Received: 31 March 2023 | Accepted: 4 May 2023

DOI: 10.1111/srt.13351

ORIGINAL ARTICLE

WILEY

Laser-assisted blepharoplasty: An innovative safe and effective technique

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Abstract

Background: Blepharoplasty is one of the most popular esthetic procedures with an acceptable risk profile and a relatively quick procedure.

Methods: The aim was to evaluate the efficacy and safety of a new CO_2 and 1540-nm laser-assisted blepharoplasty technique applied to the upper and lower eyelids. A total of 38 patients were enrolled. Photographs were taken before the treatment and at 6-month follow-up. One "blind" observer assessed the performance of this technique by ranking the results in four categories of eyelid esthetic: 1 = no or poor results (0%–25%), 2 = slight improvement (25%–50%), 3 = moderate improvement (50%–75%) and 4 = marked improvement (75%–100%). All possible complications were monitored.

Results: Thirty-two patients (84 %) achieved marked improvement, four patients (11%) moderate improvement, two patients (5 %) slight improvement, while zero subjects (0%) poor or no improvement. No serious adverse effects were observed.

Conclusions: Our results from clinical evaluations suggest that the CO_2 and 1540-nm laser assisted blepharoplasty is proved to be a sophisticate intervention efficacious in improving the treatment of patients with various degrees of eyelid and periocular aging and also in reducing downtime.

KEYWORDS

CO_2 and 1540-nm laser-assisted blepharoplasty, lower eyelid blepharoplasty, upper eyelid blepharoplasty

1 | INTRODUCTION

A plastic surgery procedure called blepharoplasty is used to treat eyelid deformities, defects, and disfigurements.[1] Treatment for excess skin and/or orbital fat is indicated with upper and lower eyelid blepharoplasty. The blepharoplasty may correct esthetic issues, such as the loss of peripheral vision caused by upper eyelid hooding, or functional issues by excising and removing extra tissues like skin and fat and smoothing, strengthening, and enhancing the muscles.[2] Due to significant advancements in facial esthetics, blepharoplasty in particular has remained one of the most popular esthetic procedures with an acceptable risk profile and a relatively quick procedure.[3] It can give the orbital regions a more relaxed appearance, as evidenced by a wider palpebral aperture, increased symmetry, and smoother eyelids.[4] Different techniques have been proposed during the years,[5–9] sometimes in combination with other facial and skin rejuvenation procedures such as brow or mid-face lift, lasers, or chemical skin resurfacing.[10] Eyelid anatomy is complex and intricate, so there are some complications, but they are typically mild and temporary.[8]

The transpalpebral cheek lift, foreheadplasty, arcus marginalis release, and coronal endoscopic brown lifts are just a few of the new surgical techniques that have been developed to improve the appearance of the periorbital region of the face.[11]

However, the actinic damage, pigmentation, fine lines, and skin texture that all contribute to the appearance of general aging are not really resolved by these surgical procedures. In addition to blepharoplasties, plastic surgeons have experimented with chemical peels, dermabrasion, and, more recently, laser resurfacing to treat these problems.[12] Specific surgical blepharoplasty side effects include scleral show, ectropion, hollow-appearing eyelid sulcus, vision loss, and diplopia (from impaired ocular motility). There are risks associated with lower lid malposition, chemosis, asymmetry, scarring, cellulitis, lagophthalmos, cellulitis, postblepharoplasty ptosis, dry eye syndrome, and corneal abrasion. Contrarily, numerous nonsurgical treatments have been investigated over time to postpone surgical blepharoplasties, including ablative fractional and no-fractional CO_2 laser and nonablative fractional laser.[13,14] The first laser-assisted blepharoplasty procedure was developed by Baket in 1980, but despite initial excitement and a relevant side effect—excessive thermal damage that results in scars—the practice was never widely adopted.[15–16] It was only possible to resolve this issue in the early 1990s with the development of new high energy pulsed carbon dioxide (CO_2) lasers; these innovations enabled medical professionals to coagulate and cut tissues with minimal thermal injury while achieving consistent results.[17,18]

The aim of this study was to evaluate the efficacy and safety of a new CO_2 laser-assisted blepharoplasty technique applied to the upper and lower eyelids.

2 | MATERIALS AND METHODS

2.1 | Patients

Patients with dermatochalasis, prominent eyelid fat pads, eyelids laxity and/or periorbital wrinkles eligible for blepharoplasty were enrolled. After obtaining a detailed personal history (skin type, clinical symptoms, health conditions, previous medications, life-style), a preoperative evaluation with a thorough medical and ophthalmologic visit was performed. The inclusion criteria included: age > 18 years; absence of systemic diseases, including autoimmune diseases, coagulation disorders, acute-angle closure glaucoma, collagenopathies; no concomitant drugs such as oral retinoid, salicylates, photo-sensitizers, and anticoagulants; no previous upper or lower blepharoplasty or other medical procedures.

After enrolment and in the absence of contraindications, patients underwent an upper and/or lower eyelids laser-assisted blepharoplasty. They were operated by the same surgeon in an accredited surgery room.

Enrolled patients signed an informed consent for treatment, containing information on all the potential benefits, the need for postoperative cares and possible complications. They also signed an informed consent to allow the use and publications of their photos for scientific purpose.

2.2 | Laser device description

The DuoGlide system (DEKA M.E.L.A, Calenzano, Italy) device was used in this research. The study device emits two laser beams with different wavelengths of 10600 nm (CO_2 laser) and 1540 nm. The CO_2 laser emits in the far-infrared spectrum where absorption of the radiation by the water molecules prevails over penetration. Sufficiently intense radiation will cause vaporization of the tissue due to evaporation of the water, with tissue penetration limited to a few micrometers. This characteristic, together with appropriate pulse management, allows for operating with extreme precision in vaporization tissues in successive passes until the clinical end-point is achieved. The wavelength of 1540 nm, instead, can achieve homogeneous, continuous and noncoagulative heating of the entire treated area, reaching further and deeper into the dermis, thanks to spots of the order of 1000 μm and thanks to 500 μm of spacing, a parameter typically used in the literature for dermatological fractional treatment[19] When the CO_2 source is enabled, this device can provide various laser emission modes, including three ultrapulsed shapes: H-Pulse (HP), S-Pulse (SP), and D-Pulse (DP)[20] With the variety of available pulse modes, this technology allows for the induction of various tissue biological effects. The S-Pulse mode acts more selectively on the papillary dermis with a more circular ablation shape, inducing coagulation of the surrounding tissues. The D-Pulse mode acts more incisively on the reticular dermis, inducing greater shrinkage of the ablation columns and more circumscribed coagulation. Finally, the great advantage of HP pulse is due to its possible use for cold, more delicate ablation thanks to the very low pulse emission times and for carrying out greater ablation than the other emission modes applied for the same pulse duration. The cold ablation allows to make a clean and precise cut while minimizing bleeding; additionally, the minimal thermal effect on the edge of the cut ensures minimal swelling and that no scar is formed. This device has different free-handpieces for ablation, vaporization and coagulation of soft tissue and different scanners for skin rejuvenation and dermatological surgery. In particular, in this study, we use CO_2 freehand handpiece with slim handle (1.5″ or 2″ focal lengths) and a fractional scanner (μScanDOT scanner) that can emit both wavelengths. Thanks to its excellent ergonomics, this slim freehand handpiece allows the tissue to be cut with precision in a simple and clean manner. The scanner, instead, can deliver one or both wavelengths in a sequential emission mode on the same point (DOT). The synergy between the CO_2 laser and the 1540-nm laser makes it possible to increase the thermal effect compared to the CO_2 laser alone, obtain greater contraction of the tissue and therefore have an excellent shrinkage effect[20] Using both lasers in sequence, it is possible to achieve effective results using low energies, and this allows to have minimal downtime for patients.

2.3 | Procedures

2.3.1 | Upper eyelid blepharoplasty

The patient was placed in a supine position, looking straight ahead into the ceiling; after he assumed a sitting position and took 5 mg Diazepam (Sandoz Pharmaceuticals SA, Rotkreuz, Switzerland) for the oral sedation, we marked the upper eyelids through a blue pen, drawing the amount of tissue to be removed like an ellipse. We outlined the inferior edge of excision about 10 mm above the lash line in the central part of the lid and 5/7 mm at the lateral canthus, while the superior one was marked according to the amount of tissue. We outlined the inferior edge of the excision 8 mm above the ciliary margin, while the superior one was marked 8 mm below the inferior brow edge; connecting these two ink signs through other two vertical lines, we could visualize a curved rectangular shape corresponding to the area to be removed. We performed a skin disinfection (Betadine, Meda AB,Solna,Sweden) and subsequently a local injection of lidocaine 2% with adrenaline 1 to 100.000 solution. As a first step, we applied CO_2 laser using freehand handpiece with slim handle (1.5″ or 2″ focal lengths) with HP Pulse, a frequency range of 50–80 Hz and a power range of 2–4 W to generate superficial vertical incisions of the skin following the premarked lines. During all treatment session, patient's eyes were protected by metallic ocular shields. After concluding the incision, an edge of skin flap is pulled upward with surgical pliers and the redundant skin flap was dissected from the underlying tissues by the focused CO_2 slim handpiece. Only the last corner of the skin flap is severed with surgical scissors. During this procedure, the laser beam of slim handpiece forms a 45-degree angle with the skin surface. With this procedure, it is possible to clivage the skin flap while keeping the orbicularis oculi muscle intact, in contrast to other laser blepharoplasty procedures that involve a deeper incision and thus also the excessive removal of the underlying tissues.[21]

The next step is to remove prolapsed orbicularis oculi muscle, with the surgical scissors and to irradiate the incision margins by defocusing laser beam with the HP pulse. These thermal effects allow for the convergence of margins, facilitating the closure by the surgeon of the incision margins with six 6–0 nylon sutures. After, we usually applied a gentle skin massage over the sutured area for minimising the postoperative possible skin folds. Only in the cases presenting an important amount of eyelid fat accumulation, we partially resected also the muscle, orbicularis oculi, in the preseptal part and through a limited gap of the orbital septum, we could arrive to the fat, deciding the amount to be removed through the CO_2 laser cauterization. The CO_2 laser employment allowed us also to guarantee a near absolute hemostasis, since the possible bleeding could be always stopped through the coagulative effect of the defocused beam of CO_2 laser.

2.3.2 | Lower eyelid blepharoplasty

Currently, lower eyelid blepharoplasty is performed either by the transcutaneous approach or by the transconjunctival approach. Transconjunctival approach is another technique that targets the excessive orbital fat excess without skin removal. Conjunctival incision is continued with posterior lamellar dissection and fat excesses removed. This is a more conservative method compared to the classical transcutaneous technique, with fewer complication rates, including scarring and bleeding.[22]

In this case the lower eyelid blepharoplasty through the transconjunctival technique was performed: this particular is procedure characterized by an incision made from the conjunctiva, the interior surface of the lower eyelid. The patient under the effect of Diazepam received a local anesthesia by a transconjunctival injection of mepivacaine chloridrate 1% (Mepivacaina Angelini, ACRAF), and his eyes were protected by metallic ocular shields. After rotating outward, the lower eyelid, we always executed the CO_2 laser subciliary incision 4–5 mm below the eyelid margin, following an imaginary transverse line from the lower part of lacrimal punctum to the lateral canthus. Compressing the eye globe we could evaluate the protruding fat, removing it through the delicate dissecting effect of CO_2 laser and without violating the orbital septum. In particular, using two cotton buds, the excess fat is pushed outward, and the subcutaneous vascular component is clamped. The CO_2 laser is used near the clamp in order to coagulate the vessels and thus remove the adipose tissue without excessive bleeding. The wound was not sutured, and it healed by second intention. We always concluded the lower eyelid transconjunctival blepharoplasty, employing the synergic fractional effects of CO_2 and 1540 lasers (μScanDOT scanner) for reducing the lines and the wrinkles left on the lower part of the periorbital area; this last procedure is relevant especially for the transconjunctival technique, which is not able to of remove excess skin. The fractional CO_2 and 1540-nm session entailed one pass only per area with numerous successive and consecutive pulses in the same point (DOT) without moving the scanner. The settings included: 12 W power, 500 μm DOT spacing, 800 μs dwell time, DP pulse, stacking 2 for CO_2 laser and 5 W power and 3 ms dwell time for 1540-nm laser. We decided to use the $CO_2 + 1540$ sequence because, following this order, there is a greater shrinkage effect on the skin.[20] The recovery period was fast, and eyelid functions were not impaired.

2.4 | Postoperative cares

For the first 3 days, we advised our patients to keep their heads elevated as much as possible while sleeping with multiple pillows to help reduce swelling and bruising. For the most severe postoperative swellings, we gave oral steroids and anti-inflammatory medications. By requesting that all patients take an antibiotic for a week, we reduced the risk of infections. The patients were instructed to avoid bending on the orbital area, blowing the nose, coughing, making Valsava maneuver, strenous activity (sports), and air travels for about 2–3 weeks. Contact lenses and the use of anticoagulants were both prohibited due to the risk of bleeding. On the third day, the patients were able to use warm eye pads for comfort and dark sunglasses to shield their eyes from wind and sunlight-related irritations. Three days after their blepharoplasty, the patients were able to watch television and read, and a week later, they were able to return to work, hiding any potential signs with makeup.

2.5 | Clinical evaluation

Photographs were taken with a Canon digital camera and a polarized flash (Anthology system, DEKA M.E.L.A., Calenzano, Italy), before the treatment and at 6-month follow-up. The front photos were standardized using the same camera, setting, twin flash, ambient light and chin holder to guarantee the same distance. One "blind" observer who had not taken part in the treatments assessed the front photos at baseline and at 6-month follow-up. He assessed the performance of this technique by ranking the results in four categories (quartiles) of eyelid esthetic: 1 = no or poor results (0%–25%), 2 = slight improvement (25%–50%), 3 = moderate improvement (50%–75%) and 4 = marked improvement (75%—100%). In addition, patients were placed in front of a mirror and asked for a subjective evaluation of the perceived overall results by means of the following score: unsatisfied, not very satisfied, satisfied, very satisfied. Possible complications such as periorbital erythema and oedema, discomfort, pain, redness, bruising, hyperpigmentation, scars, posttreatment infections, skin lacerations, ectropion, lagophtalmos, hemorrhages werebrk monitored.

FIGURE 1 Preoperative (upper panel) and postoperative (lower panel) images. Clinical improvement in upper and lower eyelid blepharoplasty in female patient at 6 months follow-up.

3 | RESULTS

A total of 38 patients, 29 women and nine men, mean age 54 years, Fitzpatrick skin types II–III, underwent an upper and/or lower eyelids laser-assisted blepharoplasty.

All the patients showed global improvement in eyelid esthetic (Figures 1 and 2), and correction of dermatochalasis, prominent eyelid fat pads, eyelids laxity, periorbital wrinkles: 32 patients (84 %) achieved marked improvement, four patients (11%) moderate improvement, two patients (5%) slight improvement, while zero subjects (0%) poor or no improvement (Figure 3).

Immediately after the session, nine patients (24 %) showed periorbital erythema and oedema lasting 7 days, discomfort and pain around the eyes for 2 days and no symptoms inside the eyeballs.

The patient's recovery time takes place 3–4 days after the laser surgery. Side effects included redness, bruising and discomfort were observed but they solved in few days. No serious adverse effects (e.g., hyperpigmentation, scars, posttreatment infections, skin lacerations, ectropion, lagophtalmos, hemorrhages) were reported in any of the patients.

Thirty-two patients (84%) were very satisfied, five (13%) were satisfied, and one (3%) was not very satisfied, whereas only zero patients (0 %) were unsatisfied with the results (Figure 4).

FIGURE 2 Preoperative (upper panel) and postoperative (lower panel) images. Clinical improvement in upper eyelid blepharoplasty in female patient at 6-month follow-up.

4 | DISCUSSION

The eyelids and periorbital regions can be rejuvenated using a variety of medical and surgical procedures.[23–25,30,31] However, blepharoplasty is still the most popular.[2,26–29] Chemical peels, platelet-rich plasma, botulinum toxin, and injectable fillers have all been proposed as ther-

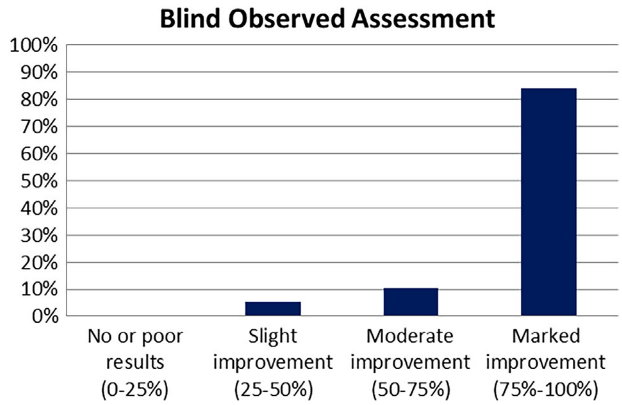

FIGURE 3 Blind observer's assessment of patients' improvements at 6-month follow-up.

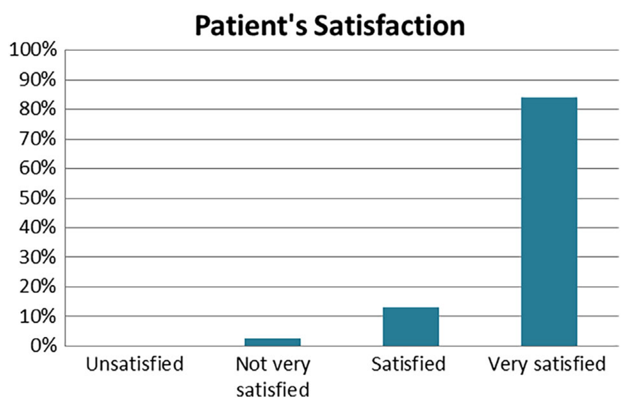

FIGURE 4 Histogram showing the degree of patient satisfaction after 6-month follow-up.

apeutic substitutes. The blepharoplasty, which treats not only the superficial skin tissue but also the connective and the muscle tissues, is defined as a medical act capable of inducing a localized alteration or transportation of live human tissues. Although Spada and Trinh et al.[24,32] have been proposed, these procedures cannot be compared to a surgical procedure. The addition of CO_2 laser-assisted blepharoplasty to upper and lower blepharoplasty has proven to be a safe and efficient procedure.[33–37]

The laser-assisted blepharoplasty may be a suitable substitute procedure for the other standard techniques, based on our findings and prior experience, as it increases efficacy without endangering the overall safety of the procedure. In fact, the CO_2 laser can function as a cutting tool, a dissecting instrument, and a cautery for coagulation if used properly, which minimizes the need for additional instruments and their transportation to the operating room.[38] Only cold steel could ensure the kind of precision needed to treat tiny anatomical structures like microvessels, tiny muscles, and their aponeurosis without causing tissue distortions, functional impairments, or hemorrhages. It enables the surgeon to perform extremely delicate incisions and dissections.[39]

The most significant benefit is the ability to heat tissue and enable perfect hemostasis in regions where the largest vessels have a diameter smaller than 1 mm when used in a defocused manner.[40]

The use of a CO_2 laser during blepharoplasty has a wide range of beneficial effects, including an improvement in operating room efficiency, a shorter recovery period for patients than with scalpel surgery (which typically lasts 6–8 days longer), a reduction in bruising, and a shorter operating time (only 1 h for four eyelids blepharoplasty vs. 94 min for the scalpel manner).

Indeed, a recent study[41] discovered that the free CO_2 beam laser took less time to complete the procedure on average for the 10 cases than the diamond laser scalpel. In addition, the shorter HP pulse duration enables us to incise the skin more precisely and without the risk of bleeding, as was already mentioned.

The most concerning complication following eyelid blepharoplasty using surgical approaches like the transcutaneous and the transconjunctival approach is postoperative retro-orbital hemorrhage, according to a recently published study.[42] This is a rare but potentially dangerous complication for vision. During the removal and manipulation of fat, bleeding must be carefully cauterized. Additionally, the transcutaneous approach's edema and hemorrhage of the orbicularis muscle may impair vision.

Rancati et al.[43] have demonstrated that the transcutaneous approach can result in complications like scleral show, lagophthalmos, insufficient skin removal, lower eyelid cicatrization, retraction, skin scar, and ectropion, but the transconjunctival approach can prevent these issues. Both transconjunctival and transcutaneous approaches to lower eyelid blepharoplasty can lead to complications such as bruising, superficial hematoma or ecchymosis, dry eyes, corneal trauma during surgery, infections, insufficient lipectomy, and damage to the inferior oblique causing diplopia, postoperative periocular pigmentation, and eyelid asymmetry.

The potential risks connected to the laser like the corneal burns and even the globe perforations are very uncommon for the large diffusion of the metallic shields, which protect the eyeballs and their structures during the laser session.[44] A potential drawback imputable to the laser by some authors[41] is the lack of the tactile feedback, which characterizes the standard scalpel-based surgery. We did not agree about it since during the laser procedure we replace the lost "tactile feedback" with the "visual feedback". With "visual feedback processing" we are able to identify the skin layer reached by CO_2 laser ablation, observing the specific features of skin colour and texture during the procedure. The typical cutaneous markers notable during the ablation are an opalescent aspect for epidermis, a flat, smooth, and pink surface for the papillary derma, a hardened yellowish tissue similar to "chamois skin" for the superficial derma, while the vaporization of the reticular derma often reveal large collagen fibers crossed that in macroscopic terms look like "waterlogged cotton threads." Some authors, however, underlined the disadvantages of using the CO_2 laser compared with the steel scalpel attributing it to its cost in terms of purchasing and maintaining the laser equipment, the need for additional and extensive laser training for surgeons and assistants, and the need for two assistants rather than the one needed for scalpel surgery.[45]

However, the CO_2 laser leads to a number of advantages in comparison to theses surgical approaches, already discussed above, such as gentle intraoperative preparation and less postoperative swelling due to an additional cauterization of blood vessels[46] and the possibility to perform precise incision and hemostasis with the same device[47] Moreover, the possibility of using fractionated CO_2 and 1540-nm laser in the lower periorbital area allows us to achieve a greater shrinkage effect than using fractionated CO_2 alone.[20] Collagen production and remodeling continues for several months after blepharoplasty CO_2 laser treatment as reported in literature[48] In addition, a study using cytotoxicity and proliferation analysis and confocal analysis showed that the 1540-nm laser leads to cell proliferation and a significant increase in type III collagen compared to a nonirradiated control sample and therefore guarantees skin rejuvenation of the lower periorbital area.[49] In conclusion, the use of a single laser device with two wavelengths made it possible to develop an optimal laser blepharoplasty technique guaranteeing:

1. wide flexibility on the choice of cold and thermal pulses in order to be able to modulate the ablative action of the laser and thus be able to appropriately separate the skin layers.
2. a precise cut minimising the thermal effect at the edges in both the eyelid and conjunctival tissue;
3. a detachment of the skin flap leaving the orbicularis muscular tissue intact;
4. a contraction of the edges of the eyelid incision due to the defocussed use of the CO_2 laser, which, therefore, allows a better and easier suturing of the wound;
5. an hemostasis of the vascular component allowing the removal of adipose tissue minimising bleeding and, therefore, maintaining a clean surgical field;
6. a minimally invasive skin rejuvenation of the lower periorbital area with excellent results and minimal downtime. Finally, the use of this advanced and minimally invasive technique in this area results in a complementary and synergistic relationship between dermatologists and plastic surgeons. As a result, this multidisciplinary approach strengthens the outcome and is useful for addressing the patients' increasing esthetic and psychological needs.

5 | CONCLUSIONS

Our findings from clinical evaluations suggest that the CO_2 and 1540-nm laser assisted blepharoplasty with a High-pulse shape emission integrated is proved to be a sophisticate intervention efficacious in improving the treatment of patients with various degrees of eyelid and periocular aging and also in reducing downtime. This kind of laser meets the needs of the majority of medical practitioners, who require a unique, versatile tool able to make a delicate technique like the blepharoplasty as safe and effective as possible. We believe that this laser technique is a worthy new modality that represents a step forward toward surgical excellence.

CONFLICT OF INTEREST STATEMENT

I.F. and F.M. are employed at El.En. Group. The other authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

FUNDING INFORMATION

This research received no external funding.

DATA AVAILABILITY STATEMENT

Data that support the study findings are available upon request from the corresponding author.

ETHICS STATEMENT

Informed consent was obtained from all subjects involved in the study. The study was conducted in accordance with the Declaration of Helsinki. As the device has been an already CE-marked device since 14/04/2021, ethical review and approval were waived for this study.

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How to cite this article: Bonan P, Fusco I, Bruscino N, et al. Laser-assisted blepharoplasty: An innovative safe and effective technique. *Skin Res Technol*. 2023;29:e13351 https://doi.org/10.1111/srt.13351