Recommendations

Standard guidelines of care: Lasers for tattoos and pigmented lesions

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ABSTRACT

Introduction: Lasers have revolutionized the treatment of pigmentary disorders and have become the mainstay of therapy for many of them. **Machines:** Though different laser machines are used, Quality-switched (QS) lasers are considered as the gold standard for treatment of pigmented lesions. Proper knowledge of the physics of laser machine, methodology, dosage schedules, etc., is mandatory. **Physician Qualification:** Laser may be administered by a dermatologist, who has received adequate background training in lasers during postgraduation or later at a center that provides education and training in lasers, or in focused workshops which provide such trainings. He should have adequate knowledge of the machines, parameters, cooling systems, and aftercare. **Facility:** The procedure may be performed in the physician's minor procedure room. **Indications:** Epidermal lesions: Café au lait macules (CALM), lentigines, freckles, solar lentigo, nevus spilus, pigmented seborrheic keratosis, dermatosis papulosa nigra (DPN). Dermal lesions: Nevus of Ota, Blue nevus, Hori's nevus (acquired bilateral nevus of Ota-like macules). **Tattoos:** Amateur, professional, cosmetic, medicinal, and traumatic. Mixed epidermal and dermal lesions: Postinflammatory hyperpigmentation (PIH), nevus spilus, periorbital and perioral pigmentation, acquired melanocytic nevi (moles), melasma and Becker's Nevus. **Contraindications:** Absolute: Active local infection, photo-aggravated skin diseases and medical conditions, tattoo granuloma, allergic reactions to tattoo pigment, unstable vitiligo and psoriasis. Relative: Keloid and keloidal tendencies, patient on isotretinoin, history of herpes simplex, patient who is not co-operative or has unrealistic expectation. **Patient selection:** Proper patient selection is important. Investigations to identify any underlying cause for pigmentation are important; concurrent topical and systemic drug therapy may be needed. History of scarring, response to previous injuries, degree of tanning needs to be considered. Detailed counseling about the need for multiple sessions is required. Informed consent should be taken in all cases. **Treatment sessions:** Epidermal lesions need an average of 1–6 sessions, while dermal lesions need average of 4–10. Some tattoos may need up to 20 sessions. All lesions may not clear completely and only lightening may be achieved even after multiple sessions in many cases. Future maintenance treatments may be needed. Hence, a realistic expectation and proper counseling is very important. Epidermal lesions are likely to recur even after complete clearing. Therefore, there is a need for continued sun protection. Dermal lesions and tattoos tend to remain clear after treatment (except conditions as dermal melasma). **Laser parameters:** Laser parameters vary with area, type of pigmentation and machine used. **Complications and their management:** Postinflammatory pigmentation changes are common in dark skin patients. Textural changes and scarring occur rarely.

Key words: Laser, Pigmented lesion, Tattoos

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LEVEL OF EVIDENCE
Level A: Strong research-based evidence; multiple relevant, high-quality scientific studies with homogeneous results.
Level B: Moderate research-based evidence; at least one relevant, high-quality study or multiple adequate studies.
Level C: Limited research-based evidence; at least one adequate scientific study.
Level D: No research-based evidence; expert panel evaluation of other information.
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INTRODUCTION, RATIONALE, AND SCOPE

Light Amplification by Stimulated Emission of Radiation (LASER) uses the principle of selective photothermolysis. Significant advancements have been made in laser technology for pigmented lesions with new and better equipment being introduced every year. Most of the data on the use of these devices are on Fitzpatrick skin types 1 to 3. Treatment of darker skin types (skin photo types 4, 5, and 6) is a challenge due to the risk of complications. Quality-switching (Q-switching) is a means of creating very short pulses (5−100 ns) with extremely high peak powers. The QS lasers also produce an additional photoacoustic effect, which results from the generation of shock waves following laser irradiation. Such waves then cause vibrational damage to cellular structures and rupture membranes, thereby disrupting melanosomes and tattoo ink particles. The QS lasers have changed the way the dermatologists approach these conditions and have become the mainstay of treatment. QS laser treatment is a safe and effective procedure.[1-6]

Long-term data on the safety and efficacy of these devices in darker patients needs to be quantified to allow consistent treatment outcomes. Considerable variations exist in results due to availability of a variety of lasers of different wavelengths, peak powers, and spot sizes. Hence, minimum uniform recommendations are necessary. These guidelines outline the indications and treatment of the following: benign pigmented lesions and tattoos, various procedures, methodology, associated complications, and expected outcome.

EVIDENCE: LEVEL B

1. Anderson RR, Parrish JA. Selective photothermolysis: precise microsurgery by selective absorption of pulsed radiation. Science 1983;220:524-7.
2. Polla LL, Margolis RJ, Dover JS, Whitaker D, Murphy GF, Jacques SL, *et al*. Melanosomes are a primary target of Q-switched ruby laser irradiation in guinea pig skin. J Invest Dermatol 1987;89:281-6.
3. Barlow RJ, Hruza GJ. Lasers and light tissue interactions. In: Goldberg DJ, Dover JS, Alam M, editors. Procedures in cosmetic dermatology: Laser and lights Volume 1. 1st ed. Philadelphia: Elsevier; 2005. p. 1-11.
4. Murphy GF, Shepard RS, Paul BS, Menkes A, Anderson RR, Parrish JA. Organelle specific injury to melanin-containing cells in human skin by pulsed laser irradiation. Lab Invest 1983;49:680-5.
5. Anderson RR, Margolis RJ, Watenabe S, Flotte T, Hruza GJ, Dover JS. Selective photothermolysis of cutaneous pigmentation by QS Nd:YAG laser pulses at 1064 nm, 532 nm, 355 nm. J Invest Dermatol 1989;93:28.
6. Dover JS, Margolis RJ, Polla LL, Watanabe S, Hruza GJ, Parrish JA, et al. Pigmented guinea pig skin irradiated with Q-Switched ruby laser pulses. Morphologic and histologic findings. Arch Dermatol 1989;125:43-9.

INSTRUMENTATION AND TECHNICAL INFORMATION

Melanin absorbs light in the ultraviolet up to the range of 1200 nm. At longer wavelength, absorption is lower and penetration deeper compared to shorter wavelength. Different laser systems such as QS lasers (QS Ruby laser 694 nm, QS Alexandrite laser 755 nm, QS Nd:YAG laser 1064 nm, and frequency doubled at 532 nm), intense pulsed light (IPL), Millisecond lasers (Alexandrite 755 nm, Diode 810 nm, 1064 nm, and 532 nm Nd:YAG, etc.) have been used for treating pigmented skin lesions [Table 1]. QS lasers target melanin (and ink particles) in the dermis allowing removal or lightening of benign pigmented lesions and tattoos, respectively. QS lasers produce ultra-short bursts of light in the nanosecond range and are the current gold standard of treatment for tattoos and benign pigmented lesions.[1-4]

QS Neodymium: yttrium-aluminum-garnet (Nd:YAG) laser 1064 nm emits light that penetrates 2−3 mm into dermis and hence is suitable for deeper dermal pigmentation such as found in nevus of Ota. By passing the beam through the potassium-titanyl-phosphate (KTP) crystal, the frequency is doubled and the wavelength is halved (532 nm). A shorter wavelength penetrates less deeply and therefore is more useful for removal of epidermal pigment such as in ephelids. The ruby laser (694 nm) penetrates less than 1 mm into skin and is used for treating superficial lesions such as freckles or CALM. However, because of its high affinity for melanin and the possible risk of hypopigmentation, the QS ruby laser is not recommended for use in patients of darker skin types. The QS alexandrite laser (755 nm) penetrates deeper than the ruby laser due to its longer wavelength and hence can be used in both epidermal and dermal pigmented lesions and tattoos.[1-4]

Table 1: Comparison of Various QS Nd:YAG lasers

System	Pulse duration	Frequency	Spot size and Max. Energy for 1064 nm			Spot size and Max. Energy for 532 nm			Merge
Palomar	2-5 ns	1–10 Hz	2 mm 12.5J	4 mm 4.2J	6 mm 1.6J	2 mm 12.5 J	4 mm 4.2 J	6 mm 1.6 J	Possible
Quanta	5 ns	2, 5, 10 Hz	2.5 mm 30 J	3.5 mm 22 J	6 mm 8 J	2.5 mm 10 J	3.5 mm 7 J	6 mm 2 J	-
VersaQS	5 ns	1–10 Hz	2 mm 15.9 J	4 mm 3.95 J		2 mm 9.54 J	4 mm 2.37 J		-
Precise PY 500 A	6 ns	1–5 Hz	Spot size variable with distance Maximum energy 450 mj			Spot size variable with distance Maximum energy 300 mj			-
Medlite C6	5–20 ns	Single shot, 1, 2, 5, and 10 Hertz	1064 nm 12.0 J/cm^2 @ 3.0 mm spot size			532 nm 5.0 J/cm^2 @ 2.0 mm spot size			
Harmony XL	20 ns	1,2,5 Hz	1064 nm Spot sizes 1, 2, 3, 4, 5, 6 Energy density 400–1200 mJ/pulse			532 nm Spot sizes 2,3,4,5 Energy density 400-1200 mJ/pulse			

Besides the QS lasers, Long-pulsed (millisecond) lasers such as the Diode 810 nm, long-pulsed alexandrite laser 755 nm, etc., can also be used for treatment of certain pigmented lesions. Intense pulse light (IPL) systems have also been used for the treatment of superficial pigmented lesions such as freckles, lentigines, etc. IPL systems are polychromatic light sources that use cut-off filters to block shorter wavelengths thus producing a broad band of IPL. These systems use wavelengths from 530 nm and above, and can be used to treat superficial pigmented lesions but are not recommended for dermal lesions or tattoo removal.[1-4]

Different laser systems and their details are listed in Table 1. It is beyond the scope of these guidelines to make specific recommendations on different brands. Proper patient selection and tailoring of the fluences appropriate to the patient's skin type remain the most important factor for effective and safe laser treatment. The treating dermatologist should always refer manufacturer's/marketing company's specifications.

EVIDENCE: LEVEL B

1. Barlow RJ, Hruza GJ. Lasers and light tissue interactions. In: Goldberg DJ, Dover JS, Alam M, editors. Procedures in cosmetic dermatology: Laser and lights Volume 1. 1st ed. Philadelphia: Elsevier; 2005. p. 1-11.
2. O'Shea DC, Callen WR, Rhodes WT. Introduction to lasers and their applications. Menlo Park (CA): Addison-Wesley Publishing Co; 1978.
3. Anderson RR, Parrish JA. Selective photothermolysis: precise microsurgery by selective absorption of pulsed radiation. Science 1983;220:524-7.
4. Polla LL, Margolis RJ, Dover JS, Whitaker D, Murphy GF, Jacques SL, *et al*. Melanosomes are a primary target of Q-switches ruby laser irradiation in guinea pig skin. J Invest Dermatol 1987;89:281-6.

PHYSICIAN QUALIFICATION

1. Any qualified dermatologist (DVD or MD) may perform the procedure.[1,2]
2. The Physician should have knowledge of basic anatomy and physiology of the skin and its variations.
3. To ensure successful cosmetic outcome, the physician should have basic knowledge and training about laser physics.
4. Proper hands-on training may be obtained either during postgraduation, if the postgraduate center provides such training; it may also be obtained from equipment supplier's medical experts or from a dermatologist/plastic surgeon experienced in regularly performing the procedure. Dedicated hands on workshops are also adequate to provide training in the use of lasers.
5. The physician should be familiar with early recognition, prevention and treatment of postlaser (postprocedure) complications such as hyper or hypopigmentation, scarring, burns, etc.

EVIDENCE: LEVEL A

1. Alster TS. Getting started: setting up a laser practice. In: Alster TS. Manual of cutaneous laser techniques. 2nd ed. Philadelphia: Lippincott, Williams and Wilkins; 2000. p. 2-4.
2. Dover JS, Arndt KA, Dinehart SM, Fitzpatrick RE, Gonzalez E. Guidelines of care for laser surgery. J Am Acad Dermatol 1999;41:484-95.

FACILITY

Laser is a simple procedure requiring only minor facilities. It may be performed in the dermatologist's clinic/minor procedure room/or day care theater.[1-9]

- Presence of a nurse assistant is desirable; A female nurse assistant is mandatory while treating female patients.
- Proper lighting, operating table/cosmetic chair, comfortable seating for the treating physician are essential.
- Room should not have mirrors.
- The cosmetic chair without metallic surface (which may reflect laser/light beams accidentally) and of washable material should preferably be used.
- Cooling system should be available, as needed for each individual machine, as per manufacturer's recommendation. Emergency hazard switch should be in place (for shutting of all systems) in case of any accidental happenings viz., fire or entry of any unauthorized persons. For further details, the reader is referred to the taskforce guidelines on laser room specifications.

EVIDENCE: LEVEL A

1. Alster TS. Getting started: setting up a laser practice. In: Alster TS. Manual of cutaneous laser techniques. 2nd ed. Philadelphia:Lippincott, Williams and Wilkins; 2000. p. 2-4.
2. Smalley PJ. Laser safety management: hazards, risks, and control measures. In: Alster TS, Apfelberg DB, editors. Cosmetic laser surgery. 2nd ed. New York: Wiley-Liss; 1999. p. 305-19.
3. ANSI Z For the Safe Use of Lasers in Health Care Facilities.New York: American National Standards Institute 1996.3;136.
4. Wausau WI:. Standards of practice for the safe use of lasers in medicine and surgery. American Society for Laser Medicine and Surgery;April 3, 1998.
5. Beck WC. Lighting the surgical suite. Contemp Surg 1978;12:9-13.
6. Drake LA, Ceilley RI, Cornelison RL, Dinehart SM, Dorner W, Goltz RW, et al.. Guidelines of care for office surgical facilities. Part I. J Am Acad Dermatol 1992;26:763-5.
7. Drake LA, Ceilley RI, Cornelison RL, Dinehart SM, Dorner W, Goltz RW, et al.. Guidelines of care for office surgical facilities. Part II. Self-Assessment checklist. J Am Acad Dermatol 1995;33:265-70.
8. Elliott RA. The design and management of an aesthetic surgeon's office and surgery suite. In: Regnault P, Daniel R, editors. Aesthetic plastic surgery: principles and techniques. Boston: Little Brown; 1984. p. 46.
9. Recommended practices for laser safety in practice settings. Association of Operating Room Nurses. AORN J 1998;67:263-4, 267-9.

INDICATIONS

Pigmented dermatological conditions which can be treated by lasers are listed in Table 2.[1-3]

CONTRAINDICATIONS

Absolute

a. Associated photoaggravated skin diseases and medical illness for example, SLE.
b. Treatment area with active cutaneous infections for example, herpes labialis, staphylococcal infections, etc.
c. Unstable vitiligo and psoriasis: for risk of koebnerization of treated area.
d. Tattoo granuloma
e. Localized allergic reactions can occur with almost any color ink and result in urticaria and granulomatous reactions. If a patient exhibits

Table 2: Pigmented lesions amenable to treatment by lasers

Epidermal lesions	CALM, lentigines, freckles, solar lentigo, nevus spilus, pigmented seborrheic keratosis, DPN
Dermal lesions	Nevus of Ota, blue nevus, Hori's nevus (acquired bilateral nevus of Ota-like macules); Tattoos - amateur, professional, cosmetic, medicinal and traumatic
Epidermal-dermal lesions	PIH, nevus spilus, periorbital, perioral pigmentation, acquired melanocytic nevi (moles), melasma and Becker's nevus

a cutaneous reaction within a tattoo, QS laser treatment should be used with caution. After QS laser treatment, the ink particles are mobilized, potentially triggering an allergic response. Systemic allergic reactions are more common in patients exhibiting a localized allergic response.

Relative

In the following indications, laser has to be used cautiously, and after proper counseling of the patient; use of laser in these situations depends on individual situation and on treating Dermatologist's judgment.

a. Keloid and keloidal tendencies
b. Patient on isotretinoin
c. History of herpes simplex/history of herpes for increased risk of reactivation, this risk should be seriously considered prior to performing the procedure; if the treating physician decides to perform the procedure, the risk and benefit should be explained to the patient and the procedure should be performed after proper informed consent and only after a course of acyclovir. Active herpes labialis is included under absolute contraindication (see above).
d. Patient who is not co-operative or has unrealistic expectation.

EVIDENCE: LEVEL C

1. Kilmer SL. Laser eradication of pigmented lesions and tattoos. Dermatol Clin 2002;20:37-53.
2. Goldberg DJ. Pigmented lesions, tattoos, and disorders of hypopigmentation. In: Goldberg DJ, editor. Laser Dermatology Pearls and Problems. 1st ed. Massachusetts: Blackwell publishing; 2008. p. 71-114.
3. Kilmer SL, Garden JM. Laser treatment of pigmented lesions and tattoos [review]. Semin Cutan Med Surg 2000;19:232-44.

Patient selection and counseling

A general medical history, current medical conditions and medications, allergies, past surgeries, including bleeding tendencies and wound healing (response of previous skin injuries whether they heal with hyper or hypopigmentation, response to previous laser sessions if any taken) should be obtained.[1-3]

Patients should be educated regarding all aspects of the laser procedure. Poorly informed patients may have an unrealistic expectation regarding their treatment. It is recommended that patients are shown photographs of similar lesions, before and after treatment and the final outcome. It is important to show average results, not perfect results.

After thorough counseling of the patient, an informed written consent (refer consent form appendix A) must be taken. Good pretreatment photographs are mandatory, as in any aesthetic procedure. Scarring often occurs during tattoo placement and may be unmasked and become more noticeable once the ink is removed. Serial photographs should therefore be taken at successive visits.

EVIDENCE LEVEL B

1. Goldberg DJ. Pigmented lesions, tattoos, and disorders of hypopigmentation. In: Goldberg DJ, editor. Laser Dermatology Pearls and Problems. 1st ed. Massachusetts: Blackwell publishing; 2008. p. 71-114.
2. Kilmer SL, Garden JM. Laser treatment of pigmented lesions and tattoos [review]. Semin Cutan Med Surg 2000;19:232-44.
3. Schmults CD, Wheeland RG. Pigmented lesions and tattoos. In: Goldberg DJ, Dover JS, Alam M editors. Procedures in cosmetic dermatology: Laser and lights Volume 1. 1st ed. Philadelphia: Elsevier; 2005. p. 41- 66.

PREOPERATIVE PREPARATION

Tanning: It is very important to ensure that the patient is not tanned. Epidermal melanin produced by UV Light exposure may interfere with laser treatment and increase the risks for scarring, hypopigmentation, or hyperpigmentation.[1-6] To ensure a tan is not present, it is wise to compare the color of the potential treatment site to that of a nonexposed skin site, similar to the buttock or axilla. If a tan is present, treatment should be delayed until the tan has faded as much as possible in the treatment area. Use of sun protection, protective clothing, and bleaching creams can be useful in treating the tan. Patients with darker skin types and tanned patients are advised to apply hydroquinone-containing compounds (2−4%) preoperatively to minimize the risk of post inflammatory hyperpigmentation (PIH).

Systemic retinoids: It has been recommended that patients on oral retinoid therapy should not undergo laser treatment of pigmented lesions and tattoos for 6-12 months following discontinuation of the medication, as they have an increased risk of keloidal

scar formation.[1,5] However, proper evidence to support such a recommendation in Indian patients, particularly for epidermal lesions is lacking. However, caution is advised while treating all patients with history of recent administration of isotretinoin.

Test patch: A test patch helps to determine the treatment parameter for an individual. It is also helpful in medico legal situations. In particular, it is advisable for all beginning practitioners to perform laser test spots in all patients prior to treating an entire lesion, since skin type and color do not always perfectly predict the response to treatment. Even seasoned experts may need to perform small test spots, particularly where response to treatment cannot be judged properly. Always evaluate the patient 4-8 weeks after the test spots.[1-6]

EVIDENCE: LEVEL B

1. Schmults CD, Wheeland RG. Pigmented lesions and tattoos. In: Goldberg DJ, Dover JS, Alam M editors. Procedures in cosmetic dermatology: Laser and lights Volume 1. 1st ed. Philadelphia: Elsevier; 2005. p. 41- 66.
2. Kilmer SL, Garden JM. Laser treatment of pigmented lesions and tattoos [review]. Semin Cutan Med Surg 2000;19:232-44.
3. Kilmer SL. Laser treatment of tattoos. Dermatol Clin 1997;15:409-17.
4. Grevelink JM, Duke D, van Leeuwen RL, Gonzalez E, DeCoste SD, Anderson RR. Laser treatment of tattoos in darkly pigmented patients: Efficacy and side effects. J Am Acad Dermatol 1996;34:653-6.
5. Goldberg DJ. Pigmented lesions, tattoos, and disorders of hypopigmentation. In: Goldberg DJ, editor. Laser Dermatology Pearls and Problems. 1st ed. Massachusetts: Blackwell publishing; 2008. p. 71-114.
6. Adrian RM, Griffin L. Laser Tattoo Removal. Clin Plast Surg 2000;27:181-92.

Anesthesia

QS laser treatment usually does not require anesthesia, but, if a large area is treated then topical eutectic mixture of local anesthetics (EMLA), 1-2 hours before procedure under occlusion are recommended.[1-3]

EVIDENCE: LEVEL B

1. Koay J, Orengo I. Application of local anesthetics in dermatologic surgery. Dermatol Surg 2002;28:143-8.
2. Epstein RH, Halmi B, Lask GP. Anesthesia for cutaneous laser therapy. Clin Dermatol 1995;13:21-4.
3. Drake LA, Dinehart SM, Goltz RW, Graham GF, Hordinsky MK, Lewis CW, *et al*. Guidelines of care for local and regional anesthesia in cutaneous surgery. J Am Acad Dermatol 1995;33:504-9.

Eye protection

QS laser light can cause permanent retinal damage and vision loss.[1-2] Eye protection in the form of optically coated glasses or goggles for the specific laser being used is necessary. All persons present in the room during laser treatment must also wear appropriate eye protection. The eye wear should block the wavelength being used and the lens should provide an optical density (OD) of at least four. Laser protective eye shields (anodized external metal eye cup) must be used when treating periorbital lesions. When treating eyelids, a metal corneal eye shield should be placed on the eye using topical anesthesia to protect the globe.

QS lasers produce ultra-short pulse durations that produce significant tissue splatter. Precautions include protective clothing, goggles, masks, and laser cone containment devices which should be used with every patient.

EVIDENCE: LEVEL B

1. Schmults CD, Wheeland RG. Pigmented lesions and tattoos. In: Goldberg DJ, Dover JS, Alam M editors. Procedures in cosmetic dermatology: Laser and lights Volume 1. 1st ed. Philadelphia: Elsevier; 2005. p. 41- 66.
2. Russell SW, Dinehart SM, Davis I, Flock ST. Efficacy of corneal Eye shields in protecting patients' eyes from laser irradiation. Dermatol Surg 1996;22:613-6.

INTRAOPERATIVE TECHNIQUE

Selecting the appropriate laser parameters

- **Fluence:** It is always preferable to begin with the lowest energy fluence that produces a visible response. Fluence may be increased if response is suboptimal. If epidermal debris is significant, the fluence should be lowered.[1-7]

- **Spot size:** For epidermal lesions, the spot size which is just large enough to accommodate the treated lesion should be selected. It is important in epidermal lesions, especially in darker individuals, to avoid treating surrounding unaffected area to avoid pigmentary alterations. For dermal lesions, the spot size that elicits immediate, brisk whitening on laser irradiation should be selected. Larger spot sizes allow deeper penetration and produce less tissue splatter.
- **Treatment end point:** With the QS laser, the end-point of treatment is immediate whitening of the lesion. With an IPL, the end point is only erythema. Higher fluences may produce pin-point bleeding and blistering.
- **Repetition rate:** Choose higher frequency i.e., 5−10 Hz while doing large area. For smaller discreet lesions a frequency of 2−3 Hz gives better control.

Laser procedure

After choosing the correct spot size and the energy fluence (J/cm^2), laser treatment is performed with the hand piece held perpendicular to the lesion and the entire area is covered with minimal overlap (up to 10% overlap). QS laser treatment will produce an immediate whitening of the lesion. Pin-point bleeding may occur if very high fluences are used. The entire lesion is covered in one pass. A popping sound is heard with each laser shot as the cells containing melanin or ink particles explode. Laser pulses are placed close to each other with minimum overlap. Keep cooling the area with ice packs/air cooling (for example, Zimmer) just before and after laser pulses to avoid heat buildup.

Number of sessions

Epidermal lesions require one to two treatments, dermal lesions may need anywhere between four to six or even more sessions. Tattoos may need five to twenty sessions for successful lightening. Professional tattoos require more treatment session for eradication. Amateur tattoos are less dense and are often made up of carbon-based ink that responds more readily to QS laser treatment. Traumatic tattoos are more superficial with minimal pigment and clear with one or two treatments. Gunpowder and firework tattoos need more care while treating as the implanted material has the potential to ignite and pox-like scars have developed after treatment.

Interval between sessions

Treatments should be done at least six to eight weeks apart. Treatment intervals can be longer when treating nevus of Ota (up to six months interval has been suggested). While treating tattoos also longer intervals are advisable. Continued clearance of the lesion occurs due to removal of pigment by macrophages and lymphatics, between treatments. Optimal interval between treatments therefore needs to be determined on an individual basis.[1-7]

EVIDENCE: LEVEL B

1. Goldberg DJ. Pigmented lesions, tattoos, and disorders of hypopigmentation. In: Goldberg DJ, editor. *Laser Dermatology Pearls and Problems*. 1st ed. Massachusetts: Blackwell publishing; 2008. p. 71-114.
2. Kilmer SL, Farinelli WF, Tearney G, Anderson RR. Use of a larger spot size for the treatment of tattoos increases clinical efficacy and decreases potential side effects. Lasers Surg Med 1994;6:S51.
3. Kilmer SL, Garden JM. Laser treatment of pigmented lesions and tattoos [review]. Semin Cutan Med Surg 2000;19:232-44.
4. Chan HH, Lam LK, Wong DS, Leung RS, Ying SY, Lai CF, *et al*. Nevus of Ota: a new classification based on the response to laser treatment. Laser Surg Med 2001;28:267-72.
5. Ueda S, Isoda M, Imayama S. Response of nevus of Ota to QS ruby laser treatment according to lesion color. Br J Dermatol 2000;142:77-83.
6. Kilmer SL, Lee MS, Grevelink JM, Flotte TJ, Anderson RR. The QS Nd:YAG laser (1064nm) effectively treats tattoos: A controlled, dose-response study. Arch Dermatol 1993;129:971-8.
7. Adrian RM, Griffin L. Laser Tattoo Removal. Clin Plast Surg 2000;27:181-92.

POSTOPERATIVE CARE

- Broad spectrum sunscreens with good UVA/UVB coverage are recommended before and throughout the treatment period.[1,2]
- Immediately after laser treatment, the treated area appears abraded, and inflamed. Apply ice packs till burning sensation subsides, then apply a layer of antibiotic such as mupirocin and cover with gauze. Patient is instructed to clean the area with copious amount of water and apply the ointment twice daily till lesions heal which can take around 5−10 days.
- Oral antibiotics may be used, if considered essential, by the treating physician, but are not

mandatory. Anti-inflammatory agents may be needed while treating large lesions. Patient should be instructed to avoid sun exposure and cosmetics on the treated area. Treatments are scheduled at an interval of 6–8 weeks.

- Patients are instructed to apply an antibiotic ointment or petrolatum ointment for about a week after procedure. Strict sun protection is advised for darker patients. Ice packs may be used after the procedure to minimize discomfort.
- Postprocedure bleaching agents may be used, but only after the crust subsides.[1,2]

EVIDENCE: LEVEL C

1. Schmults CD, Wheeland RG. Pigmented lesions and tattoos. In: Goldberg DJ, Dover JS, Alam M editors. Procedures in cosmetic dermatology: *Laser and lights* Volume 1. 1st ed. Philadelphia: Elsevier; 2005. p. 41- 66.
2. Kilmer SL, Garden JM. Laser treatment of pigmented lesions and tattoos [review]. Semin Cutan Med Surg 2000;19:232-44.

COMPLICATIONS AND THEIR MANAGEMENT

1. PIH resolves with time; some patients may need bleaching agents such as hydroquinone along with sunscreens.[1-14]
2. Postinflammatory hypopigmentation may persist for several weeks to months and may be difficult to treat. Phototherapy may be used to treat the hypopigmentation.
3. Textural changes and scarring
4. Darkening of tattoo pigment, especially flesh colored cosmetic tattoos. Red tattoos can turn black. If it occurs, it is difficult to treat.
5. Thermal injury and burns.
6. Localized allergic reactions can occur with almost any color ink and can result in urticaria and granulomatous reactions. Mercury-containing red ink is the commonest cause for allergic tattoo reactions. Other reactions reported include lichenoid and photoallergic reactions. Cadmium in the yellow ink is known to cause photoallergic reactions. After QS laser treatment, the ink particles may get further mobilized and trigger a severe allergic response. Systemic allergic reactions may also occur in such patients. Hence, if a patient exhibits a cutaneous reaction within a tattoo, QS laser treatment should be used with caution, only after treating the reaction with steroid creams. A test patch is always recommended. Patients with persistent allergic reactions in tattoos, may be treated with CO2 or Er:YAG laser ablation.
7. Scarring: May occur if very high fluence is used which results in a burn which if gets infected may pose a high risk for scar formation.
8. Acute compartment syndrome of the upper extremity has been reported following Q-switched 1064-nm Nd:YAG laser treatment of a decorative tattoo.
9. Infection; An antibiotic ointment and a nonadherent dressing should be applied upon completion of treatment. Patients should be instructed in the proper local wound care.[1-14]

EVIDENCE: LEVEL C

1. Kono T, Nozaki M, Chan HH, Mikashima Y. A retrospective study looking at the long-term complications of Q-switched ruby laser in the treatment of nevus of Ota. Lasers Surg Med 2001;29:156-9.
2. Rheingold LM, Fater MC, Courtiss EH. Compartment syndrome of the upper extremity following cutaneous laser surgery. Plast Recontr Surg 1997;99:1418-20.
3. Grevelink JM, Duke D, van Leeuwen RL, Gonzalez E, DeCoste SD, Anderson RR. Laser treatment of tattoos in darkly pigmented patients: Efficacy and side effects. J Am Acad Dermatol 1996;34:653-6.
4. Lam AY, Wong DS, Lam LK, Ho WS, Chan HH. A retrospective study on the efficacy and complications of Q-switched alexandrite laser in the treatment of acquired bilateral nevus of Ota-like macules. Dermatol Surg 2001;27:937-41.
5. Anderson RR, Geronemus R, Kilmer SL, Farinelli W, Fitzpatrick RE. Cosmetic tattoo ink darkening. A complication of Q-switched and pulsed-laser treatment. Arch Dermatol 1993;129:1010-4.
6. Ross EV, Yashar S, Michaud N, Fitzpatrick R, Geronemus R, Tope WD, *et al*. Tattoo darkening and non-response after laser treatment: a possible role for titanium dioxide. Arch Dermatol 2001;137:33-7.
7. Fusade T, Toubel G, Grognard C, Mazer JM. Treatment of gunpowder traumatic tattoo by Q-switched Nd:YAG laser: An unusual adverse effect. Dermatol Surg 2000;26:1057-9.
8. Jacob CI. Tattoo-associated dermatoses: A case report and review of the literature. Dermatol Surg 2002;28:962-5.
9. Bhardwaj SS, Brodell RT, Taylor JS. Red tattoo reactions. Contact Dermatitis 2003;48:236-7.
10. Ashinoff R, Levine VJ, Soter NA. Allergic reactions

to tattoo pigment after laser treatment. *Dermatol Surg* 1995;21:291-4.
11. England RW, Vogel P, Hagan L. Immediate cutaneous hypersensitivity after treatment of tattoo with Nd:YAG laser: a case report and review of the literature. *Ann Allergy Asthma Immunol* 2002;89:215-7.
12. Kyanko ME, Pontasch MJ, Brodell RT. Red tattoo reactions: treatment with the carbon dioxide laser. *J Dermatol Surg Oncol* 1989;15:652-6.
13. De Argila D, Chaves A, Moreno JC. Erbium:YAG laser therapy of lichenoid red tattoo reactions. *J Eur Acad Dermatol Venereol* 2004;18:332-3.
14. Jimenez G, Weiss E, Spencer JM. Multiple color changes following laser therapy of cosmetic tattoos. *Dermatol Surg* 2002;28:177-9.

GUIDELINES FOR USE OF LASER FOR INDIVIDUAL PIGMENTED LESIONS [TABLE 3]

Epidermal lesions

Epidermal lesions respond readily to QS laser treatment. The wavelength used is 532 nm using the frequency doubled QS Nd:YAG laser. QS Ruby (694 nm) and QS alexandrite laser (755 nm) also can be used. Epidermal lesions require 1−6 sessions for clearing. These lesions are prone to recurrences and adequate sun protection is recommended to maintain clearance.

1) Café au lait macules (CALM): CALM are difficult to treat and usually require multiple treatments over months to years and recurrences are common, occurring in up to 50% of patients within a year of clearance. Risk of pigmentary alteration is higher in darker individuals and laser treatment may result in partial or incomplete clearance, with a speckled pattern of hyperpigmentation.[1-3]

Table 3: Guidelines for treating pigmented lesions by lasers

A	Confirm the diagnosis (biopsy if uncertain)
B	Avoid a tanned patient
C	Choose appropriate QS laser and do a test area if necessary
D	Epidermal lesions, for example, Lentigines use 532 nm QS Nd:YAG
E	Dermal Lesions, for example, Nevus of Ota use 1064 nm QS Nd:YAG
F	Evaluate test spots after 4−8 weeks
G	If lesion clears well proceed for rest of area
H	If marginal improvement with Laser, test the area again at eight weekly intervals and only after significant pigment dilution is produced, proceed for rest of the area.
I	If any worsening/scarring stop further treatments

EVIDENCE: LEVEL B

1. Kilmer SL, Wheeland RJ, Goldberg DJ, Anderson RR. Treatment of epidermal pigmented lesions with the frequency-doubled Q-switched Nd:YAG laser. A controlled, single-impact, dose-response, multi-center trial. Arch Dermatol 1994;130:1515-9.
2. Levy JL, Mordon S, Pizzi-Anselme M. Treatment of individual café au lait macules with the Q-switched Nd:YAG: a clinicopathologic correlation. J Cutan Laser Ther 1999;1:217-23.
3. Grossman MC, Anderson RR, Farinelli W, Flotte TJ, Grevelink JM. Treatment of cafe au lait macules with lasers. A clinicopathologic correlation. Arch Dermatol 1995;131:1416-20.

Lentigines/solar lentigo: Lentigines can usually be removed completely in one to three treatments. The treatment of the lentigines found on the mucosal surface in Peutz-Jeghers syndrome may produce equally good results as those found on the skin surface. Treatment with Q-switched lasers is more effective than with other modalities such as liquid nitrogen, 35% trichhloroacetic acid, and glycolic acid peels.[1-8]

EVIDENCE: LEVEL B

1. Jiang SB, Levine V, Ashinoff R. The treatment of solar lentigines with the Diode (Diolite 532nm) and the Q-switched ruby laser: A comparative study. Laser Surg Med Suppl: 2000;12:55.
2. Wang CC, Sue YM, Yang CH, Chen CK. A comparison of Q-switched alexandrite laser and IPL for the treatment of freckles and lentigines in Asian persons: A randomized, physician-blinded, split-face comparative trial. J Am Acad Dermatol. 2006;54:804-10.
3. Kilmer SL, Wheeland RJ, Goldberg DJ, Anderson RR. Treatment of epidermal pigmented lesions with the frequency-doubled Q-switched Nd:YAG laser. A controlled, single-impact, dose-response, multi-center trial. Arch Dermatol 1994;130:1515-19.
4. Todd MM, Rallis TM, Gerwels JW, Hata TR. A comparison of three lasers and liquid nitrogen in the treatment of solar lentigines: A randomized, controlled comparative trial. Arch Dermatol 2000;136:841-6.
5. Li YT, Yang KC. Comparison of frequency-doubled Q-switched Nd:YAG laser and 35% trichloroacetic acid for the treatment of face lentigines. Dermatol Surg 1999;25:202-4.

6. Bjerring P, Christiansen K. IPL source for treatment of small melanocytic nevi and solar lentigines. J Cutan Laser Ther 2000;2:177-81.
7. Kono T, Manstein D, Chan HH, Nozaki M, Anderson RR. Q-switched ruby versus long-pulsed dye laser delivered with compression for treatment of facial lentigines in Asians. Laser Surg Med 2006;38:94-7.
8. Chan HH, Fung WK, Ying SY, Kono T. An *in vivo* trial comparing the use of different types of 532nm Nd:YAG lasers in the treatment of facial lentigines in oriental patients. Dermatol Surg 2000;26:743-9.

2) *Freckles:* Since freckles are known to recur after treatment, maintenance treatments may be necessary and adequate sun protection should be emphasized during counseling. They respond very well to QS lasers with most lesions clearing in 1-2 sessions.[1-3]

EVIDENCE: LEVEL B

1. Kilmer SL, Wheeland RJ, Goldberg DJ, Anderson RR. Treatment of epidermal pigmented lesions with the frequency-doubled Q-switched Nd:YAG laser. A controlled, single-impact, dose-response, multi-center trial. Arch Dermatol 1994:130:1515-9.
2. Jang KA, Chung EC, Choi JH, Sung KJ, Moon KC, Koh JK. Successful removal of freckles in Asian skin with a Q-switched alexandrite laser. Dermatol Surg 2000;26:231-4.
3. Wang CC, Sue YM, Yang CH, Chen CK. A comparison of Q-switched alexandrite laser and IPL for the treatment of freckles and lentigines in Asian persons: a randomized, physician-blinded, split-face comparative trial. J Am Acad Dermatol 2006;54:804-10.

3) *Nevus Spilus:* Since nevus spilus has a dual component of pigmentation, the entire lesion may not respond uniformly to the laser treatment. The darker macular lesions (junctional or compound melanocytic nevus component) tend to respond better than the lighter component (CALM) to the laser treatment. Partial or complete clearance has been reported with the use of Q-switched lasers, long-pulsed lasers and IPLs.[1-4]

EVIDENCE: LEVEL C

1. Grevelink JM, Gonzalez S, Bonoan R, Vibhagool C, Gonzalez E. Treatment of nevus spilus with the Q–switched Ruby laser. Dermatol Surg 1997;23:365-9.
2. Gold MH, Foster TD, Bell MW. Nevus spilus successfully treated with an IPL source. Dermatol Surg 1999;25:254-5.
3. Moreno-Arias GA, Bulla F, Vilata-Corell JJ, Camps-Fresneda A. Treatment of widespread segmental nevus spilus by Q-switched alexandrite laser (755nm, 100nsec). Dermatol Surg 2001;27:841-3.
4. Abecassis S, Spatz A, Cazeneuve C, Martin-Villepou A, Clerici T, Lacour JP, *et al*. Melanoma within nevus spilus: five cases. Ann Dermatol Venereol 2006;133:323-8.

4) *Dermatosis papulosa nigra (DPN) and pigmented seborrheic keratoses:* These lesions have significant epidermal proliferation with normal to slightly increased number of melanocytes and increased melanization of keratinocytes. These lesions can be readily treated by non-specific ablation with ultra-pulsed carbon dioxide laser, erbium: YAG laser, radio frequency (RF) devices, etc. The QS lasers and long-pulsed lasers that target melanin can also be used to treat these lesions more specifically. Laser spot size should be limited to just below the size of the lesion. The non-specific ablative methods are preferred means of treatment due to the cost-effectiveness and good results obtained with them.[1-3]

EVIDENCE: LEVEL C

1. Fitzpatrick RE, Goldman MP, Ruiz-Esparza J. Clinical advantage of the CO2 laser superpulsed mode. Treatment of verucca vulgaris, seborrheic keratoses, lentigines, and actinic chelitis. J Dermatol Surg Oncol 1994;20:449-56.
2. Khatri KA. Ablation of cutaneous lesions using an erbum:YAG laser. J Cosmet Laser Ther 2003;5:150-3.
3. Mehrabi D, Brodell RT. Use of the alexandrite laser for the treatment of seborrheic keratoses. Dermatol Surg 2002;28:437-9.

Dermal lesions

1) Nevus of Ota: Nevus of Ota is extremely satisfying to treat and it readily responds to QS laser treatment. The longer wavelength 1064 nm QS Nd:YAG laser is the most widely used laser to treat, especially in darker skin types. The longer wavelength along with a large spot size allows deep penetration of photons and is ideally suited to treat this dermal condition. Multiple treatments are necessary (typically 6–8 sessions) with an interval of at least two months between treatments. Intervals of even six months between treatments are recommended and lesions continue to clear between sessions. Purpura and pin point bleeding may occur

if very high fluences are used or if smaller spot sizes are employed. Postinflammatory hyper and hypo pigmentation is a common problem in Indian skin and good pre and postoperative care is necessary to minimize side effects. The PIH usually clears within a few weeks, without scarring.[1-16]

EVIDENCE: LEVEL B

1. Chan HH, Leung RS, Ying SY, Lai CF, Kono T, Chua JK, *et al*. A retrospective analysis of complications In the treatment of nevus of Ota with the Q-switched Alexandrite and Q-switched Nd:YAG lasers. Dermatol Surg 2000;26:1000-6.
2. Chan HH, King WW, Chan ES, Mok CO, Ho WS, Van Krevel C, Lau WY. *In vivo* trial comparing patients' tolerance of Q-switched Alexandrite (QS Alex) and Q-switched neodymium:yttrium-aluminum-garnet (QS Nd:YAG) lasers in the treatment of nevus of Ota. Lasers Surg Med 1999;24:24-8.
3. Chan HH, Ying SY, Ho WS, Kono T, King WW. An *in vivo* trial comparing the clinical efficacy and complications of Q-switched 755 nm alexandrite and Q-switched 1064 nm Nd-YAG lasers in the treatment of nevus of Ota. Dermatol Surg 2000;26:919-22.
4. Kono T, Nozaki M, Chan HH, Mikashima Y. A retrospective study looking at the long-term complications of Q-switched ruby laser in the treatment of nevus of Ota. Lasers Surg Med 2001;29:156-9.
5. Kilmer SL, Anderson RR. Clinical uses of Q-switched ruby and Q-switched Nd:YAG (1064nm and 532nm) lasers for treatment of tattoos. J Dermatol surg oncol 1993;19:330-8.
6. Goldberg DJ, Nychay SG. Q-switched ruby laser treatment of nevus of Ota. J Dermatol Surg Oncol 1992;18:817-21.
7. Watanabe S, Takahashi H. Treatment of nevus of Ota with the Q-switched ruby laser. N Engl J Med 1994;331:1745-50.
8. Geronemus RG. Q-switched ruby laser therapy of nevus of Ota. Arch Dermatol 1992;128:1618-22.
9. Alster TS, Williams CM. Treatment of nevus of Ota by the Q-switched Alexandrite laser. Dermatol Surg 1995;21:592-6.
10. Turnbull JR, Assaf Ch, Zouboulis C, Tebbe B. Bilateral nevus of Ota: a rare manifestation in a Caucasian. J Eur Acad Dermtol Venereol 2004;18:353-5.
11. Kopf AW, Bart RS. Malignant blue (Ota's?) nevus. J Dermatol Surg Oncol 1982;8:442-5.
12. Patel BC, Egan CA, Lucius RW, Gerwels JW, Mamalis N, Anderson RL. Cutaneous malignant melanoma and oculodermal melanocytosis (Nevus of Ota): report of a case and review of the literature. J Am Acad Dermatol 1998;38:862-5.
13. Lowe NJ, Wieder JM, Sawcer D, Burrows P, Chalet M. Nevus of Ota: treatment with high energy fluences of the Q-switched ruby laser. J Am Acad Dermatol 1993;29:997-1001.
14. Ueda S, Isoda M, Imayama S. Response of nevus of Ota to Q-switched ruby laser treatment according to lesion color. Br J Dermatol 2000;142:77-83.
15. Chan HH, Lam LK, Wong DS, Leung RS, Ying SY, Lai CF, *et al*. Nevus of Ota: A new classification based on the response to laser treatment. Laser Surg Med 2001;28:267-72.
16. Chan HH, Lam LK, Wong DS, Wei WI. Role of skin cooling in improving patient tolerability of Q-switched alexandrite (QS Alex) laser in nevus of Ota treatment. Lasers Surg Med 2003;32:148-51.

2) Hori's nevus (acquired bilateral nevus of Ota-like macules): Acquired bilateral nevus of Ota-like macules or Hori's macules can mimic nevus of Ota. The differentiating features are late age of onset, lesions are bilateral and symmetrical and absence of mucosal involvement. It is amenable to treatment by longer wavelength QS lasers.[1-4]

EVIDENCE: LEVEL B

1. Kunachak S, Leelaudomlipi P. Q-switched Nd:YAG laser treatment for acquired bilateral nevus of Ota-like maculae a long-term follow-up. Laser Surg Med 2000;26:376-9.
2. Polnikorn N, Tanrattanakorn S, Goldberg DJ. Treatment of Hori's nevus with the Q-switched Nd:YAG laser. Dermatol Surg 2000;26:477-80.
3. Lee B, Kim YC, Kang WH, Lee ES. Comparison of characteristics of acquired bilateral nevus of Ota-like macules and nevus of Ota according to therapeutic outcome. J Korean Med Sci 2004;19:554-9.
4. Lam AY, Wong DS, Lam LK, Ho WS, Chan HH. A retrospective study on the efficacy and complications of Q-switched alexandrite laser in the treatment of acquired bilateral nevus of Ota-like macules. Dermatol Surg 2001;27:937-41.

3) Blue nevus: The melanocytes in blue nevi are located deep within the dermis and their blue-black color results from the tyndall effect of the over lying tissues. Like the nevus of Ota and Ito, the blue nevi

respond readily to QS laser treatment. Lesions that extend into the subcutaneous fat are more difficult to treat.[1-2]

EVIDENCE: LEVEL C

1. Milgraum SS, Cohen ME, Auletta MJ. Treatment of blue nevi with the Q-switched ruby laser. J Am Acad Dermatol 1995;32:307-10.
2. Kilmer SL. Laser eradication of pigmented lesions and tattoos. Dermatol Clin 2002;20:1,37-51.

Tattoos

Tattoos' may be classified as decorative, cosmetic, traumatic, medical and iatrogenic. Decorative tattoos are most commonly encountered and are further subdivided into amateur and professional. Amateur tattoos are made of carbon based ink and tend to be blue-black in color. Professional tattoos are denser, placed deeper in the dermis and can be multi-colored. Professional tattoos generally contain larger quantity of ink and are more variable in their composition. Decorative tattoo pigments contain both inorganic and organic compounds. The common inorganic elements used are iron, titanium, cobalt, cinnabar, cadmium, mercury, copper, chlorine, bromine, aluminum, silica, and magnesium and carbon ink. The organic compounds used in tattoos include both dyes (azo or non-azo dyes), and polycyclic compounds. QS lasers are very effective for dark-blue, black and green tattoos, where as red and yellow tattoos are more difficult to treat. Pigments which contain iron oxide tend to darken on exposure to laser; hence a test patch is desirable. While amateur tattoos can be removed in fewer sessions, professional tattoos which are intricate and multi-colored may need larger number of sittings. Some professional tattoos may not clear completely, in spite of repeated treatments, and a ghost image of the design may be left behind.[1-14] Guidelines for lasers for tattoo have been summarized in Table 4.

Table 4: Guidelines for use of lasers for treatment of tattoo

A.	Avoid a tanned patient
B.	Choose appropriate QS laser and do a test area
C.	Red Tattoo: use: 532 nm QS Nd:YAG
D.	Dark blue and black Tattoo: use 1064 nm QS Nd:YAG
E.	Green Tattoo: use 694 nm QS Ruby
F.	Evaluate test spots after 4–8 weeks
G.	If lesion clears well proceed for rest of area
H.	If any worsening/scarring stop further treatments

EVIDENCE: LEVEL B

1. Kilmer SL. Laser treatment of tattoos. Dermatol Clin 1997;15:409-17.
2. Grevelink JM, Duke D, van Leeuwen RL, Gonzalez E, DeCoste SD, Anderson RR. Laser treatment of tattoos in darkly pigmented patients: Efficacy and side effects. J Am Acad Dermatol 1996;34:653-6.
3. Kilmer SL. Laser eradication of pigmented lesions and tattoos. Dermatol Clin 2002;20:37-53.
4. Kilmer SL, Anderson RR. Clinical uses of Q-switched ruby and Q-switched Nd:YAG lasers for treatment of tattoos. J Dermatol Surg Oncol 1993;19:330-8.
5. Kilmer SL, Farinelli WF, Tearney G, Anderson RR. Use of a larger spot size for the treatment of tattoos increases clinical efficacy and decreases potential side effects. Lasers Surg Med 1994;6:S51.
6. Kilmer SL, Garden JM. Laser treatment of pigmented lesions and tattoos [review]. Semin Cutan Med Surg 2000;19:232-44.
7. Levine VJ, Geronemus RG. Tattoo removal with the Q-switched ruby laser and the Q-switched Nd:YAG laser: a comparative study. Cutis 1995;55:291-6.
8. Leuenberger ML, Mulas MW, Hata TR, Goldman MP, Fitzpatrick RE, Grevelink JM. Comparision of the Q-switched alexandrite, Nd:YAG, and ruby lasers in treating blue-black tattoos. Dermatol Surg 1999;25:10-14.
9. Kilmer SL, Lee MS, Grevelink JM, Flotte TJ, Anderson RR. The Q-switched Nd:YAG laser effectively treats tattoos. A controlled, dose-response study. Arch Dermatol 1993;129:971-8.
10. Kilmer SL, Lee MS, Anderson RR. Treatment of multicoloured tattoos with the Q-switched Nd:YAG laser (532nm): A dose response study with comparison to the Q-switched ruby laser. Lasers Surg Med Suppl 1993;5:54.
11. Haedersdal M, Bech-Thomsen N, Wulf HC. Skin reflectance-guided laser selections for treatment of decorative tattoos. Arch Dermatol 1996;132:403-7.
12. Adrian RM, Griffin L. Laser Tattoo Removal. Clin Plas Surg 2000; 27:181-92.
13. Alster TS. Q-switched alexandrite laser treatment (755nm) of professional and amateur tattoos. J Am Acad Dermatol 1995;33:69-73.

1) Traumatic tattoos: These occur after road traffic accidents where asphalt granules may be deposited in the skin. Usually a small amount pigment as deposited

superficially in the skin and often clears with one or two treatments with Q-switched lasers.[1-2]

EVIDENCE: LEVEL C

1. Moreno-Arias GA, Casals-Andreu M, Camps-Fresneda A. Use of Q-switched alexandrite laser (755 nm, 100 ns) for removal of traumatic tattoo of different origins. Laser Surg Med 1999;25:445-50.
2. Ashinoff R, Geronemus RG. Rapid response of traumatic and medical tattoos to treatment with the QS Ruby laser. Plast Reconstr Surg 1993;91:841-5.

2) Cosmetic tattoos: Cosmetic tattoos are usually red, white or flesh colored and is placed to create areolae after breast reconstruction surgery or is in the form of lip liner tattoos. Pigment darkening may occur after laser therapy of these tattoos, hence test patches are recommended. The patients are followed up for 6-8 weeks after a test patch and if no darkening occurs (and the tattoo lightens/fades) then treatment can be undertaken for the rest of the tattoo. It's best to avoid further treatments if the tattoo darkens.[1,2]

EVIDENCE: LEVEL C

1. Anderson RR, Geronemus R, Kilmer SL, Farinelli W, Fitzpatrick RE. Cosmetic tattoo ink darkening: A complication of Q-switched and pulsed-laser treatment. Arch Dermatol 1993;129:1010-4.
2. Ross EV, Yashar S, Michaud N, Fitzpatrick R, Geronemus R, Tope WD, *et al*. Tattoo darkening and non-response after laser treatment: a possible role for titanium dioxide. Arch Dermatol 2001;137:33-7.

3) Gunpowder and firework tattoos: Care should be taken while treating them, as the implanted material has the potential to ignite, and pox-like scars can develop. A test spot is mandatory in such cases and only after evaluating the patient after 6-8 weeks, further treatments should to be taken up.[1,2]

EVIDENCE: LEVEL C

1. Fusade T, Toubel G, Grognard C, Mazer JM. Treatment of gunpowder traumatic tattoo by Q-switched Nd:YAG laser: An unusual adverse effect. Dermatol Surg 2000;26:1057-9.
2. Taylor CR. Laser ignition of traumatically embedded firework debris. Lasers Surg Med 1998;22:157-8.

MIXED EPIDERMAL AND DERMAL PIGMENTATION

1) Melasma: Melasma is best treated medically. Lasers have a limited role in the treatment of melasma. Though successful use of QS lasers, fractional lasers, IPL and combination lasers have all been reported, response to treatment is unpredictable, and pigmentation frequently recurs. Also, postinflammatory pigmentation is common in Indian patients. For these reasons, lasers are not routinely recommended as the treatment of choice for treating melasma in Indian patients. It may be used in selected resistant cases, at the discretion of the treating physician, after proper counseling. A test patch may be performed prior to treating the lesion.[1-5]

EVIDENCE: LEVEL C

1. Angsuwarangsee S, Polnikorn N. Combined treatment of melasma with ultrapulse carbon dioxide laser and Q-switched alexandrite laser in Thai patients. Dermatol Surg 2003;29:59-64.
2. Nouri K, Bowes L, Chartier T, Romagosa R, Spencer J. Combination treatment of melasma with pulsed CO2 laser followed by Q-switched alexandrite laser: a pilot study. Dermatol Surg 1999;25:494-7.
3. Wang CC, Hui CY, Sue YM, Wong WR, Hong HS. IPL for the treatment of refractory melasma in asian persons. Dermatol Surg 2004;30:1196-200.
4. Manaloto RM, Alster T. Erbium:YAG laser resurfacing for refractory melasma. Dermatol Surg 1999;25:121-3.
5. Rokhsar CK, Fitzpatrick RE. The treatment of melasma with fractional photothermolysis: A pilot study. Dermatol Surg 2005;31:1645-50.

2) Becker's nevus: Becker's nevus is a hamartomatous pigmented hairy lesion that occurs in adolescence and young adulthood. The condition is difficult to treat and uniform results are difficult to obtain. These lesions require long-pulsed lasers for the removal of hairs and the use of QS laser treatment for pigment reduction. However, pigment reduction is variable and use of test spots with different pigment specific lasers is recommended to determine the laser (or combination of lasers) best suited to treat an individual lesion. However, it should be emphasized that the outcome of laser treatment in these conditions may be suboptimal and unpredictable. Proper counseling is essential before treatment about the possible suboptimal outcome.[1-4]

EVIDENCE: LEVEL C

1. Kilmer SL, Garden JM. Laser treatment of pigmented lesions and tattoos [review]. Semin Cutan Med Surg 2000;19:232-244.
2. Nanni CA, Alster TS. Successful treatment of a Becker's nevus using 694 nm long-pulsed ruby laser energy. Dermatol Surg 1998;24:1032-4.
3. Trelles MA, Allones I, Moreno-Arias GA, Velez M. Becker's nevus: a comparative study between erbium:YAG and Q-switched neodimiyum:YAG; clinical and histopathological findings. Br J Dermatol 2005;152:308-13.
4. Kopera D, Hohenleutner U, Landthaler M. Quality-switched ruby laser treatment of solar lentigines and Becker's nevus: a histopathological and immunohistochemical study. Dermatology 1997;194:338-43.

3) Nevocellular nevi: Nevocellular nevi may be congenital or acquired.[1-7] Acquired nevi are further subdivided into junctional, compound, and intradermal types. Any of the currently available QS lasers can be used to treat nevi. Frequency-doubled Nd:YAG at 532 nm are considered suitable for superficial junctional nevi; however, longer-pulsed pigment specific lasers, with pulse duration of up to 3 ms, may also be used for the treatment of nevi. Compound and intradermal nevi are best treated by radiofrequency surgery or surgical excision. In Junctional nevi, the response to treatment is variable. These superficial lesions may lighten or clear only partially and lesions may recur. The QS lasers at 532 nm, 755 nm are more effective than the 1064 nm wavelength due to better melanin absorption of these wavelengths, though the latter is safer in darker skin types. On an average, 1−3 sessions are required for clearing. The risk of dyschromia and atrophic scarring is high in darker individuals. Due to these reasons laser treatment should be used with caution and test treatments are recommended.[1-7]

Congenital melanocytic nevi, which are generally very dark and bulky, with a deep dermal component, are difficult to treat and need a combination of different approaches such as excision, grafting, and lasers. Combination of QS and subsequent longer-pulsed lasers have been reported to be effective, but the lesion may clear only partially and the response is unpredictable. Multiple treatments, generally between three and five are usually needed. Patients should be followed-up regularly to check for recurrences, as nonpigmented deep nests of nevus cells may remain.[1-7]

EVIDENCE: LEVEL C

1. Goldberg DJ, Stampien T. Q-switched ruby laser treatment of congenital nevi. Arch Dermatol 1995;131:621-3.
2. Grevelink JM, Van Leeuwen RL, Anderson RR, Byers HR. Clinical and histological responses of congenital melanocytic nevi after single treatment with Q-switched lasers. Arch Dermatol 1997;133:349-53.
3. Rosenbach A, Williams CM, Alster TS. Comparison of the Q-switched alexandrite (755nm) and Q-switched Nd:YAG (1064nm) lasers in the treatment of benign melanocytic nevi. Dermatol Surg 1997;**23**:239-44.
4. Waldorf HA, Kauvar AN, Geronemus RG. Treatment of small and medium congenital nevi with Q-switched ruby laser. Arch Dermatol 1996;132:301-4.
5. Ueda S, Imayama S. Normal-mode ruby laser for treating congenital nevi. Arch Dermatol 1997;133:355-9.
6. Kono T, Ercocen AR, Chan HH, Kikuchi Y, Nozaki M. Effectiveness of normal-mode ruby laser and the combined (normal-mode plus q-switched) ruby laser in the treatment of congenital melanocytic nevi: A comparative study. Ann Plast Surg 2002;49:476-85.
7. Kono T, Ercocen AR, Nozaki M. Treatment of congenital melanocytic nevi using the combined (normal-mode plus Q-switched) ruby laser in Asians: Clinical response in relation to histological type. Ann Plast Surg 2005;54:494-501.

4) Postinflammatory hyperpigmentation (PIH): PIH may have epidermal and dermal components.[1] Although the epidermal component can be targeted with QS lasers and IPL systems, the dermal component is often refractory to treatment and the pigmentation may worsen on treatment. Hence, lasers are of limited value. If the treating physician feels the need to use QS lasers for such lesions, test patches are always recommended when attempting laser therapy. Strict sun protection and topical bleaching agents remains the mainstay of therapy.[1]

EVIDENCE: LEVEL C

1. Taylor CR, Anderson RR. Ineffective treatment

Table 5: Summary of different indications and their treatment with lasers

Level of pigmentation	Condition	Wavelength and laser used	Number of sittings	Level of evidence	Remarks	Recommendations
Epidermal	Freckles, lentigines	532 nm, 755 nm QS IPL	1–3	B	Sun protection to avoid recurrence	QS lasers- treatment of choice
	CALM	532 nm	Multiple	B	Up to 50% recurrence within a year	Use with caution as incomplete or partial clearing common
	Nevus Spilus	532 nm	Multiple	C	Junctional and compound nevus component clear well, but CALM remain	Use with caution as incomplete or partial clearing common
	DPN and Pigmented seborrheic keratoses	Ablative lasers, QS lasers, Long-pulsed lasers	1–3	C		Ablative lasers, RF preferred
Dermal	Nevus of Ota	1064 nm, 755 nm QS	4–10	B	Recurrences uncommon	QS lasers treatment of choice, 1064nm preferred WL in darker individuals
	Tattoo	532 and 1064 nm,755 nm, QS	5–20	B	100% clearing may not occur, ghost-like outline may remain	QS lasers-treatment of choice
	Hori's nevus	1064 nm, 755 nm,	6–8	B		QS lasers-treatment of choice
	Blue nevus	1064 nm, 755 nm,	6–8	C		QS lasers-treatment of choice
Mixed epidermal and dermal	Becker's nevus	Long-pulsed laser + QS	Multiple	C		Treat with caution, test patches recommended.
	Melasma	Fractional photothermolysis, IPL, QS lasers	Multiple	C	Medical management, response to laser unpredictable	Lasers NOT the first choice. Use in selected resistant cases. Test spots recommended
	Nevocellular nevi	532 nm, 755 nm, QS	1–3	C		QS lasers useful
	PIH	532 nm, 1064 nm	Multiple	C	Medical management, response to laser unpredictable	Lasers of limited value, test patches recommended

QS-Q-switched, IPL-Intense pulsed light, CALM-Café au lait macule, PIH-Postinflammatory hyperpigmentation, DPN-Dermatosis papulosa nigra. RF-Radio frequency.

of refractory melasma and post-inflammatory hyperpigmentation by Q-switched ruby laser. J Dermatol Surg Oncol 1994;20:592-7.

A summary of the different benign pigmented lesions and tattoos and their treatment with lasers and IPL is listed in the Table 5.

CONCLUSION

Laser treatment of pigmented lesions and tattoos is a safe and effective procedure. Adequateknowledge of the machine, the parameters to be used and laser-tissue interaction are essential before undertaking laser treatment. Proper patient selection, counseling and choosing the correct wavelength allow safe laser treatment even in darker individuals with excellent outcomes.

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CONSENT FORM FOR LASER FOR PIGMENTED LESIONS

Mr./Mrs./Miss _____

Age _____

Address_____

_____City_____

Phone Numbers _____, _____, Mobile_____

Name of procedure and machine used_____

I undersigned Mr/Miss/Ms_____ have been explained regarding above said procedure in my regional language, I am fully aware of the possible side effects and risks involved in this procedure. I am also aware that this particular procedure may not always be successful and no guarantee can be made for successful outcome of such procedure.

I have been explained that multiple sessions may be needed for satisfactory results and even after final results, maintenance treatments may be essential

I also know that this procedure will be performed by _____. I also give my consent that during this procedure if any complication arises, I may be given any emergency treatment best suitable to me without asking my prior permission.

I further state that I have carefully read and understood all the information provided in this form and under fully conscious mind I hereby give my written consent for the said procedure with its risks involved.

Signature of Patient/thumb impression

Signature of Parents/Guardian (For Minors) DATE: _____

_____

Name and Relationship if Signed by other than Parent DATE: _____

WITNESS:

NAME_____ Signature_____

DATE: _____