Aesth Plast Surg
DOI 10.1007/s00266-010-9485-y

ORIGINAL ARTICLE

Melasma Treated with Intense Pulsed Light

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Received: 12 September 2009 / Accepted: 11 February 2010

Abstract
Background Hypermelanosis includes a diverse group of genetic and acquired skin anomalies that appear as darker, hyperpigmented areas. Melasma, in particular, is a hypermelanotic condition that affects sun-exposed skin in females. Whether this condition is acquired or genetic is still controversial. However, it clearly correlates with exposure to UV light, a genetic predisposition, and hormonal variations (from pregnancy or oral contraceptives).
Methods Between October 2006 and March 2008, 38 patients with melasma were treated with intense pulsed light (IPL) at the LASER Center of the Department of Health Science, Plastic and Reconstructive Surgery Session, University of L'Aquila. Diagnosis was based on medical history, physical examination, and video microscopy.
Results Results were graded as excellent, good, moderate, or poor. Grades were given according to outcome scale and reported complications. All 38 patients had follow-up checks at 30 days, 3 months, and 6 months and someone at more than 1 year. Results were excellent in 18 patients (47.37%), good in 11 (28.95%), moderate in 5 (13.16%), and poor in 4 cases (10.52%).
Conclusion From a careful review of the scientific literature and according to our personal clinical experience, IPL stands out as an effective tool in the treatment and healing of a high percentage of hypermelanosis and melasma, with a very low risk of complications and an excellent satisfaction rate among patients.

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Keywords Pregnancy mask · Melasma · Chloasma · Intense pulsed light (IPL) · Hypermelanosis · Epiluminescence · Dermoscopy

Melasma is an acquired hypermelanosis of unknown origin that affects sun-exposed skin. Ninety percent of those affected are female [1, 2]. Although all wavelengths of sun radiation can induce melasma, including the visible spectrum, overexposure to UV rays seems to be the main cause of the abnormal deposition and accumulation of melanin. Ultraviolet light induces peroxidation of lipids in cellular membranes, formation of free radicals, and ultimately abnormal melanin production. Other etiologic conditions that may cause melasma include a nonspecific genetic predisposition (30%) and variations in female hormonal balance from pregnancy or oral contraceptives. Melasma has also been described in patients with ovarian dysfunction, thyroid autoimmune disease, and liver disease, and in association with photosensitizing drugs (Phenitoin, Mephenitoin) or cosmetics [2–5].

From a clinical standpoint, melasma affects both sides of the face with irregular, asymmetric, intensely pigmented, and well-demarcated areas. The areas vary in number, size, and color, ranging from ochre-yellow to dark gray. Melasma can be classified according to location, histological pattern, and morphology under Wood's lamp [1, 2, 6].

According to location, melasma is classified as (1) craniofacial (forehead, nose, cheeks, upper lip, chin) (63% of cases), (2) malar (cheeks, dorsum of the nose) (21% of cases), and (3) mandibular (mandibular rami) (16% of cases).

Histological classification is based on the location of pigment accumulations in the skin.

Published online: 12 March 2010

- *Epidermal*: Melanin is concentrated in the basal and/or suprabasal layer of the epidermis. Few and sparse melanophages are seen in dermal papillae. Wood's lamp shows an enhanced chromatic contrast between lesion and normal skin [1, 2, 6, 7].
- *Dermal*: Melanin is found in the midsuperficial dermis. Pigment and macrophages concentrate in the perivascular spaces [6, 8, 9]. Wood's lamp shows less contrast between dyschromia and normal skin [7].
- *Mixed*: Melanin is seen in both skin layers. Contrast is variable under Wood's lamp [1, 7].
- *Indeterminate*: Melanin deposits mainly in the dermis. This histological pattern is typical of dark-skinned individuals. Lesions are not visible under Wood's lamp because of insufficient contrast [1, 2, 6, 9].

Many treatment protocols for melasma have been described in the literature. Therapy can be difficult due to melanin depth. Treatment is easier if melanin is epidermal and much more difficult if it is located in the dermis. We know that dermal pigment originates from the epidermis. Therefore, if we inhibit epidermal melanogenesis for a sufficiently long period of time, dermal melanin cannot be replaced and melasma may slowly evolve toward healing [10] (Table 1).

In this article, we report on our personal experience in treating melasma using IPL. Details of the therapeutic protocol and clinical results are described.

Materials and Methods

Between October 2006 and March 2008, 38 consecutive patients with melasma were treated with IPL at the LASER Center of the Department of Health Science, Plastic and Reconstructive Surgery Session, University of L'Aquila. Age of the patients ranged between 18 and 64 years (Table 2). The diagnosis of 38 patients with Fitzpatrick phototype III–IV was based on medical history, physical examination, and video microscopy (Nevuscreen—Arkè s.a.s., Avezzano-L'Aquila, Italy). Patients who were on any type of estroprogestin drugs had to stop hormonal therapy 2 months before IPL treatments. To assess the efficacy of the power settings of the instrument and any cutaneous reactivity, all patients underwent a pre-test 30 days before treatment started [11]. In addition, our protocol included 4 weeks of the same topical skin care that we usually administer before a laser CO_2 resurfacing (Table 3).

The IPL device we use (Deka me.la. S.r.l., Calenzano-Florence, Italy) has different handpieces for wavelengths of 500 and 550 nm. The setting was customized to the individual's phototype and the clinical characteristics of the hypermelanosis (Table 4).

The number of IPL sessions ranged between 3 and 5, at intervals of 40–45 days. No particular post-treatment therapy was necessary other than topical balming creams for 24–48 h and sunscreen (SPF 15 minimum) every morning at all times of the year.

We take a photo of the patient before the first treatment and before the second treatment to estimate the results and to have an objective evaluation of outcome. To understand the outcome objectively and in reproducible form using the

Table 1 Treatments for melasma (review of literature)

Mechanism of action	Therapy
Tyrosinase inhibition	Hydroquinone
	Tretinoin
	Azelaic acid
	Kojic acid
Nonselective suppression of melanogenesis	Corticosteroids
Inhibition of ROS	Azelaic acid
Removal of melanin	Chemical peels
Thermal damage	Laser treatments

ROS reactive oxygen species

Table 2 Distribution of types of melasma in our series (38 patients)

No. of patients	Hypermelanosis type		
22	Melasma	7	Craniofacial
		13	Malar
		2	Mandibular
12	Pregnancy mask	8	Craniofacial
		4	Malar
		0	Mandibular
4	Post oral contraceptives (all patients showed a malar pattern)		

Table 3 Pretreatment skin care

Kojic acid cream twice per day
Alpha-hydroxy acid cream every morning
Sun protection applied every morning

Table 4 IPL device settings (the choice was secondary to melasma localization and phototype)

Parameter	Range
Wavelengths	550 nm
Pulse	5–10 ms
Delay	10–20 ms
Fluence	6–14 J/cm^2

Table 5 Outcome scale

Results	Reduction of hyperpigmented area (%)	Decrease of dark tones (%)
Excellent	80–100	80–100
Good	60–79	60–79
Moderate	40–59	40–59
Poor	<39	<39

pre- and post-treatment photos, we set a grading scale where reduction of the hyperpigmented area and the decrease of dark tones are the parameters. The grade of improvement was calculated using a computer graphics program (Anthology—Deka me.la. S.r.l., Calenzano-Florence, Italy) (Table 5, Fig. 1). Also the patient's opinion on results was recorded.

Results

Clinical results were graded as excellent, good, moderate, or poor. Grades were given according to outcome scale and reported complications. All 38 patients had follow-up checks at 30 days, 3 months, and 6 months and someone more than 1 year. Results were excellent in 18 patients (47.37%), good in 11 (28.95%), moderate in 5 (13.16%), and poor in 4 cases (10.52%) in which a recurrence of hyperpigmented areas occurred within 2 and 4 months. The patients' opinions are reported in Table 6. We have seen no untoward effects or complications.

Discussion

Hypermelanosis in general and melasma in particular are complex skin problems with difficult solutions and

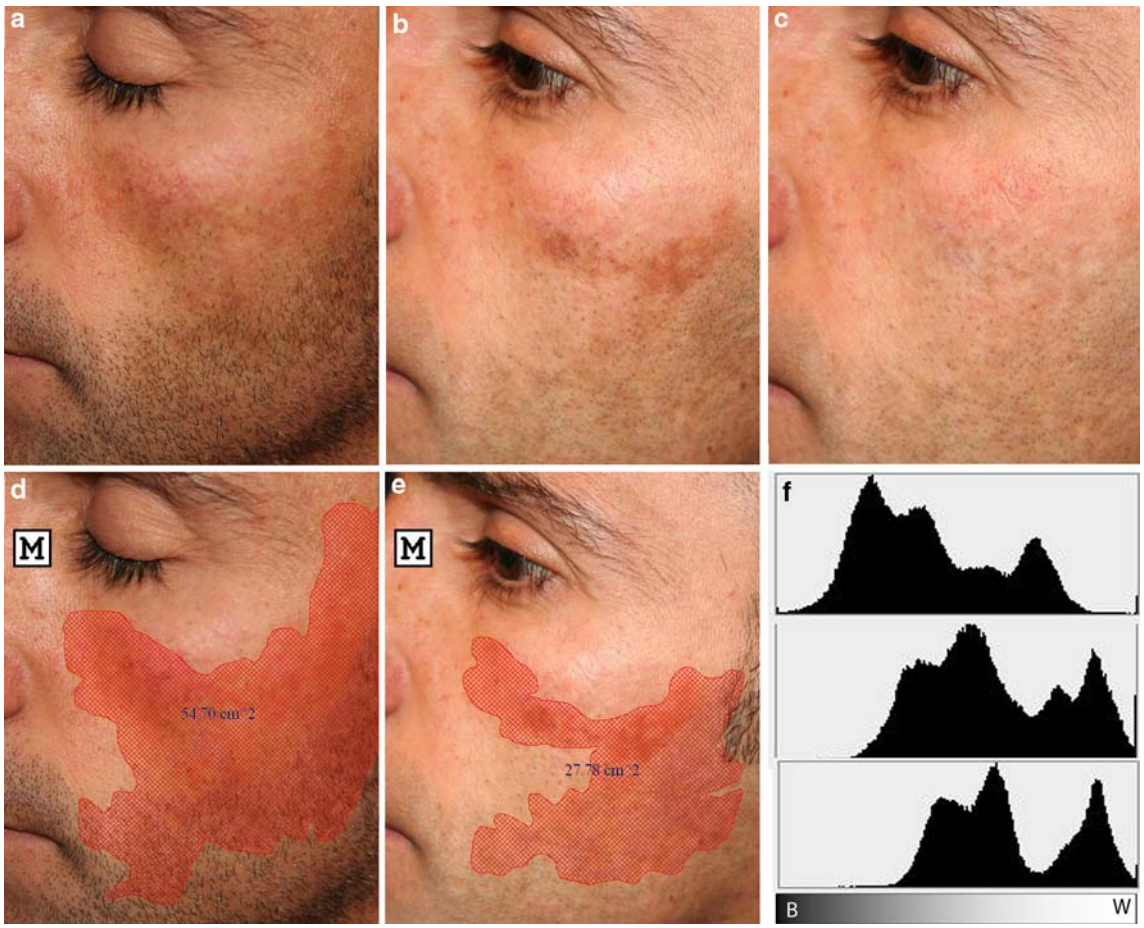

Fig. 1 A 38-year-old man with malar melasma. **a** Preoperative view. **b** After 40 days from first treatment (2 pulse = 5–10 ms, delay = 10 ms, fluence = 11.5 J/cm^2) there is a persistent hyperpigmented area on the zygoma but a reduction of cheek hyperpigmentation. **c** Three months after three sessions (2 pulse = 5–10 ms, delay = 10 ms, fluence = 13.5 J/cm^2), there is persistent light but acceptable pigmentation. **d** Computer evaluation of melasma area (54.70 cm^2) before treatment. **e** Computer evaluation of melasma area (27.78 cm^2) after the first treatment. **f** Histograms of treated area showing (from the upper to the lower) a progressive reduction of dark tones and the increase of light tones

Table 6 Patient opinions

Results	No. of patients	%
Excellent	23	60.53
Good	9	23.68
Moderate	4	10.53
Poor	2	5.26

significant negative effects on the patient's psychological well-being. Their etiology is still unclear but their pathogenesis seems to correlate with an abnormal melanocytic hyperactivity and an increase in the number of melanosomes in phase IV [12]. Phase IV is the last stage of maturation of melanosomes and involves a quantitative increase of intracellular organelles (rough endoplasmic reticulum, Golgi's reticulum, mitochondria). Only stage III and stage IV melanosomes can synthesize melanin [1, 12]. Melanocytic hyperactivity accelerates pigment transfer from melanocytes to keratinocytes, melanin accumulation in the epidermis, and cutaneous hyperpigmentation [1, 9, 12].

Dermoscopic examination before and after each IPL session is critical for a correct diagnosis and an objective analysis of clinical results. Epiluminescence of the dyschromia spot shows pigmentation irregularities, chromatic variations ranging from ochre-yellow to dark brown associated with melanin depth, and a typical pseudoreticular distribution with concave edges ("jelly sign") [13]. Quite noteworthy is the chromatic change immediately after IPL exposure. The biophysical interaction between light and melanin triggers a transient hyperpigmentation. The affected skin surface starts to lighten after 12 h and pigmentation continues to decrease over the following weeks (Fig. 2). Post-treatment dermoscopy is critical in the evaluation of both the IPL efficacy and the healing process. The post-IPL dermoscopic pattern can vary as follows: (1) spotty, distributed in tiny points, (2) reticular, and (3) complex [13]. Kawada et al. [13] state that IPL efficacy on hyperpigmentation correlates with selective photolysis,

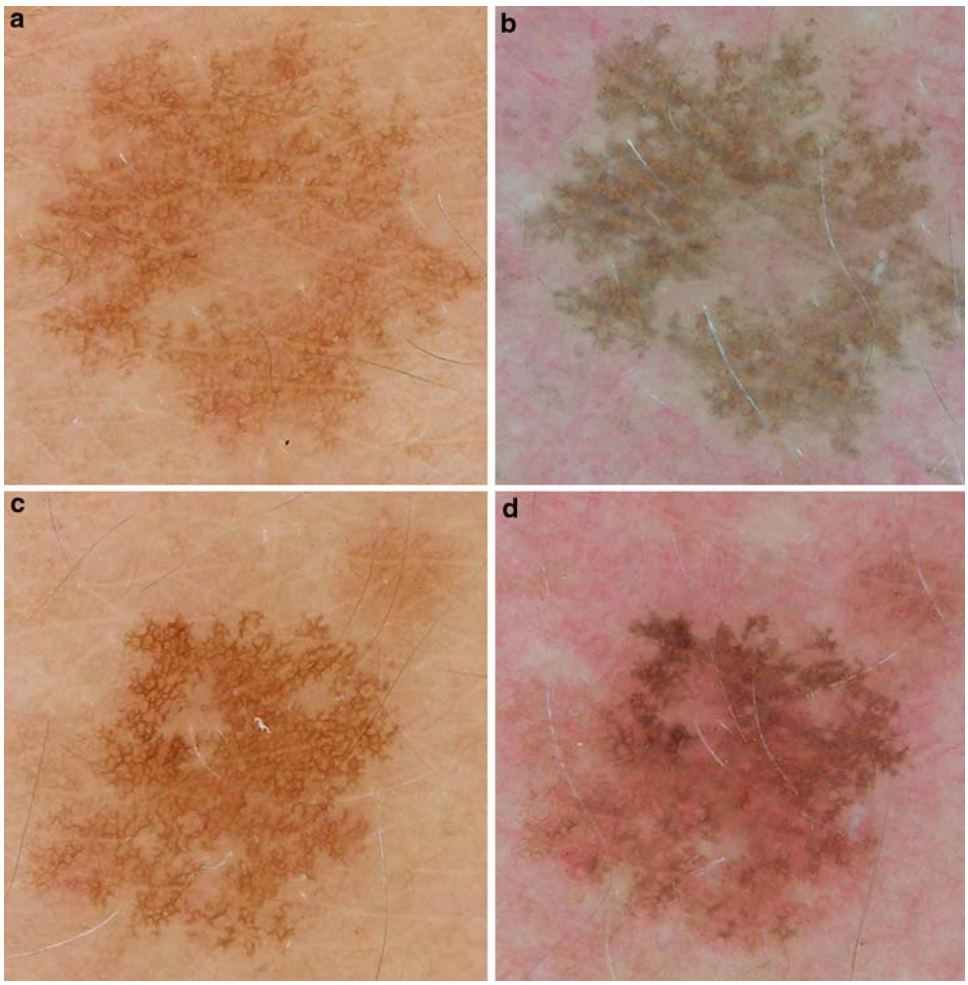

Fig. 2 The epiluminescence analysis of melasma lesion. **a**, **c** Views before treatment show a brown nonhomogeneous pigmentation and "jelly sign." **b**, **d** Photos taken 5 min after IPL treatment show the increase in the stain's darkness. This is an expression of melanin interaction with IPL and the correct device setting. **b** Reticulated pattern. **d** Clumped pattern

tissue photocoagulation, and melanin drop-off with small occasional post-session crusts.

Intense pulsed light (IPL) was introduced in the late 1990s and involves the use of a pulse source of light, which, unlike the laser, is not coherent, not collimated, and has a wide spectrum. Although not a laser, IPL has similar clinical dermatologic applications. Covering a wide wavelength spectrum, IPL has shown to be efficacious in the treatment of vascular lesions, dyschromia, hirsutism, and hypertrichosis. The light source is a xenon-chloride lamp that emits light energy at a wavelength between 500 and 1200 nm (some of the latest devices cover an even wider spectrum from 390 to 1200 nm). IPL produces a very short, intense, and incoherent pulse. It can be customized for each patient by changing wavelength, power, number, duration, and delay of pulses to ensure the best effectiveness on target depth, size, and uptake [14].

Collateral effects are minimal and include burning pain during treatment and a short-lasting erythema. Possible complications include transitory hyperpigmentation changes, persistent hypopigmentation, and, rarely, scarring [14–16].

The device setting plays an important role in the treatment of hypermelanosis, not only in melasma. Our IPL can operate with the factory setting (the physician chooses only the pathology) or in manual mode, in which the physician can modulate fluence, delay, and pulse time. In our first clinical experiences we performed treatment using the manufacturer's setting of 550-nm wavelength. With that setting we obtained a reduction of the hyperpigmented area of nearly 60% and a decrease in darkness in the remaining stain of about 40%. However, there was partial or complete relapse within 6 months, especially in the supralabial region. When we changed the default to the manual setting, we reduced the number of relapses and obtained an average clinical improvement of 80%.

We always use the 550-nm handpiece because it has great selectivity for melanin and reaches the deeper epidermis. We use two pulses (the second is the longer pulse) of 5–10 ms with 10–20 ms delay between the pulses. In our opinion, it is wrong to reduce the delay time below 10 ms because the irradiated tissue cannot reduce its temperature within that time, so there is an increased risk of thermal damage.

The fluence is modulated in relation to the anatomic area: energy levels of 12–14 J/cm^2 are used to treat the cheek and zygoma, 10–12 J/cm^2 for the forehead, and lower levels (7–8 J/cm^2) are reserved for the perioral region and neck.

Performing a test and immediately checking the area with a dermoscope is helpful in choosing the parameters; a transient hyperpigmentation (the stain changes its color to gray) indicates a correct IPL setting.

We obtained satisfactory results with just four sessions in the 38 patients with melasma that was related to pregnancy or oral contraceptive use (Fig. 3). A 54-year-old female patient with craniofacial chloasma for about 10 years required five sessions before we could reach a significant clinical result. In addition, her skin showed areas of seborrhoeic keratosis that was treated with CO_2 laser (Fig. 4). Two subjects presented with hyperpigmentation of the upper lip secondary to a combination of oral contraceptives and mechanical hair removal. A poor clinical result after two standard IPL sessions was attributed to possible local inflammation from the trauma of hair removal. After four and five sessions and higher IPL energy, we obtained clinical improvement (Figs. 5, 6). In two other patients with malar and perioral melasma, we documented a recurrence of hyperpigmentation at 6 months post-treatment, most probably due to poor compliance in the diligent use of sunscreen (Figs. 7, 8).

According to our patients' opinions, the percentage of satisfaction is higher than our outcome scale. We think that this may be the result of the high emotional impact that the pathology has on the patients' lives so that they tend to overestimate their satisfaction and are less critical of the results.

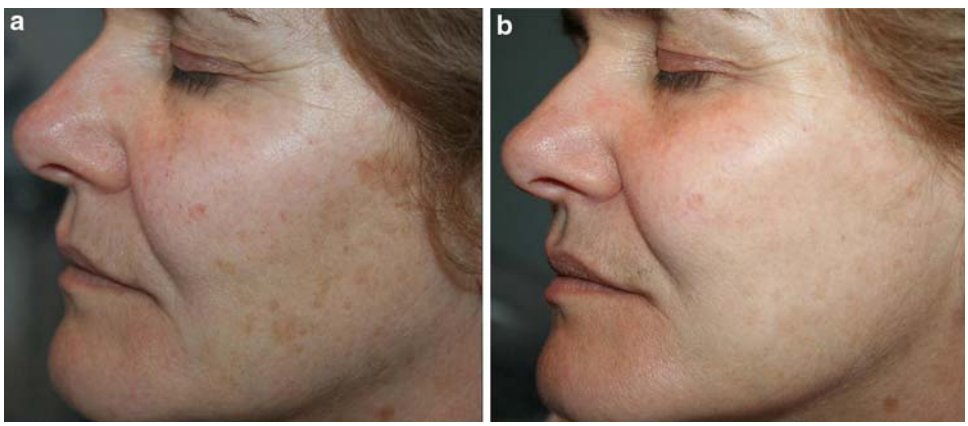

Fig. 3 A 49-year-old woman with malar chloasma. **a** Pretreatment view. **b** Four months after four sessions (2 pulse = 5–10 ms, delay = 10 ms, fluence = 10 J/cm^2)

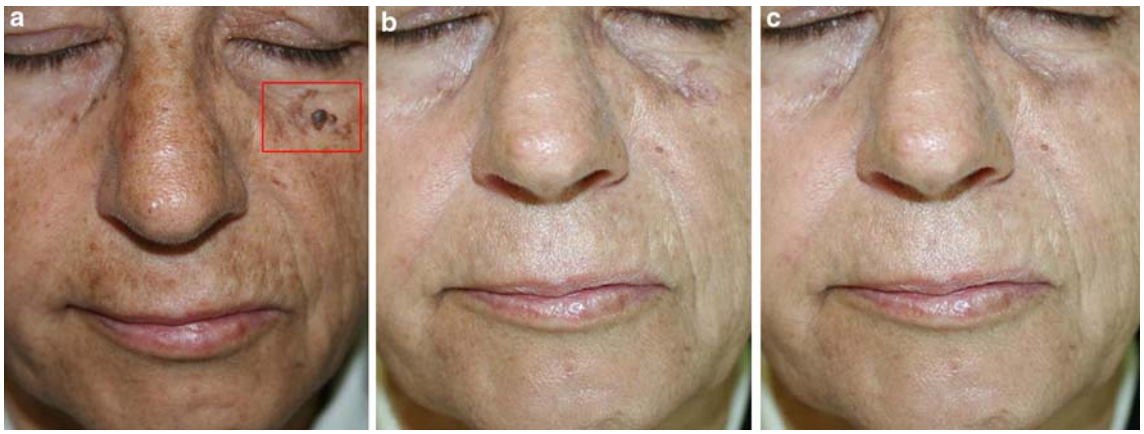

Fig. 4 A 54-year-old patient with craniofacial chloasma. The onset of hypermelanosis occurred 10 years before. **a** Before treatment; the seborrhoeic keratosis treated with CO_2 is in the square. **b** Post-treatment view 45 days after the third session with 550 IPL (malar region: 2 pulse = 5–10 ms, delay = 10 ms, fluence = 13 J/cm^2; moustache area: 2 pulse = 5–10 ms, delay = 10 ms, fluence = 9 J/cm^2) and one treatment with CO_2 laser (5 × 5-mm scanner at 5 W/cm^2 of power). **c** View 6 months after the fourth IPL treatment

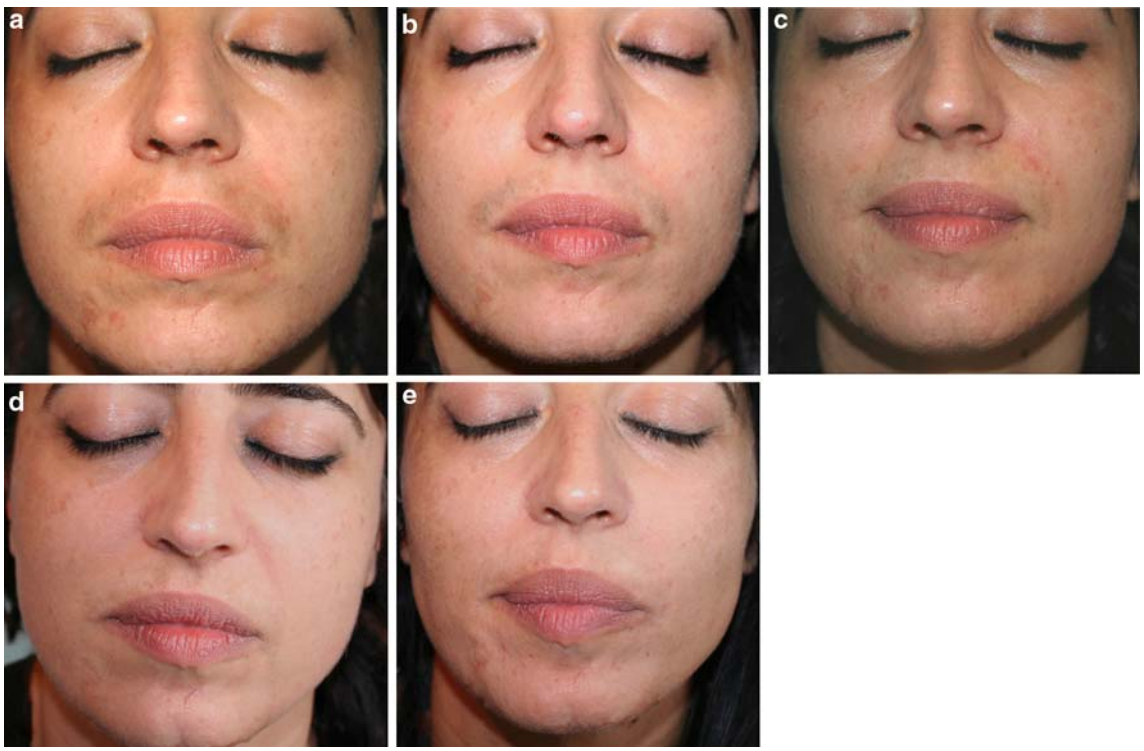

Fig. 5 A 23-year-old woman suffering from perioral hypermelanosis that started during contraceptive therapy. **a** Pretreatment view. **b** One month after one IPL session (2 pulse = 5–10 ms, delay = 10 ms, fluence = 9 J/cm^2). **c** One month after the second IPL session (2 pulse = 5–10 ms, delay = 10 ms, fluence = 10 J/cm^2). **d** Three months after the end of treatment (5 IPL exposure). **e** One year after the last treatment

Conclusions

Melasma is a serious pathology of the skin, affecting a significant portion of the female population. So far no therapeutic protocols have been able to radically solve all clinical manifestations. Products containing hydroquinone are well known to be among the most effective, but they are not approved in all countries. Chemical peels and other topical medications introduced in the past have their limits. From a careful review of the scientific literature and according to our personal clinical experience, IPL stands out as an effective tool in the treatment and healing of a high percentage of hypermelanosis and melasma, with a very low risk of complications and an excellent satisfaction rate among patients.

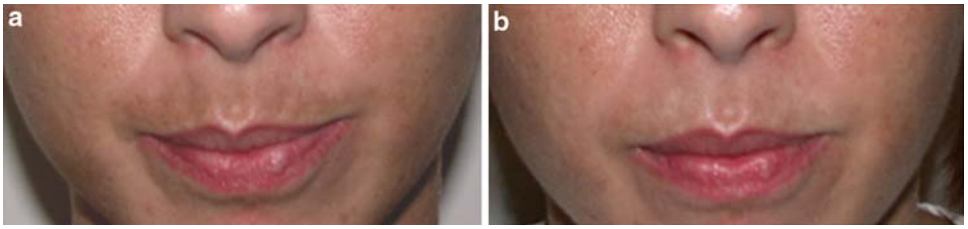

Fig. 6 A 24-year-old woman with hyperpigmentation of the upper lip. **a** Pretreatment view. **b** View 3 months after the fourth IPL treatment (2 pulse = 5–10 ms, delay = 10 ms, fluence = 9 J/cm^2)

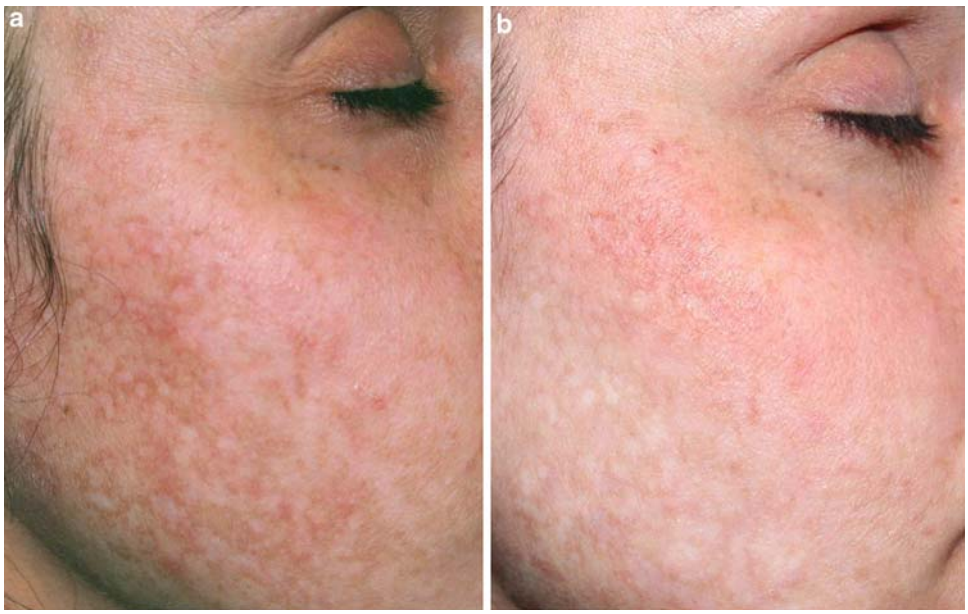

Fig. 7 A 27-year-old woman with malar melasma with an important inflammatory component. **a** Before treatment. **b** Three months after two sessions at 550-nm wavelength (2 pulse = 5–10 ms, delay = 10 ms, fluence = 13.5 J/cm^2) and another two treatments at 500-nm wavelength (2 pulse = 5–10 ms, delay = 10 ms, fluence = 8 J/cm^2). Residual hypermelanotic areas on mandibular ramus and signs of inflammation are visible

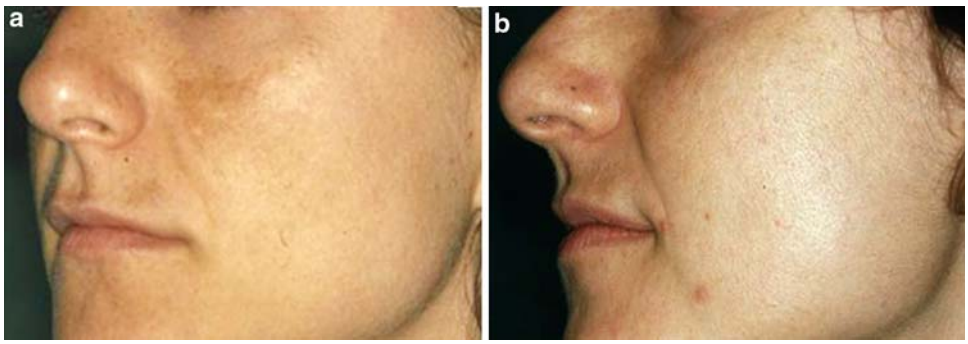

Fig. 8 A 35-year-old patient with malar chloasma. **a** Before treatment. **b** View after three sessions with 550 IPL (2 pulse = 5–10 ms, delay = 10 ms, fluence = 13.5 J/cm^2). Residual hypermelanotic areas on the mustache area are visible

To conclude, we would like to mention our agreement with Kim et al. [17], who recommended that we follow IPL treatments at 550 nm with one or two sessions at 500 nm to improve the final clinical results in hypermelanosis with an important vascular component.

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