

ORIGINAL ARTICLE

Application of dual-frequency ultrasound for reduction of perilesional edema and ecchymosis after rhinoseptoplasty

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Abstract

Objectives: Biological aspect and clinical research demonstrated that dual-frequency ultrasound (local dynamic micro-massage, LDM) waves of very high frequency can significantly modify cellular signaling providing anti-inflammatory and anti-fibrotic effects. During the recent past, these waves were successfully applied for the treatment of various inflammatory skin conditions, hypertrophic scars, and chronical wounds. Since the main complications after rhinoseptoplasty are caused by excessive inflammatory reactions and development of fibrosis along nasal implants which can lead to a revision rhinoseptoplasty, in this retrospective multicenter blinded study we have evaluated the efficacy of LDM ultrasound for the treatment of the postoperative perilesional ecchymosis and edema in patients after rhinoseptoplasty.

Methods: Twenty-four patients received daily LDM treatment (study group) for 5 days starting from the first day postoperative, whereas 24 patients (control group) were treated with conventional ice packs. Dynamic reduction of the postoperative perilesional ecchymosis and edema was followed up, and the total duration of these side effects was determined within specific paranasal anatomical areas.

Results: Post-rhinoseptoplasty ecchymosis and edema were observed in the areas of anterior cheek, lower eyelids, and upper eyelids. Duration of the postoperative perilesional edema was significantly reduced in the group treated with LDM (1.9 ± 0.9 days) compared with control group (4.5 ± 2.1 days). Duration of the ecchymosis was also significantly reduced in LDM group (2.8 ± 1.4 days) compared with controls (7.4 ± 2.8 days). Postoperative patient satisfaction in LDM-treated and control groups was 3.1 ± 1.3 and 1.5 ± 0.7 , respectively, demonstrating significantly higher satisfaction in LDM-treated group.

Conclusions: This study proved that the post-rhinoseptoplasty group treated with LDM ultrasound showed a significantly shorter duration of the postsurgical perilesional ecchymosis and edema, with no substantial adverse effects other than those observed in the control group. It can be suggested that ultrasound treatment can

serve as an alternative option for the noninvasive management of postoperative perilesional ecchymosis and edema.

KEY WORDS

ecchymosis, edema, post-rhinoseptoplasty, rhinoseptoplasty, ultrasound

1 | INTRODUCTION

Rhinoseptoplasty is not only one of the most popular facial plastic surgery procedures but also one of the most challenging.^{1–3} The significant constriction of nasal passages that can occur after rhinoseptoplasty poses a serious concern. This often results from insufficient septal cartilage and the formation of thick, disorganized fibrotic skin, which compromises the effectiveness of surgical treatment.^{1,2} To avert complications following surgical procedures, treatments with agents are commonly employed. These complications mainly arise due to excessive inflammatory reactions and fibrosis around nasal implants, often necessitating a revision rhinoseptoplasty.^{3,4} To achieve optimal surgical outcomes and concurrently diminish the risk of recurrent scarring, it is essential to minimize the duration of inflammatory reactions after rhinoseptoplasty. One potential approach to achieve this reduction involves appropriate pre- and/or postsurgical management.^{4,5} This approach can also decrease downtime, thereby enhancing patient satisfaction. The presence of swelling and bruising around the treated area after rhinoseptoplasty and revision rhinoseptoplasty indicates an ongoing inflammatory response, which is distressing for both surgeons and patients, as it leads to undesirable complications.^{4,5}

Numerous strategies have been proposed to mitigate the post-rhinoseptoplasty swelling and bruising. These encompass the utilization of corticosteroids, inducing controlled low blood pressure during surgery, implementing cooling techniques to minimize bleeding resulting from bone and soft tissue trauma and incorporating halotherapy in the postoperative period.^{6,7} Very high-frequency dual-wave ultrasound (VHF-US) therapy can be an another interesting option for the management of the post-rhinoseptoplasty edema and ecchymosis. This therapy also known as local dynamic micro-massage (LDM) is based on the application of a very high-frequency ultrasound with frequencies of 10 MHz or higher as well as on a quick alternative application of ultrasound waves of two different frequencies. Previous research demonstrated strong anti-inflammatory and regenerative effects of this therapy in the skin and subcutaneous adipose tissue by different indications, among others in chronic wounds,^{8,9} acne and rosacea,¹⁰ injection lipolysis,¹¹ radiation-induced fibrosis,^{12,13} postoperative wounds,¹³ ulcerative necrobiosis lipoidica,¹⁴ and breast reconstruction surgery.¹⁵ It was revealed that anti-inflammatory and anti-fibrotic effects of VHF-US should be mainly caused by its effective modulation of the signaling protein caveolin-1 in

plasma membranes of the cells located in the affected area.^{16–18} It is well recognized that tissue injury, resulting among others in development of perilesional edema and ecchymosis, is associated with local accumulation of HA in damaged area.¹⁹

This accumulation leads to increased viscosity of the extracellular matrix and thus to a substantial reduction of transport rates in affected tissue. This is the reason for a broad application of hyaluronidase for the treatment of edema and hematoma.²⁰

LDM of higher intensities can produce a thixotropic effect—transformation of the HA-bounded water into free water that is much less viscous and can be more easily removed from the tissue.^{21,22} Additionally, mathematical modeling revealed that high-frequency ultrasound waves produce sufficient temperature gradients in dermis and subcutis that can significantly enhance the transport rates in the skin.²³

These results point to the fact that LDM ultrasound may be effectively applied for reduction of the post-rhinoseptoplasty edema and ecchymosis. In this article, we present a retrospective study conducted across multiple medical centers, where a blinded cohort analysis was performed to assess the effectiveness and safety of LDM therapy in treating perilesional ecchymosis and edema that occur after rhinoseptoplasty or revision rhinoseptoplasty. Our primary focus in this research was to investigate the duration of postoperative edema and ecchymosis in patients treated with LDM, in comparison with a control group of individuals matched in age.

2 | METHODS

2.1 | Patients

In this retrospective study conducted across multiple medical centers, we examined a total of 48 Korean patients (26 men and 22 women) with a mean age of 29.5 ± 7.1 years (age range: 20–48 years). These patients had undergone either rhinoseptoplasty or revision rhinoseptoplasty at our clinic between May 2021 and January 2022. The study consisted of two groups: Group #1 comprised 24 patients (13 men and 11 women) with a mean age of 29.9 ± 6.7 years (age range: 20–46 years) who received daily LDM therapy for 5 days, while Group #2 included 24 patients (13 men and 11 women) with a mean age of 31.1 ± 8.4 years (age range: 20–48 years) who were treated with conventional ice pack application daily for 5 days (control group). The study design incorporated blinding to ensure unbiased analysis. Two doctors can

assess the initial severity of both investigated parameters directly after surgery and then we compare the scores. All patients were administered systemic second-generation cephalosporins as a prophylactic antibiotic for 2 days after surgical intervention. No systemic corticosteroids were administered to any of the patients. Patients with a medical background involving conditions such as diabetes mellitus, chronic renal disease, chronic liver disease, hypertension, ischemic heart disease or stroke, peripheral artery disease, hemorrhagic disease, a high risk of cardio-embolism, predisposition to bleeding, current use of anticoagulants, blood clotting disorders, or concurrent smoking were excluded from the study. These factors have the potential to significantly impact the duration of postoperative edema and ecchymosis. It is important to note that all patients provided written informed consent prior to participating in the study.

2.2 | Postoperative application of VHF-US therapy

Twenty-four patients from the Group #1 received daily five sessions of LDM (device LDM-MED®, Wellcomet, Karlsruhe, Germany). The protocol was set as 10MHz with intensity of 1.5 W/cm² and 1.0 W/cm²

for 2 min each followed by a 3/10 MHz dual-frequency setting (LDM) with intensity of 1.0 W/cm² and 2.0 W/cm² for 3 min each. The initial session was conducted on the first day after the surgery, followed by four subsequent sessions up to the fifth day after the surgery. The skin on the face and upper neck was cleansed using 70% ethanol without prior application of a topical anesthetic cream. A standard ultrasound gel was evenly applied to the face and neck as a coupling medium (refer to Figure 1A). The applicator was continuously moved across both temples, cheeks, upper neck, and forehead at a speed of 5 mm/s (refer to Figure 1B–D). No post-treatment cooling or proactive administration of systemic or topical corticosteroids or antibiotics was implemented. In the control group, conventional ice packs were applied to the face and upper neck for 20 min per day over a span of 5 days.

2.3 | Objective and subjective outcome assessments

Photographs were captured using consistent camera settings, lighting conditions, and patient positioning during each visit. These photographs were taken prior to ultrasound treatment or ice pack



FIGURE 1 Post-rhinoseptoplasty ultrasound treatment. (A) Neutral emulsion was uniformly applied to the face and neck after cleansing with 70% ethanol before ultrasound treatment. (B–D). The applicator was continuously moved on both cheeks, temples, forehead, and upper neck at 5 mm/s.