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Case Report

Novelty Combination of Radiofrequency and Endogenous Oxygenation for Skin Regeneration in Indonesian Women: Case Series

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Abstract

Introduction: Demographic data projects 68% of Indonesian female population will reach mature age in 2030. Aging Indonesian skin is characterized by redistribution of the skin tone, roughness of the skin surface, substantial decrease of the radiance and prominent wrinkling in periorbital and perioral areas. The current series investigated the efficacy and safety of the novelty treatment combining radiofrequency and technology inducing endogenous oxygenation. The combination provides a multivariant approach in targeting the age-induced skin deficiencies.

Methods: Seven Indonesian female patients (age 36-41 years old, Fitzpatrick IV-V) with photo- and chrono-damaged skin received the treatment course including Radiofrequency (RF) and RF-microneedling combined with Oxygeneo.

Results: One month after, smoothening and tightening of the skin, more defined jawline, clearing of the skin and more even skin tone was observed on the standardized photos. Photo-based improvement was quantified by the physician and the patients at average Global Aesthetic Improvement Scale (GAIS) of 4.0 and 5.0, respectively. Overall wrinkle severity decreased by 50%, from mean 2.00 ± 0.71 to 1.00 ± 0.46, one month after the treatments ($p<0.05$).

Conclusion: The combination of non-ablative radiofrequency, RF microneedling and the technology inducing cutaneous oxygenation was safe and effective in the treatment of aging facial skin. At greatly reduced downtime this combination is suitable for Asian skin.

Keywords: Radiofrequency Microneedling; Voluderm; Oxygeneo; TriPollar; Radiofrequency

Introduction

According to the demographic data, 68% of Indonesian female population projected to reach mature age in 2030 [1]. Unavoidable aging of the skin has a significant impact on the social blending and present a major challenge for the rejuvenation treatments. Structural and biochemical degradation of the dermal cells is associated with decreased activity of cell mitochondria, low oxygen content and decreased production of adenosine triphosphate. Besides deficiency of Extracellular Matrix Elements (ECM), the process results in increased Trans-Epidermal Water Loss (TEWL), malfunction of the natural cell-shedding mechanism and in accumulation of dead cells in the epidermis and senescent toxic cells in the dermis. The process is manifested by skin dryness and uneven texture, appearance and worsening of the wrinkles, skin laxity and constant inflammatory conditions. Aging Indonesian skin is characterized by redistribution of the skin tone (darkening in cheek and lightening in forehead), roughness of the skin surface, substantial decrease of the radiance and prominent wrinkling in periorbital and perioral areas [2]. Mature Indonesians demonstrate a high prevalence of melasma, solar lentigines and seborrheic keratosis, irrespective of hijab wearing. Current anti-aging treatments provide a higher efficacy when combining multivariant methods - neurotoxins, dermal fillers, laser resurfacing and Radiofrequency (RF) [3,4]. The thermal stress generated by RF and applied to dermal tissues leads to the shrinking of collagen fibers and boosted activity of dermal fibroblasts. Accelerated neocollagenesis and neoelastinogenesis contribute to facial tightening and wrinkle reduction. Contrary to lasers with their selective photothermal effect on dermal chromophores, the electrothermal effect of RF has a more generalized impact and can be used in all skin types [5]. Radiofrequency Microneedling (RFMN) utilizes an array of microneedle electrodes to deliver Radiofrequency current (RF) to the dermal layers. The microneedles penetrate the stratum corneum and emit RF creating fractional zones of thermal ablation

and coagulation. The healing process promotes neocollagenesis in correction of skin laxity and the texture and wrinkle reduction [6]. Nevertheless, energy-based modalities cannot facilitate deficiency of oxygen in the aging skin. Auxiliary methods to enhance cutaneous oxygenation through endogenous sources would benefit the treatment outcomes more sufficient and safer [7]. Innovative Oxygeneo technology (Geneo, Pollogen Ltd) utilizes physiologic mechanism of the Bohr's effect, according to which erythrocytes release O_2 to the tissues in the presence of high concentration of Carbon Dioxide (CO_2) [8]. The technology implements the effervescence chemical reaction between citric acid and sodium bicarbonate, both contained in the Oxygeneo tablet and activated on the skin surface. As a result, a large amount of CO_2 diffuses through the epidermal barriers and triggers an increase in skin oxygenation through the influx of oxygen-rich blood. We rationalize that combining RF and endogenous oxygenation could achieve the desired results at minimal discomfort.

Methodology

The efficacy and safety of the combination treatments were retrospectively analyzed in the adult females treated in the outpatient aesthetic clinic in May-September 2023. The patients were seeking improvement of the facial appearance and gave informed consent to the treatments and photo consent. Pregnant, lactating and patients with keloidal tendency, vascular disorders, active acne and chronic dermal conditions in the treatment area, recent resurfacing procedures and injected dermal fillers/neurotoxins were excluded. The participants were asked to abstain from other cosmetic or aesthetic procedures during the entire investigation period. The treatment course consisted of 5 sessions spaced 1 week apart, three of which included non-fractional RF and RF-microneedling combined with Oxygeneo (T1, T3, T5) and two intermittent sessions of only Oxygeneo procedure (T2, T4). Efficacy was assessed 1 month after the last treatment (follow-up, FU) (Fig. 1). RF technologies implemented for the treatments included TriPollar RF and Voluderm RF microneedling, both in Divine Pro device (Pollogen Ltd). TriPollar RF employs a four-electrode configuration, in which the electrical current flows between 2 positive and 2 negative electrodes. Such arrangement delivers a high density of the heat between electrodes, without consuming large power. A disposable Voluderm RF microneedling tip (Gen36L) employs a 6 × 6 array of non-insulated ultrathin 1.0 mm-length microneedles and generates 36 entry-points over $1cm^2$ skin area at each pass.

Treatment Procedures

The combination sessions were conducted in sequential steps. First, non-fractional TriPollar RF was performed on the entire face for 10 min with the target skin temperature not exceeding 41^0C. Second, an Oxygeneo capsule was activated with the water-based gel and massaged over the face to exfoliate the skin, generate CO_2 bubbles and increase inflow of oxygen-rich blood. The gel contains kojic acid, Rosa Canina fruit oil, tocopheryl acetate and hyaluronic acid to additionally brighten the skin, uniform the tone and maintain skin hydration. The procedure was completed with Voluderm RF microneedling, applied to the entire face in a single pass, while the most problematic areas (wrinkles, solar lentils, prominent laxity) received two passes. The settings for the pulse power and the pulse duration were gradually increased to the tolerable maximum.

Efficacy Assessment

Clinical photographs taken at standardized conditions before and one month after the last treatment (Reveal Imager, Canfield Scientific, USA) were reviewed. Severity of the facial wrinkles before and after the treatment was graded according to the photo-numeric Lemperle Classification of Facial Wrinkles (LFW): (0) no wrinkles, (1) just perceptible, (2) shallow, (3) moderately deep wrinkle, (4) deep with well-defined edges, (5) very deep or redundant fold. The images were also separately graded by the physician and patients using Global Aesthetic Improvement Scale (GAIS), comprised of "much worse", "worse", "no change", "improved", "very much improved". Analysis of the treatment tolerability was based on the patient's subjective discomfort documented at each procedure. It was graded using the 1-10 Visual Assessment Scale (VAS), from "no pain" to "most excruciating pain".

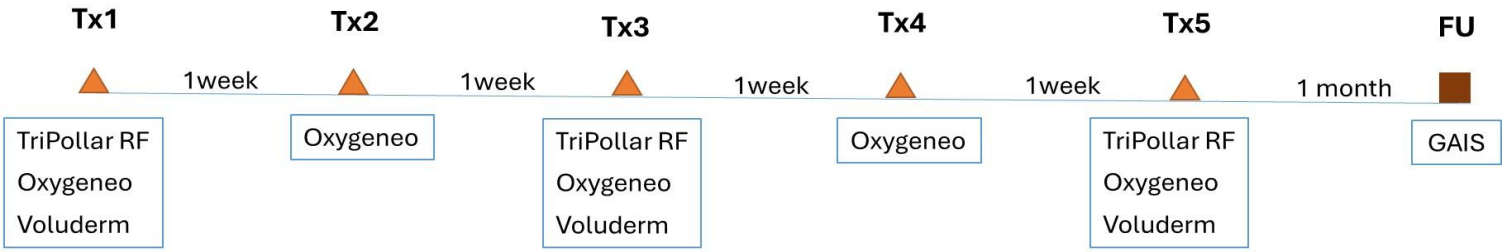

Figure 1: Study procedure protocol.

Results

Seven female patients (age range 36-41 years old, Fitzpatrick range IV-V) with photo- and chrono-damaged skin and shallow to moderately deep wrinkles received the treatment course and were included in the analysis (Table 1). Following the treatments, patients reported self-perceived smoothening and tightening of the skin, more defined jawline, clearing of the skin and more even skin tone (Fig. 2). Photo-based improvement was quantified by the physician and the patients at average GAIS of 4.0 and 5.0, respectively. Overall wrinkle severity decreased by 50%, from mean 2.00 ± 0.71 to 1.00 ± 0.46, one month after the treatments ($p<0.05$). However, the decrease was statistically significant only in forehead, periorbital and corner of the mouth regions ($p<0.05$) (Fig. 3). A mild transient erythema observed after the treatment was induced by increased skin temperature and the CO_2-triggered dilation of cutaneous blood vessels. Tiny scabs appeared after Voluderm microneedling spontaneously resolved in 1-2 days after the treatment. Treatments were easily tolerated without pre-procedural anesthesia. The microneedling discomfort was mild, at mean VAS 4.0 ± 1.184.4 on the 1-10 VAS scale.

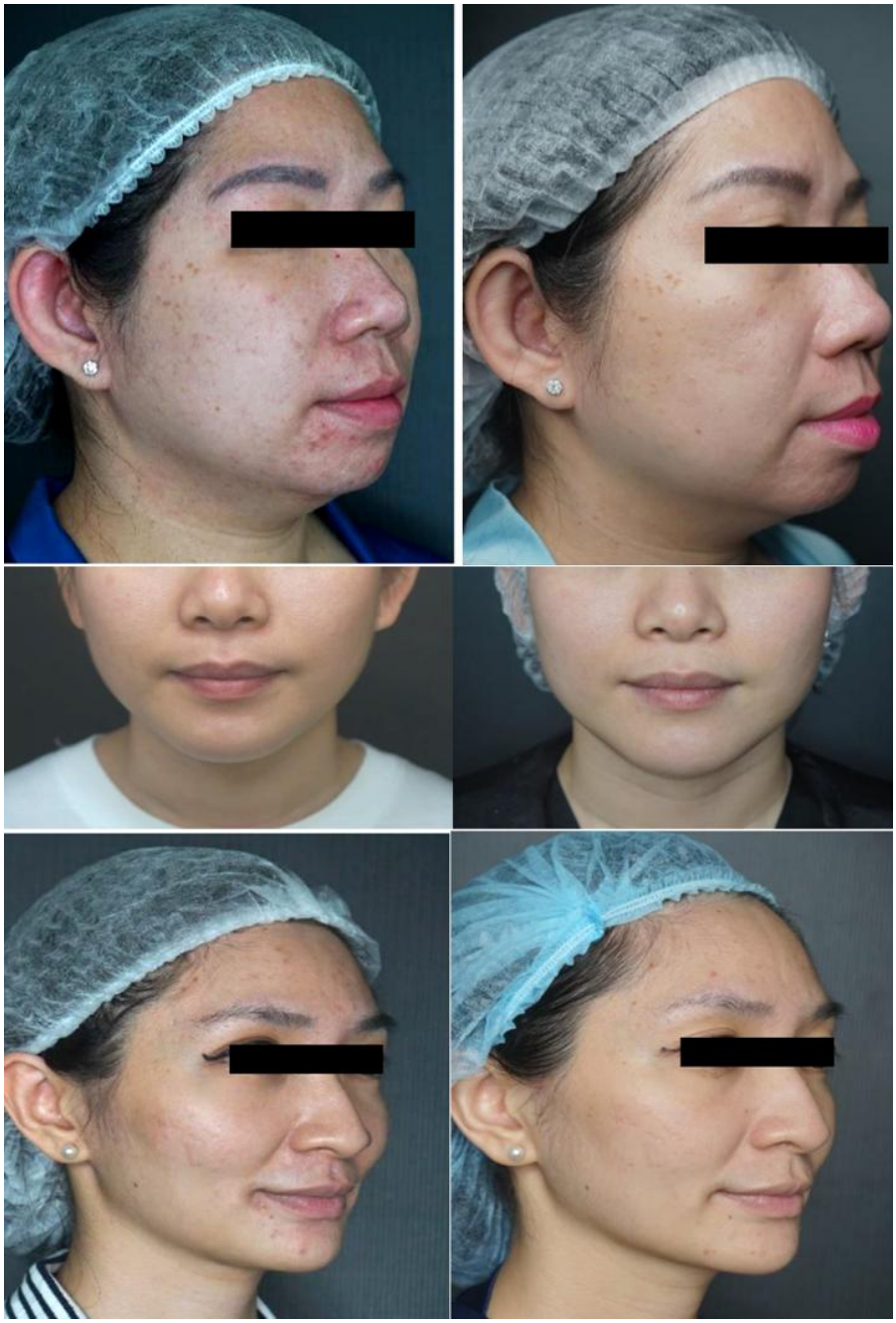

Figure 2: Pictures before and after: A) 41-years old female: drastic improvements in skin texture and reduced inflammation; B) 39-years old female: improved jaw contouring and better-defined V-shape; C) 37-years old female: decreased inflammation, improvements in acne scar, reduction in pore size, lower-face skin tightening, and pronounced jawline contouring.

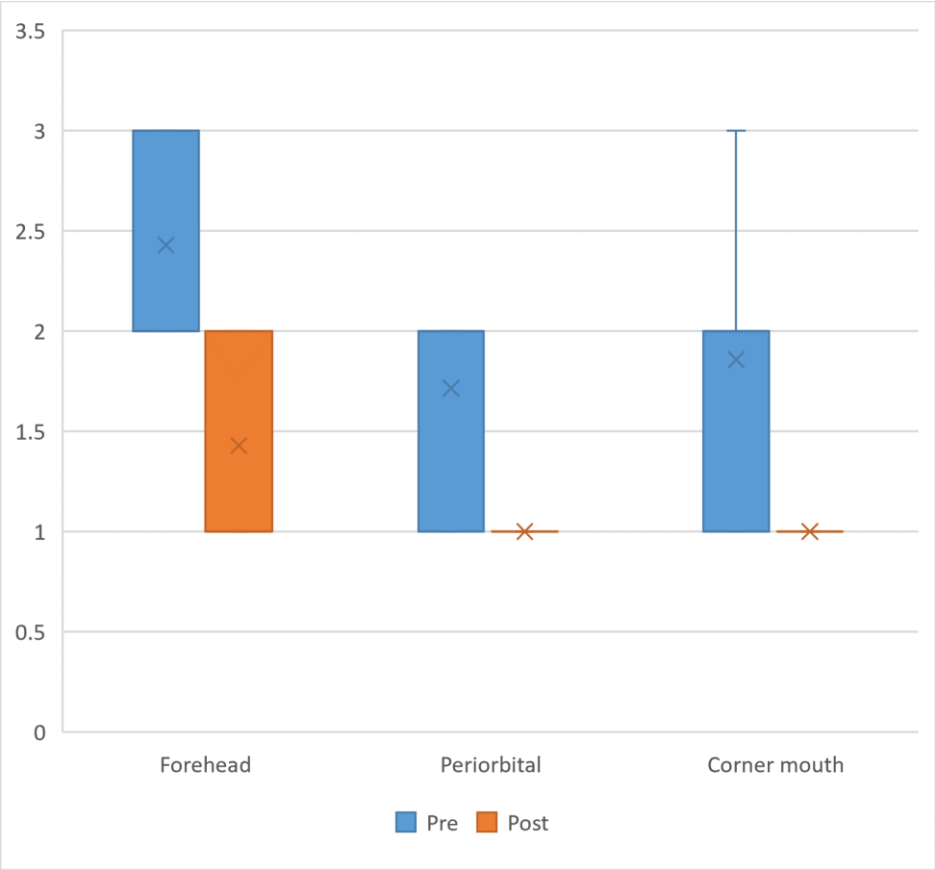

Figure 3: Statistically significant changes in the wrinkle severity ($p<0.05$).

#	Gender	Age	Fitzpatrick Skin Type
1	Female	38	4
2	Female	36	4
3	Female	38	4
4	Female	39	4
5	Female	37	5
6	Female	37	4
7	Female	41	4

Table 1: Baseline characteristics of the patients.

Discussion

Retrospective case series investigated the efficacy of combining radiofrequency and endogenous oxygenation in a group of mid-age Indonesian females presented with facial wrinkles, hyperpigmented and inflammatory spots and rough skin texture. The combination provided a multivariant approach in targeting the age-induced skin deficiencies.

TriPollar Efficacy Mechanism

As the electrical current of RF propagates through the skin, it causes oscillation of the water molecules resulting in heat production. The thermal impact triggers contraction of the collagen fibers and initiation of the wound healing mechanism leading to accelerated synthesis of new collagen and repair of extracellular matrix. Due to the configuration of the RF emitting electrodes, TriPollar has an ability to focus the heat into the dermal layer and keep the epidermis protected, without the need for supplemental cooling of the electrodes or the skin. TriPollar studies demonstrated regeneration effect for the facial laxity, wrinkling, skin tone and texture. Beilin achieved a 41% decrease in facial wrinkles in 23 female patients after the 6-week repetitive treatments [10]. Potekaev observed a significant reduction of static facial wrinkles and improved homogeneity of the skin color in 20 women after the eight TriPollar treatments [11].

Voluderm Efficacy Mechanism

As a derivative of RF technology, the minimally invasive Voluderm RF microneedling delivers electromagnetic oscillation in a fractional manner, through the array of thin metal electrodes. Voluderm uses a unique mechanism for skin penetration. Contrary to the forceful mechanical entry used in other RFMN devices, Voluderm employs a burst of RF energy to bypass the epidermis and penetrate the dermis. The high temperature generated by RF electrical emission evaporates the tissue along the microneedle length and creates microscopic cone-shaped ablation channel surrounded by the zones of coagulation and volumetric heating, triggering the surrounding viable tissue to induce the biological effect. Histology studies demonstrated a significant increase of the epidermal mitotic index and 10% increase in collagen content after the Voluderm impact [12]. Coagulative necrosis in the epidermis and in papillary and upper reticular dermis observed immediately after the impact was completely resolved to progressive dermal renewal and epidermal regeneration on Day 14 [13]. Shapiro, clinically evaluated Voluderm for reduction of facial wrinkles in 37 subjects [14]. The photographic analysis revealed reduction in the Fitzpatrick wrinkle score in 97% of cases, along with significant dermal volume enhancement, reduction of nasolabial folds, perioral and periorbital lines and improvement of skin laxity. The authors related the achieved efficacy to the process of collagen remodeling that continued 3 months after completion of the treatment sessions. A study of Kauvar, demonstrated the efficacy of the Voluderm microneedling in improving facial skin wrinkles and texture [15]. The treatments were associated with less to no downtime, low discomfort and improved skin laxity, rough texture and wrinkles in 88.9% of participants. Fitzpatrick Elastosis Wrinkle score decreased from baseline 4.33 ± 0.67-3.33 ± 0.67 ($p < 0.005$).

Oxygeneo Efficacy Mechanism

Increased oxygen content benefits mechanisms of regeneration in the aging skin. However, delivery of exogeneous oxygen is limited by the low permeability of the stratum corneum. Instead, Oxygeneo employs a mechanism to raise the tissue oxygen through the endogenous resources. The chemical reaction between sodium bicarbonate and citric acid in the Oxygeneo tables roughens its surface for exfoliation of the facial skin. The same reaction produces a watery foam consisting of carbon dioxide bubbles. On contact with the water, CO_2 becomes easily soluble, exceeding oxygen solubility 20 times [16]. As a result of the exfoliation, the stratum corneum becomes semi-permeable for diffusion of the dissolved CO_2 through the water channels in the epidermal cell membrane. The rate of diffusion is enhanced by the concentration gradient of carbon dioxide on the skin surface and intradermal. The resulted abundance of CO_2 in the dermal tissues triggers reactive dilation of cutaneous blood vessels and activates demand for endogenous oxygenation. Physiological response increases influx of the oxygen-reach blood and decreases hemoglobin's affinity for oxygen, described as rightward shift of the hemoglobin dissociation curve or Bohr effect [17]. A comparative study by Seidel measured changes in Transcutaneous O_2 tension ($TcPO_2$) after Oxygeneo and facial dermabrasion treatments [18]. A 22%-rise of $TcPO_2$ observed after Oxygeneo was statistically greater than after dermabrasion. The authors concluded that improved cutaneous oxygenation was attributed to combined effect of CO_2 and exfoliation. In a separate experiment, $TcPCO_2$ returned to the pre-treatment level in 15 minutes after Oxygeneo procedure, while TcO_2 maintained above the baseline [18]. Assessed with the laser Dopler, cutaneous blood perfusion showed an increase by 16 units immediately after the treatment and retained above the baseline 15 minutes after treatment.

Efficacy of Oxygeneo and TriPollar combination was previously demonstrated by Levenberg in the study of 11 middle-aged women. Using 3D micro-topography, Levenberg, observed not only improved skin texture and brightness, but also a measurable reduction in the depth of fine periorbital lines [19]. The effect was thought to be associated with reorganization and bundling of the collagen fibers leading to a firmer, better structured dermis. In the current case series, we rationalized that adding RF microneedling to the RF/O_2-boosting combination would further stress dermal fibroblasts for more powerful neocollagenesis. One month after the combination treatments, photography demonstrated statistically significant grade reduction of the facial wrinkles across the entire tested group.

The treatments were not only effective but also demonstrated safety in the patients with darker skin. Abnormal melanin deposition in the epidermis or Post-Inflammatory Hyperpigmentation (PIH), presents a major concern for the energy-based treatments in the South Asian population, including Indonesia. However, no PIH was reported in a 1-month follow-up period. All three implemented modalities minimally affected the epidermis and did not trigger hypermelanosis. Oxygeneo exfoliation is mild and removes accumulated dead cells on the skin surface. Electrothermal impact of TriPollar RF targets the dermis, keeping the temperature of the epidermal surface at the safe 40-41^{0}C. Voluderm RF microneedling avoids mechanical trauma to epidermis by utilizing the low-energy RF-assisted penetration [19].

Conclusion

A novel combination of non-ablative radiofrequency, RF microneedling and the technology inducing cutaneous oxygenation was safe and effective in the treatment of aging facial skin. The treatment demonstrated visible skin tightening, reduction of rhytidids and improved skin texture, at greatly reduced downtime. This combination is suitable for Asian skin, although multiple treatments sessions are required for best results.

Conflicts of Interest

Glenn Sugandi declares no conflict of interest that may influence the research, authorship or publication of the article.
Yuri Vinshtok is employee of Pollogen Ltd. and declares no conflict of interest that may influence the research, authorship or publication of the article.

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Authors' Contributions

Both authors have contributed equally to this work and have reviewed and approved the final manuscript for publication.

Consent for Publication

Informed consent for publication was obtained from the patient involved in this case report, as documented in the manuscript.

Ethical Statement

This project was exempt from IRB review due to retrospective nature of this research, as it did not qualify as human subject research under federal regulations.

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