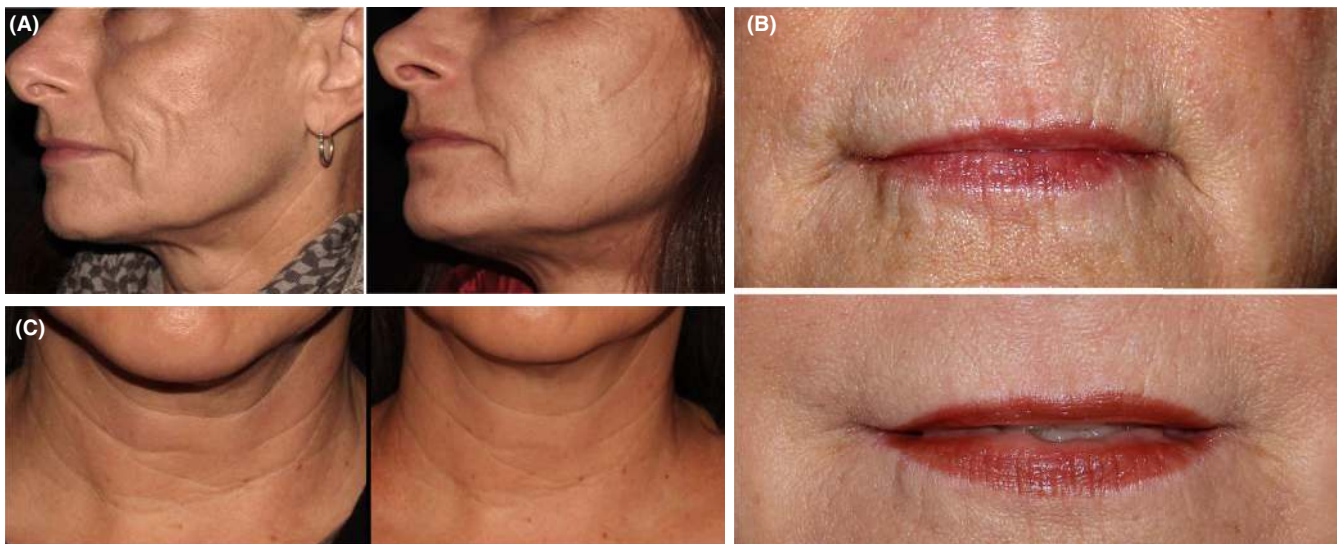
**TABLE 2** Evaluation of posttreatment wrinkle perception (GAIS), mean ± SD

Treated area	GAIS (patient)	GAIS (investigator)
Perioral	1.0 ± 1.0	1.0 ± 0.5
Cheeks	1.0 ± 0.9	1.0 ± 0.4
Neck	2.0 ± 1.2	1.0 ± 0.7
Total	1.0 ± 1.2	1.0 ± 0.6

Note: (3) Very much improved, (2) much improved, (1) improved, (0) no change, (-1) worse, (-2) much worse, and (-3) very much worse.

All patients tolerated the treatments well. Improvement was observed in the entire population: mean LRS score decreased by one full degree in all treated areas (Table 1).

After the treatment, patients and investigators independently scored the wrinkles as “improved” (Table 2). The best score (“much improved”) was achieved for the neck lines (Figure 3). All patients expressed satisfaction with the treatment, at mean satisfactory score of 4.0 ± 1.4.



**FIGURE 3** Pretreatment and follow-up photographs taken at 3 mo demonstrate diminished rhytoidosis in: (A) 48-year-old woman with prominent accordion and marionette lines; (B) 58-year-old woman with perioral lines; and (C) 51-year-old woman with neck lines

“very satisfied”. Injection pain was assessed by 0-10 Numeric Pain Rating Scale.

### 3 | RESULTS

Thirty-four female patients (average age 42 years) received jet-injection treatments; thirty patients were present for the follow-up assessment (Table 1). At baseline, patients demonstrated prominent rhytoidosis in perioral, cheek, and neck areas with high emotional impact: the mean disease burden was scored at 4 ± 0.57 in perioral and 4 ± 0.45 in neck areas.

### 4 | DISCUSSION

Analysis of the retrospective treatment data showed successful implementation of kinetic energy-assisted treatments in correction of aging middle and lower facial regions. Previously, hyaluronic acid demonstrated significant stimulation in production of extracellular matrix components in human and animal models.<sup>10,11</sup> With jet injection, the effect is synergistically enhanced by microtraumatic dispersion of HA particles leading and had a much higher regenerating effect than hydrating and rejuvenation functions of the conventional HA gels. In vitro studies indicated 50% increase in collagen

synthesis and skin hydration after a single JVR injection in the UV-aged human skin.<sup>12</sup> The generated multidirectional spread of HA particles increases total surface of the hyaluronan-to-tissue contact, hence augmenting its therapeutic activity and preventing encapsulation. Histological study revealed focal thickening of collagen fibers, increased number of dermal fibroblasts, and focal upturn of elastin fibers at the injection site.<sup>8</sup> Ultrasound examination performed 6 months after the series of monthly treatments demonstrated significant improvement in dermis thickness in neckline area, nasolabial folds, and forehead compared with baseline ( $P < .05$ ).<sup>7</sup> The most substantial effect was noted in periorbital area with average 2.5 times increase over baseline.

We also assumed that jet-injected HA may have a positive effect on the age-related deterioration of the fibro-septal system (retinacula cutis). Intra- and subdermal spread of HA microparticles generates additional mechanical stress to retinacula cutis (RC). As a result, the density of RC fibers decreases and the deep fascial membrane may become less adhered to the skin. This would allow for greater skin elasticity and increased mobility of the underlying muscles and will result in the lessening of skin sagging in the lower face.<sup>13</sup>

#### 4.1 | Approach for material selection

Although we used Vycross<sup>®</sup>-based HA (Juvederm Vollure), the method of cross-linking plays a minor role in jet treatments. More important criterion is cohesivity of hyaluronan gel since it primarily determines material's integration into soft tissues. Medium cohesiveness of Vollure provided a good spread in the upper and mid-dermis of the treated facial regions. Unfortunately, information on the filler cohesivity is not always readily available, so elasticity modulus G-prime ( $G'$ ) can be used instead. For wrinkle reduction and tightening effect in photoaged facial skin, we recommend hyaluronic acid with low or, in the case of neck skin laxity, even lowest possible  $G'$ .

Additional consideration should be given to viscosity of the injectable material. In order to overcome high viscosity of the hyaluronan gel unsuitable for creating jet of fluid, we diluted the gel with normal saline. The targeted viscosity level was previously determined in experiments and corresponded to HA concentration of 2.5 mg/mL. As the material became less viscous, it created a stream of fluid optimal for skin penetration.

#### 4.2 | Tolerability and side effects

Jet injections of HA has been demonstrated to be associated with minimal injection pain and distress.<sup>5,9,14</sup> The rapid time at which the high-speed liquid jet penetrates the skin produces low stimulation of nociceptors and lessens the pain. Along the propagation, the jet stream applies pressure on the soft tissues and compressed intradermal blood vessels decreasing the chance of posttreatment bruising. In our group, all patients reported low degree of discomfort which contributed to their tolerability and acceptance of the

treatment procedure. Three patients (8%) had minor bruises along with transient swelling and erythema.

Each injection was associated with appearance of transient skin papules and scabbing. The papules indicated intradermal dispersion of HA and were resolved within 24-48 hours; the scabs resulted from the miniscule damage to superficial capillary plexus and stayed for 3-4 days. However, the longevity varied between the patients and mainly depended on the skin hydration levels.

#### 4.3 | Longevity of effect

Published data demonstrated continuous effect of the jet injections up to 9-12 months.<sup>7,8</sup> The wound-healing cascade induced by the tissue microtrauma was reported to last up to 1 year and include collagen proliferation, maturation, and reorganization along with extracellular matrix remodeling.<sup>15</sup> The initial effect observed right after the first treatment was most likely caused by hydration of HA. However, at 6 months after the treatments, 78% of our patients reported continuous improvement which was associated with ongoing wound healing-related dermal regeneration. Nevertheless, a 6-month follow-up was not sufficient for longevity analysis and is considered as a limiting factor in this trial.

### 5 | CONCLUSION

Retrospective analysis of the treatment data demonstrated efficacy of jet injections in correction of age-related skin deterioration in middle and lower face. The synergy between the pharmaceutical mechanism of hyaluronic acid and kinetic energy of the liquid jet decreased facial sagging, and increased skin thickening and tightening. The treatments had short downtime, minimal pain, and no side effects. Results independently assessed by the patients and investigators showed a decrease in the rhytidosis severity which was maintained for 6 months after the treatments.

#### CONFLICT OF INTEREST

Lisa Espinoza, Jaclyn McCreech, Jaclyn Tyson and Maureen McSorley are employees of La Chelé Medical Aesthetics LLC. No conflict of interest claimed. Yuri Vinshtok is an employee of PerfAction Technologies Ltd.

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