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Laser excision of benign skin lesions: a comparative analysis of two CO_2 laser systems

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ABSTRACT

Lasers are common dermatological tools used for both clinical and aesthetic indications. The CO_2 laser is the gold standard system used for ablative removal of benign lesions. Due to its high absorption in water and low ablation threshold, it can be used to remove, cut, and coagulate skin tissue. This retrospective analysis compared the 3-month safety and performance of the Alma Hybrid/Hylight 50 and Pixel CO_2 Focus laser systems used to remove benign skin lesions in adult patients. Treatment tolerability was rated immediately after the procedure, while clearance and patient satisfaction with treatment outcomes were assessed at the 6-month follow-up visit. Overall, 37 lesions were excised with the Hybrid/Hylight 50 laser, and 41 lesions were excised with the Pixel CO_2/Focus laser. In both cohorts, 70% of the lesions removed were intradermal nevi or skin tags, all lesions were nonvascular, and most were located on the face (Hybrid/Hylight: 75.7%; Pixel CO_2/Focus: 61.0%). Median lesion size was 7.65 mm and 7.09 mm in the Hybrid/Hylight and Pixel/Focus cohorts, respectively. Complete removal of all lesions was achieved after a single treatment session, regardless of the laser system used. Patients reported very low pain levels and were highly satisfied with the treatment outcomes. Hypopigmentation was reported for two patients in the Hybrid/Hylight cohort and 1 patient in the Pixel cohort; 1 patient in each cohort developed post-inflammatory hyperpigmentation. All adverse events resolved within 5-10 months. Our findings indicate that CO_2 lasers can safely and effectively remove benign skin lesions of varying sizes and locations on the body.

Key words: CO_2 laser; benign skin lesion; excision.

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Introduction

Lasers have been a mainstay dermatological tool for decades, with well-established efficacy in the treatment of common skin diseases. They are currently the treatment of choice for benign skin lesions and facial aesthetics. The rapid and continuous evolution of laser technologies served as fertile ground for new laser system designs with improved accuracy and expanded indications, which vary with laser wavelength. The CO_2 laser, emitting a 10,600 nm beam, is one of the most widely used and versatile lasers and is the gold standard for ablative applications, including the removal of benign growths and the treatment of scars.[1-3] Infrared light is absorbed by water, its target chromophore, causing selective photothermolysis of water-containing soft tissues. When coupling its instantaneous effect at high power densities with linear movement of the delivery handpiece, the laser provides a scalpel-like action. The CO_2 laser is considered relatively safe, conferring minimal deep-tissue damage, owing to the quenching of incident energy by surrounding water. The residual thermal damage along the perimeter of the CO_2-affected zone ensures photocoagulation of small blood vessels and thermal photoactivation of bioreactions.[4] Together, these culminate in a clean incision with minimal hemorrhage, pain, inflammation, and charring, which translates to faster healing compared to conventional surgery.

The myriad of currently available CO_2 laser systems offers beams with various specifications impacting beam irradiance and fluence. Together, these dictate light penetration depth, treatment precision, outcomes, and safety. In addition, the introduction of laser beam fractionation has expanded the indications of the traditionally ablative CO_2 laser to include skin rejuvenation, deeper skin remodeling, and other aesthetic dermatology applications and has broadened patient eligibility to include those with darker skin types.

In our institution, the CO_2 laser is frequently used for a wide range of applications, including the removal of benign skin lesions. The current work presents a comparative, single-center, retrospective review of the outcomes of benign skin lesion excisions executed with two CO_2 laser systems.

Materials and Methods

This chart review was approved by the ethics committee of the Albanian Ministry of Health (application number 635/66), and the requirement for informed consent was waived due to the retrospective nature of the study. The study examined the electronic medical records of adults (≥18 years) who received laser treatment for benign skin lesions (*e.g.*, acrochordon, cutaneous neurofibroma, seborrheic keratosis, verruca vulgaris) and were followed up for at least 3 months between April 2022 and March 2024. Patients with an active local infection at the treatment site, photo-aggravated skin disease, a cultured epithelial autograft at the treatment site, unstable epithelium within a few weeks of injury, or ongoing/within 1 month of completion of isotretinoin treatment were not eligible to participate in the study.

Following initial confirmation of patient eligibility, patient records were anonymized before data analysis. Patient demographics, treatment outcomes, and treatment safety information were extracted from the database.

CO_2 laser devices

Hybrid/Hylight

The Alma Hybrid/Hylight 50 (Alma Lasers Ltd., Israel) is an adjustable full-spot applicator that can deliver either 10,600 nm (cut and coagulate) or 1570 nm (coagulate) laser energy. The 50 refers to 50 mm from the lens to the focal point on the skin. In this study, the "cut and coagulate" 10,600 nm mode was employed. Working at the distance defined by the edge of the tip from the skin results in cutting, while defocusing the tip results in a more coagulative effect when operating at low powers. This is particularly useful when cutting soft tissue, as the defocused mode limits bleeding.

Pixel CO_2/Focus

The Alma Pixel CO_2/Focus (Alma Laser Ltd., Israel) incorporates a focusing lens that directs the beam to a focal distance of 50 mm (spot sizes 0.125 mm). The laser system can serve as an effective tool for cutting and for precise ablation and coagulation of soft tissues. When working in the focused mode, the tip of the applicator is placed close to the treatment area. The fluence that reaches the tissue is high, resulting in a precise cutting effect. When working in the defocused mode, the applicator is held at a distance from the treatment area. Low settings lead to tissue coagulation, whereas high settings result in ablation. The "cut

and coagulate" treatment allows for the selection of power levels in three work modes: continuous wave, pulses wave, and repeat.

Procedure and follow-up

All lesion excision procedures were performed by the same surgeon. After disinfection of the target area, local anesthesia was applied (lidocaine 100 mg/50 mL). Laser parameters were first set to the lowest possible setting (1.0 W) and gradually adjusted to suit the size and thickness of the lesion. Overall, power levels used ranged between 4 W and 15 W. Pedunculated lesions and lesions were excised, while flat lesions were ablated. After the treatment, the area was cleaned thoroughly with antiseptics. Lesions were visually assessed with the naked eye and with a standard dermatoscope (x10 lens) before, immediately after, and 3-12 months after the procedure. Immediately after the procedure, patients were asked to rate the tolerability of the treatment using an 11-point numeric scale, ranging from 0, indicating "no pain," to 10, indicating "worst pain imaginable." In addition, device- and procedure-related adverse events were documented. At the 6-month follow-up visit, patients were asked to rate their satisfaction with the treatment using a 5-point numeric scale, ranging from 1, indicating "very dissatisfied," to 5 indicating "very satisfied."

Statistical analysis

Safety and efficacy measures were summarized with descriptive statistics. Age and lesion size were summarized by a mean, standard deviation, median, interquartile range (IQR), minimum, and maximum and compared between treatments using the Mann-Whitney test. Categorical variables were summarized by count and percentage and compared between treatments using Fisher's exact test. In the statistical tests performed, nominal p-values are presented, and two-sided $p<0.05$ are considered statistically significant. Analyses were carried out using R-4.4.1 (R Foundation for Statistical Computing, Vienna, Austria).
The target clearance rate (100% disappearance) at 3-6 months post-treatment was based on a review of the state-of-the-art laser performance and prespecified at 46% for non-vascular lesions. The null hypothesis was tested with an exact binomial test against the null value of 46%; if the p-value of the test was <0.05 and the percent of treated non-vascular tumors with 100% clearance was 70%, the null hypothesis was to be rejected, and the performance acceptance criterion deemed successfully met.

Sample size calculation

The sample size is calculated to test the null hypothesis with at least 80% power at a two-sided 5% level of significance using an exact binomial test. At least 37 subjects were required to test the null hypotheses, assuming the expected percentage of treated non-vascular tumors with 100% clearance is at least 70%.

Results

All patients included in this analysis underwent laser procedures to remove a benign skin lesion. In total, 37 procedures were performed with the Hybrid/Hylight 50, and 41 procedures were performed with the Pixel CO_2. The distribution of patient gender, age, skin type, and lesion type was similar across the two patient cohorts (Table 1), with the vast majority of patients being female (70.5%) and with skin type II or III (Hybrid: 94.5%; Pixel: 90.5%). The mean age was 37.9 years. In both cohorts, the most commonly treated lesions were intradermal nevi (Hybrid: 35.0%; Pixel: 36.5%) and skin tags (Hybrid: 35.1%; Pixel: 34.1%). Additional excised lesion types included seborrheic keratosis, moles, and fibromas. All lesions were nonvascular, either sessile or pedunculated, and most were located on the face (Hybrid: 75.7%; Pixel: 61.0%). Median lesion size was similar across the two cohorts (Hybrid: 7.65 mm; Pixel: 7.09 mm).
Complete clearance of all lesions was achieved with both laser systems after a single treatment session (Figure 1, 2). All patients in both cohorts reported very low pain levels. The vast majority of patients treated with the Hybrid/Hylight 50 device were highly satisfied with the treatment outcomes (94.6%); the remaining two patients were satisfied with the outcomes. All patients treated with the Pixel CO_2 device (100%) were highly satisfied with treatment outcomes. In the Hybrid/Hylight 50 cohort, 2 patients (5.4%) experienced hypopigmentation, which self-resolved within 6-8 months, and 1 (2.7%) suffered post-inflammatory hyperpigmentation, which was treated with hydroquinone 4% (Merit Pharmaceutical, Los Angeles, CA, USA) and resolved within 5 months. In the

Pixel CO_2 cohort, hypopigmentation and post-inflammatory hyperpigmentation were reported for one patient (2.4%). Both events were resolved without any intervention within 10 and 5 months, respectively.

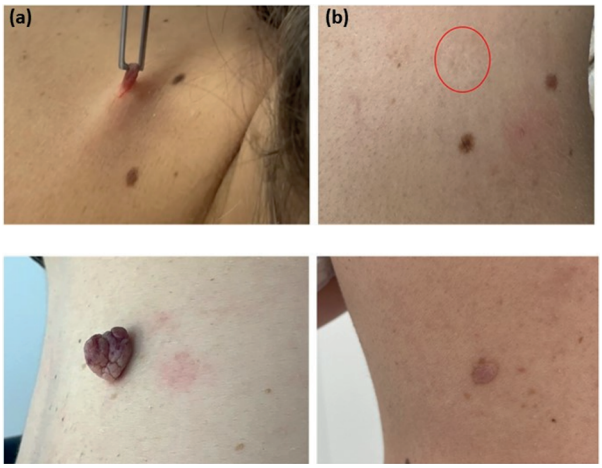

Figure 1. Clearance of skin tags following a single Alma Pixel CO_2/Focus CO_2 laser treatment session. Representative skin tags on the (a) back and (b) abdomen before (left) and 2 months following (right) excision with the Alma Pixel CO_2/Focus CO_2 laser.

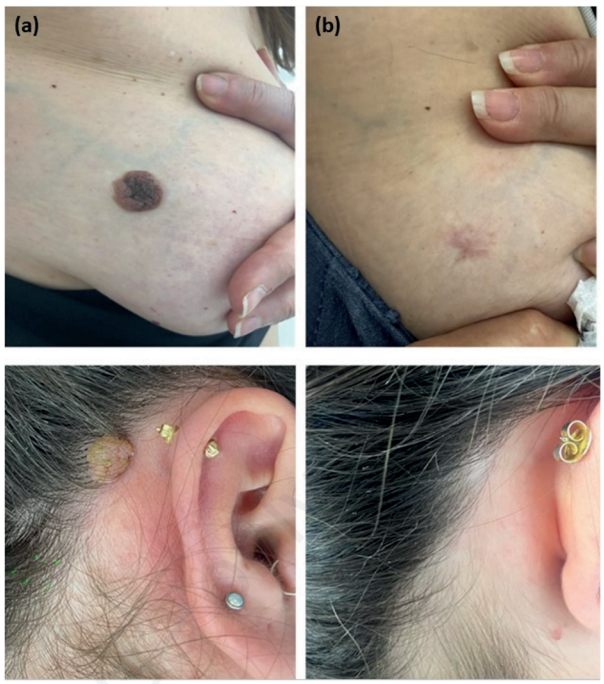

Figure 2. Clearance of skin tags following a single Alma Hybrid/Hylight 50 CO_2 laser treatment session. Representative skin tags on the (a) breast and (b) scalp before (left) and after (right) 2 (breast) or 3 (scalp) months following excision (right) with the Alma Hybrid/Hylight 50 CO_2 laser.

Table 1. Patient demographics and baseline lesion characteristics.

Characteristics	Measure/Category	Hybrid/Hylight 50 (N=37)	Pixel/Focus (N=41)
Age (years)	Mean (SD)	35.3 (8.9)	37.6 (9.6)
Sex, n (%)	Male	10 (27.0)	13 (31.7)
	Female	27 (73.0)	28 (68.3)
Skin type, n (%)	II	17 (45.9)	13 (31.7)
	III	18 (48.6)	24 (58.5)
	IV	2 (5.4)	4 (9.8)
Lesion location, n (%)	Face	28 (75.7)	25 (61.0)
	Abdomen	2 (5.4)	1 (2.4)
	Back	3 (8.1)	8 (19.5)
	Neck	1 (2.7)	5 (12.2)
	Breast	1 (2.7)	N/A
	Chest	1 (2.7)	N/A
	Armpit	1 (2.7)	N/A
	Scalp	N/A	1 (2.4)
	Nose	N/A	1 (2.4)
Lesion type, n (%)	Intradermal nevus	13 (35.1)	15 (36.6)
	Seborreic keratosis	9 (24.3)	5 (12.2)
	Skin tag	13 (35.1)	14 (34.1)
	Fibroma	2 (5.4)	1 (2.4)
	Mole	N/A	6 (14.6)
Lesion geometry	Sessile	22 (59.5)	19 (46.3)
	Pedunculated	15 (40.5)	22 (53.7)
Lesion size, (mm)	Mean (SD)	7.7 (2.0)	6.6 (2.6)
	Range	4, 13	2, 17

Discussion

Ablative treatment with CO_2 laser systems is a routine dermatological practice for a broad range of indications. It has proven significantly advantageous over cold steel surgical approaches, particularly considering the reduced mechanical damage and lower risk of surgical site infection.[1] Furthermore, when delivered in a fractionated pattern, the intermittent zones of intact skin drive wound healing and tissue regeneration processes, ultimately shortening downtime and reducing pain and risk of side effects. Compared to laser wavelengths with target chromophores other than water, it induces less thermal damage and postoperative pain, owing to the rapid quenching as soon as the beam is defocused.[5] The current work demonstrated equal performance and safety of two CO_2 laser systems, with complete clearance of all 78 lesions within 3-12 months of treatment. The systems achieved optimal results for a wide range of lesion sizes (2.0-17.0 mm) and body areas. The high patient satisfaction with treatment outcomes takes on an additional dimension when considering the fact that most lesions were in the facial area and likely removed for cosmetic reasons. These favorable outcomes were the direct result of the versatility of the two platforms, which allows for tailoring of the treatment parameters to the lesion and patient characteristics, ensuring maximal precision and patient comfort.

Köse reported similar results after a retrospective analysis of 684 facial nevi (330 patients) followed up for 12 months following their removal with an ablative CO_2 fractional laser.[6] However, while the mean lesion size (4.55 mm) in the cohort was considerably smaller than in the current study (~7 mm), 13% of the nevi required a second, 5% of the nevi required a third, and 1% required more than three treatment sessions to achieve full clearance. In addition, only 59% of the patients rated satisfaction as excellent. The remainder rated it as good (32%), fair (5%) or poor (3%). At the 12-month assessment, 4% of the patients still suffered from hyperpigmentation and 1% from hypopigmentation. Other long-term complications sequelae included fibrosis (3%), dimples (2%), and scars (2%). Recurrence was reported in 2% of the cases.

A systematic review of publications regarding laser therapy for congenital melanocytic nevi identified five reports involving 45 patients in total using a CO_2 laser to remove the lesions. When compared to other laser options, the ablative laser modalities were the most commonly used to treat large and giant lesions. Yet, they were associated with the highest procedure-related complication rate, including wound infection (18%). In addition, scarring was most common with this class of lasers and more frequently reported for continuous wave and low-energy pulsed CO_2 lasers as compared to their high-energy, ultrashort pulsed counterparts.[7] Due to the wide range of laser settings used in the identified studies, as well as patient demographics and nevi characteristics, the authors were unable to identify definitive predictors of treatment outcomes.

Seborrheic keratosis and skin tags are also considered ideal targets of CO_2 laser treatment, which allows for controlled and precise removal either in a layer-by-layer method or by focusing the beam on the base of the lesion subjected to traction forces.[8] In a self-controlled comparison of the safety and performance of CO_2 laser, Er:YAG laser, cryotherapy, and electrodesiccation of facial seborrheic keratosis in 30 patients, improvement rates and patient satisfaction were significantly higher for the two laser options and electrodesiccation as compared to cryotherapy.[9] Erythema duration in the regions treated with the Er:YAG laser was 2-4 days longer than in regions treated with one of the other treatment options.

Temporary hyperpigmentation is a common sequela of both non-fractionated and fractionated CO_2 laser treatment, with their extent largely dependent on the treatment settings.[10] Post-inflammatory hyperpigmentation is the result of hypermelanosis secondary to dermal inflammation induced by thermal damage. Its incidence varies from 0-100%, with reports showing an inconsistent correlation with skin phototype.[11] Other factors that contribute to the risk of such reactions include hormone status, pretreatment condition, and anatomical location of the lesion.[12] Various studies have suggested the prophylactic effect of topical corticosteroids, anti-inflammatory drugs, antimicrobials, and epidermal growth factors, but further studies are still needed to determine their efficacy.[11] While such reactions generally resolve spontaneously, several creams are available to accelerate the process, but they remain considered experimental.[2,11]

Hypopigmentation is a less common reaction, generally with a late onset and longer duration.[12] It is thought to be the result of the destruction of melanin-producing cells and is more common with lasers of wavelengths well absorbed by this chromophore.[13]

The current study was limited by its retrospective nature, with restrictions to data documented in medical records before research questions were delineated. Neither of the cohorts included patients with skin types I or V. In ad-

dition, treatment precision for resectioning lesions smaller than 2.0 mm remains to be determined. In cases of small lesions, laser treatment is generally preferred over surgical resection as it carries a lower risk of scarring.

Conclusions

CO_2 laser treatment proved to be an effective and safe method for removing benign skin tumors of varying sizes and locations on the body. Yet, further studies with a large sample should be performed.

Conflict of interest

The author reports no conflicts of interest relevant to this work.

Ethics approval and consent to participate

This chart review was approved by the ethics committee of the Albanian Ministry of Health (application number 635/66), and the requirement for informed consent was waived due to the retrospective nature of the study.

Availability of data and materials

All data generated or analyzed during this study are included in this published article.

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