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SPECIAL ISSUE ARTICLE

Treatment of injection-induced ecchymoses with light/laser-assisted technology

Ines Verner[1,2] | Hadas Prag Naveh[1] | Dario Bertossi[3]

[1]Verner Clinic for Dermatology and Aesthetics, Tel Aviv, Israel

[2]Department of Dermatology and Regenerative Medicine, University of Rome "Guglielmo Marconi", Rome, Italy

[3]Maxillo Facial Surgery, University of Verona, Verona, Italy

Correspondence
Ines Verner, Verner Clinic for Dermatology and Aesthetics, Tel Aviv, Israel.
Email: ines.verner@gmail.com

Abstract

An increasing number of minimally invasive cosmetic procedures, such as filler or botulinum toxin injections, are performed annually. These procedures are associated with a high risk of post-procedure bruising or ecchymosis. Ecchymoses arise following hemorrhage and extravasation of red blood cells into the subcutaneous tissue, leading to local skin discoloration. Although ecchymoses generally resolve within 14 days, their appearance is cosmetically bothersome, and they may be painful and cause major distress to patients. Recent clinical evidence suggests that light/laser technology with pulsed dye laser (PDL) or intense pulsed light (IPL) can dramatically alleviate and minimize bruising when delivered within 24–72 hr of the injection. This article, will review reports of treatment of ecchymosis by lasers and IPL.

KEYWORDS

ecchymosis, IPL, oxyhemoglobin and deoxyhemoglobin, pulsed dye laser

1 | INTRODUCTION

Minimally invasive aesthetic procedures have become very popular. According to the American Society of Plastic Surgeons (ASPS), 15.7 million minimally invasive cosmetic procedures were performed in 2017, including more than 9.5 million botulinum toxin and soft-tissue filler injections (ASPS 2018). Bruising is one of the most common side effects of filler injection procedures, with an incidence ranging from 19 to 68% (Lemperle, Rullan, & Gauthier-Hazan, 2006), rendering it of primary concern to many patients considering such procedures (Molenda, Sroa, Campbell, Bechtel, & Opremcak, 2010). Even though postinjection bruising will generally subside within 14 days of onset, it is very bothersome to most patients, primarily due to the prominent accompanying skin discoloration, which discloses that a procedure was performed, and the associated (mostly mild) swelling and pain (Payne & Verner, 2015; Nestor, Ablon, & Stillman, 2010). Several treatment methods have been introduced to treat post-procedure ecchymoses, but most show very limited efficacy. Recent clinical evidence suggests that light/laser technology with pulsed dye laser (PDL) or intense pulsed light (IPL) can minimize or resolve bruising within 24–28 hr. This review will focus on the literature and on the clinical experience gained with laser and light-based technologies in the treatment of injection-induced ecchymoses in our center.

2 | ECCHYMOSIS, PURPURA, PETECHIAE—DEFINITION

Ecchymoses are a reddish or bluish discoloration of the skin arising from extravasation of blood from ruptured blood vessels. These patches of blood are typically larger than 1 cm in diameter, do not blanch on application of external pressure and have diffuse borders. The etiology may be traumatic or nontraumatic. Ecchymosis that occurs after an injury is generally referred to as a bruise. Purpura refers to dark purple spots or patches with a diameter of 4–10 mm, which tend to have a defined border and look more like a rash than a bruise. Unlike ecchymosis, purpura is not caused by injury but usually by an infection, medication, or blood clotting disorder. Petechiae are pinpoint macules, <4 mm in size, which may be purple, red, or brown, caused by burst capillaries and appear in groups. Like purpura, petechiae look more like a rash and are usually the result of medication or an underlying medical condition.

3 | ECCHYMOSIS—ETIOLOGY & PATHOPHYSIOLOGY

Vascular endothelial cells normally function to prevent large amounts of blood from egressing from blood vessels. Integrity of endothelial

cells can be compromised by direct trauma (such as injection), circulating toxins in case of sepsis, lactic acid accumulation in states of hypoxia or mechanical obstruction resulting in increased intraluminal pressure. The resulting erythrocyte extravasation from the damaged capillaries into the interstitial space induces discoloration, together with an inflammatory response; subsequent onset of edema and pain are generally seen within a few hours of the injury.

4 | ECCHYMOSES—BIOLOGY

Ecchymoses are generally associated with pain and inflammation of the adjacent surrounding skin. (Payne & Verner, 2015; Molenda et al., 2010; Nestor et al., 2010). The natural chromatic evolution of ecchymoses (Figure 1a) is a function of the degradation of oxyhemoglobin and shows a typical pattern (Payne & Verner, 2015; Nestor et al., 2010). First, the extravasated red blood cells are degraded, releasing hemoglobin, resulting in a red hue in the skin. Within 1–2 days, the reddish iron from the blood undergoes a change and the bruise appears blue or purple. By Day 6, the color changes to green and by Day 9, the bruise appears yellowish-brown, reflecting the heme degradation into biliverdin (green) and bilirubin (yellow) (Figure 1b). The bruised area generally heals within 2–3 weeks, with restoration of normal skin color.

5 | BRUISING AFTER DERMAL FILLER INJECTION

Bruising is more common in the perioral and periorbital areas, as well as in the superficial dermal and immediate subdermal planes. Deeper injections are associated with a lower risk of bruising. Fanning or threading techniques are also more frequently associated with bruising, as compared to the deeper bolus injection technique delivering to the pre-periosteal level (Chiang YZ et al.). Overall, the incidence of bruising following filler injections is higher in middle-aged and elderly people due to thinner skin and thinner subcutaneous fat tissue layer, as well as compromised protection of blood vessels (Alegre-Sánchez et al., 2018; Urdiales-Gálvez et al., 2017). In addition, patients on anticoagulation therapy may run a higher risk of bruising and developing large ecchymoses. A number of steps can be taken to minimize bruising, including avoiding all blood-thinning medications starting 10 days before the procedure (aspirin, warfarin, dipyridamole, clopidogrel, nonsteroidal anti-inflammatory drugs [NSAIDs], fish oil, vitamin E supplements, St. John's Wort, garlic tablets, gingko biloba, and ginseng). Bruising can also be limited by using the smallest possible gauge needle, a slow injection technique, blunt cannulas and limiting the number of transcutaneous puncture sites. Application of ice packs or cold compresses for a few minutes immediately after the injection, can also minimize bruising. Vigorous exercise should be avoided for the first 24 hr after injection to avoid raising blood pressure.

6 | TREATMENT OF ECCHYMOSIS BY ENERGY-BASED TECHNOLOGY

Therapeutic options for ecchymosis have traditionally focused on preventative measures, including improving injection technique, steroid injection, application of hydrogen peroxide 15%, parallel use of cooling systems and use of vitamin K cream in patients with bleeding disorders, yet none have shown consistent effectiveness (Alegre-Sánchez et al., 2018; Lemperle et al., 2006; Molenda et al., 2010; Nestor et al., 2010; Urdiales-Gálvez et al., 2017). In recent years, several laser and light treatment options have been described (Alegre-Sánchez et al., 2018; Funt & Pavicic, 2013; Morton, Smith, Dover, & Arndt, 2013; Varughese, Keller, & Goldberg, 2016). These modalities target the hemoglobin of extravasated red blood cells and have been shown to shorten the time to resolution of ecchymoses from 14 days to 24–48 hr. To the best of the authors' knowledge, while many energy-based platforms exist, those summarized below are the only ones, which have been reported to be applied for ecchymosis management.

Pulsed dye laser treatment (PDL; 585/595 nm), which relies on the principle of selective photothermolysis, has been widely used to treat vascular lesions (Alegre-Sánchez et al., 2018). The main target chromophore of PDL is oxyhemoglobin (absorption peak: 577 nm), likely underlying its effectiveness in resolving ecchymoses. Yet, it is assumed that the effectiveness of this therapy will be lower in later-stage,

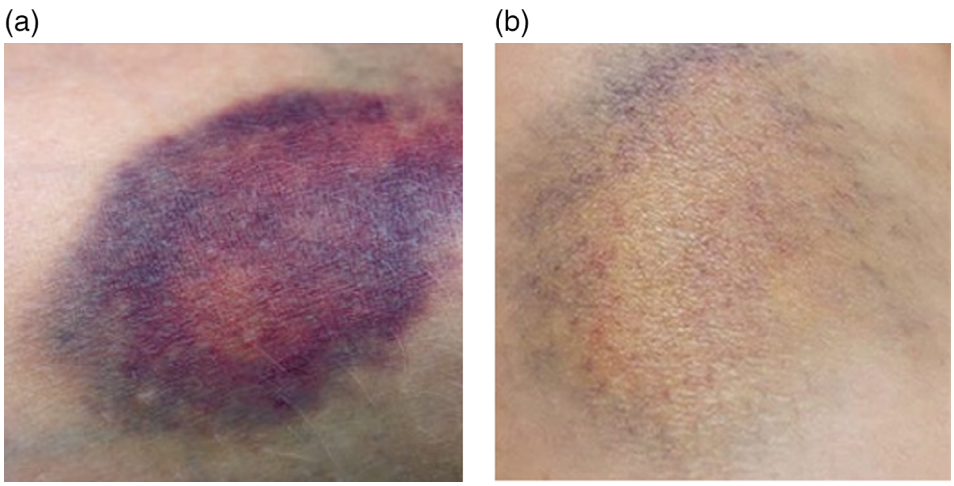

FIGURE 1 (a) A fresh hemoglobin-rich ecchymosis showing the typical red, blue, and purple discoloration of the first 3 days. (b) A late-stage, bilirubin rich ecchymosis showing the typical yellowish, greenish discoloration of Days 6–10

bilirubin-rich bruises (absorption peak: 460 nm). DeFatta and colleagues reported their experience with the 595 nm yellow light PDL in treating 20 patients presenting ecchymoses secondary to facial plastic surgery (DeFatta, Krishna, & Williams, 2009). At postoperative Day (POD) 5 or 6, half of the bruise was treated with a PDL (V-beam, Candela) at 6 J/cm^2, 10 mm spot, 10 ms pulse duration, and 30 ms of cryogen, with a 20 ms delay for three passes. The patients returned 48–72 hr later for PDL of the untreated areas under the same parameters, and had a final follow-up assessment 48 hr thereafter. Three independent, blinded observers graded photographs using an ecchymosis scale created by the investigators, and found a 63% reduction in ecchymosis score. In addition, they noted that earlier PDL intervention was associated with better outcomes. Minimal edema and no dyspigmentation were noted after treatment.

Karen and her colleagues published their experience with a PDL in 10 patients presenting traumatic injury- or cosmetic procedure-related ecchymoses (Karen, Hale, & Geronemus, 2010). The treatment parameters were more robust than in the previous study: 7.5 J/cm^2, 10 mm spot, 6 ms pulse duration, and 30 ms cryogen, with a 20 ms delay for a single pass. Patients were assessed 24 hr, 48 hr and 7 days after the procedure. Relative to the untreated ecchymosis, treated lesions resolved more rapidly, with improvements observed within 24 hr of PDL treatment. At this same time point, the average ecchymosis size reduction was 62 and 13% for treated and untreated bruises, respectively. Forty-eight hours after treatment, the average improvement was 76 and 37% for treated and untreated lesions, respectively. One week after treatment, treated and untreated bruises had improved by 87 and 81%, respectively. Two patients experienced minor transient crusting. The investigators observed the most dramatic responses in bruises with pronounced erythematous and/or violaceous components, suggesting that laser intervention is most effective if initiated when hemoglobin predominates (24–48 hr after the procedure).

The same PDL (6.5 J/cm^2, 7 mm spot, 0.45 ms pulse duration, cooling 30 ms/20 ms in 6, 2 x 2 cm zones) was used by Mayo and colleagues to induce purpura on the lower abdomens of 17 patients (Mayo, Khan, Hunt, Fleming, & Markus, 2013). Immediately after bruise infliction, each bruise was randomly treated with a cold compress, hydrogen peroxide-soaked gauze, a bruise serum for 10 min, or with a PDL (6.5 J/cm^2, 7 mm spot, 6 ms, 30/20), deployed 30 min after purpura induction. Two blinded evaluators grading the bruises at 30 min, 3 days and 7 days thereafter, found no significant reduction in bruise duration in the three control interventions, while PDL-treated patients experienced a statistically significant increase in time to resolution. The authors hypothesized that the application of PDL light energy shortly after bruise induction may actually generate an additive effect by disrupting hemostasis.

Alegre-Sanchez and her colleagues deployed 595 nm PDL to treat 34 patients presenting ecchymoses induced by trauma, surgery, cosmetic procedure or anti-coagulants (Alegre-Sánchez et al., 2018; DeFatta et al., 2009). They reported either complete resolution or a substantial improvement 24 hr after PDL treatment. Ecchymosis with intense edema, deeper ecchymosis or light-colored bruises with minimal discoloration did not respond as well as the darker, more superficial bruises with minimal edema.

Recently, a narrow-band intense pulsed light (IPL) emitting green light mainly between 500 and 600 nm, was developed for the treatment of vascular lesions (Varughese et al., 2016). This spectrum narrows the generally broad optical spectrum of IPL technology to primarily target oxyhemoglobin and deoxyhemoglobin, providing greater precision and safety. This new narrow-band IPL technology was applied in our center (Verner Clinic, Tel Aviv, Israel), on 11 female subjects presenting with 145 ± 278 mm^2, mostly purple ecchymoses which developed following filler injection. All patients were females, aged 40–73 years (mean age: 41). Eight patients had skin type II, one patient skin type III, one had skin type IV and one patient had skin type V. All patients signed consent forms prior to treatment and were treated 24–72 hr following filler injection. A layer of ultrasonic gel (1–2 mm-thick) was applied to clean skin. A commercially available Dye-VL module (Alma Beauty Rejuve, Alma Lasers US, Buffalo Grove, IL), with a spot size of 3 cm^2 was used to deliver a single 10 ms pulse at a fluence of 7–10 J/cm^2. Additionally, 2 weeks after treatment, the patients and investigator filled out global aesthetic improvement (GAI) scale forms; all patients and physicians

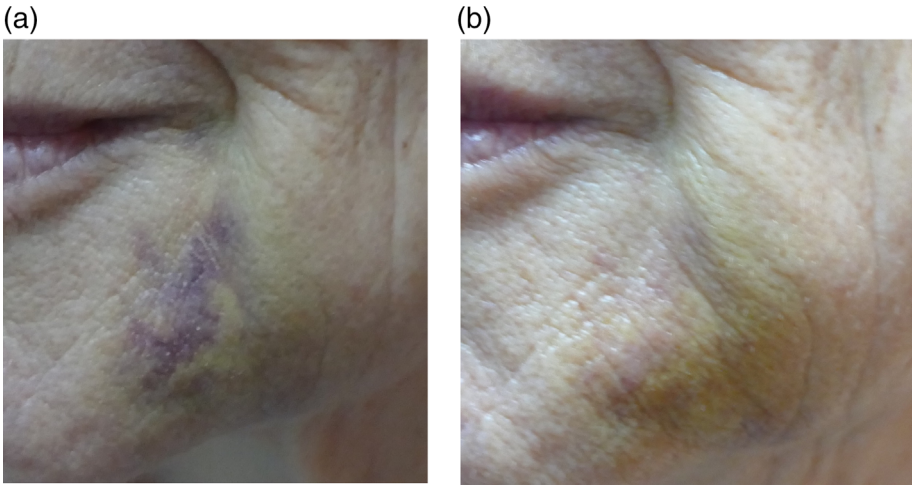

FIGURE 2 DyeVL treatment (a) Before: A 73-year-old patient presenting with an ecchymosis 72 hr following dermal filler injection. (b) After: A 73-year old patient 24 hr after DyeVL treatment. Demonstrating effectiveness of dye-VL on ecchymosis even several days after ecchymosis occurrence

TABLE 1 Comparison between PDL and narrow band IPL technology for the treatment of ecchymosis

	PDL	Dye-VL
Wavelength	585/595 nm	500–600 nm
Ecchymosis treatment timing	Early	Early and late
Targeted chromophores	Oxyhemoglobin	Oxyhemoglobin, deoxyhemoglobin and other heme derivatives
Spot size	<12 mm	3 cm^2
Treatment time	Slower	Faster
Treatment area	Limited	May be larger

were either satisfied or very satisfied with the treatment. Due to the larger spot size and limited number of pulses required, Dye-VL treatment was very fast, requiring only a few minutes, and was well tolerated by all patients; there were no major complaints or side effects. Pain during treatment, assessed using a 10-point visual analog scale, was almost negligible (0.18 ± 0.4). All patients experienced full ecchymoses resolution within 48 hr of Dye-VL IPL treatment. Figure 2a shows a 72-year-old patient with an ecchymosis 72 hr following filler injection. In Figure 2b, the same patient is shown 24 hr after Dye-VL treatment, demonstrating the effectiveness of the treatment even when delivered several days after ecchymosis occurrence. Notably, the pain and the swelling that were associated with the ecchymoses, improved within this same period. A comparison between PDL and narrow-band IPL technology for the treatment of ecchymosis is shown in Table 1.

7 | SUMMARY

All filler injections are associated with the risk of early and late or delayed complications. Among the early postinjection adverse events, ecchymoses are a primary concern to many patients considering such aesthetic procedures. The risk of ecchymoses following injections is higher among older patients, patients on anticoagulant drugs and patients with coagulation disorders or with uncontrolled hypertension.

Use of PDL for the treatment of ecchymosis was found to be effective. However, its limited impact is likely due the single wavelength emitted (595 nm), which underlies its failure to treat the evolving ecchymoses characterized by different chromophores at each stage. In addition, the PDL spot size is quite small (≤12 mm spot size), which may be a limiting factor in the treatment of larger ecchymoses. The narrow-band Dye-VL technology offers a broader spectrum of wavelengths (500–600 nm), thus targeting both oxy- and deoxyhemoglobin, together with other heme derivatives, as well as a larger spot size (3 cm^2). Accordingly, its efficacy is expected to be higher than that of PDL and it is expected to still be effective several days after ecchymosis onset. The larger spot size enables faster treatment time, as well as the possibility of treating large posttraumatic ecchymoses. Dye-VL treatment was well tolerated by all patients; there were no major complaints, pain or any other side effects. Taken together, narrow-band IPL emitting mainly between 500 and 600 nm, offers a fast, easy, and safe means of treating both early and late ecchymoses.

CONFLICT OF INTEREST

All authors have completed and submitted the ICMJE form for disclosure of potential conflicts of interest and have no conflict of interest. Dr Ines Verner is a scientific consultant for Alma Lasers.

ORCID

Ines Verner https://orcid.org/0000-0001-9824-8343

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