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Lasers for Tattoo Removal

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Table 1.

Lasers for Tattoo Removal Based on Tattoo Color[a]

		Tattoo Colors Treated by Lasers						
Laser	**Wavelength**	**Black**	**Blue**	**Green**	**Red**	**Orange**	**Yellow**	**Purple**
Pulsed dye	585–595 nm				X	X	X	X
QS Nd:YAG (frequency doubled)	532 nm				X	X	X	
QS ruby	694 nm	X	X	X				
QS alexandrite, PS alexandrite	755 nm	X	X	X				
QS Nd:YAG	1064 nm	X	X					

Abbreviations: QS, quality switched; PS, picosecond.

[a]Quality-switched lasers produce a very short pulse of energy in the nanosecond range, which allows for deeper penetration and minimal absorption by other chromophores in the skin (ie, water, hemoglobin). Picosecond lasers have ultrashort pulse duration (picoseconds) with lower fluence required compared to QS. Ink particles are shattered into tiny particles, allowing for easier and faster removal by the body. Good for blue, green, and recalcitrant tattoos previously treated with QS.

Table 2.

Helpful Hints on Using Lasers for Tattoo Removal

- Side effects of quality-switched lasers include immediate darkening of white, red, pink, orange, tan, or brown tattoos (occurs due to reduction of ink and may be permanent [eg, white ink turns dark blue or black because Ti^{4+} is reduced to Ti^{3+} in titanium dioxide]); dyspigmentation; scarring; infection; pain; blistering; erythema; swelling; allergic reaction secondary to release of pigment particles.
- Black and blue tattoos respond best to treatment, especially if it is an amateur, traumatic, or radiation tattoo (color is not as dense and is not placed as deep compared to professional tattoos). White responds worst (titanium dioxide particles very large and difficult to break down and thus be removed by the body) and darkens immediately (and usually permanently); in general, there is no specific laser that does well in removing white pigment.
- Multicolored tattoos are very difficult to treat, especially yellow, orange, and purple.
- Treatment end point is immediate whitening of treated color, which usually lasts for approximately 20 minutes (occurs from cavitation when water inside the skin is vaporized by the laser).
- Factors that make tattoo removal more difficult include: multicolored light colors, nonblack or deep blue; large tattoos, >30 cm^2; age of tattoo, >36 months.
- With professional tattoos, color is placed deeper in skin and more dense pigments are used.
- Smoking impairs the healing response, which involves pigment clearance.
- Distal anatomic location such as distal extremity is associated with decreased lymphatic drainage.

Abbreviation: Ti, titanium.

Table 3.

Pigment Sources for Tattoos

Tattoo Color	Pigment Source
Black	Carbon (india ink), iron oxide, logwood
Blue	Cobalt aluminate
Green	Chromium oxide, lead chromate, phthalocyanine dyes
Red	Mercuric sulfide (cinnabar), ferric hydrate (sienna), sandalwood, brazilwood, cadmium selenide, azo dye
Orange	Disazodiarylide, disazopyrazolone
Yellow	Cadmium sulfide, ochre, curcumin
Purple	Manganese, aluminum
Brown	Ferric oxide, ochre
White	Titanium dioxide, zinc oxide

Table 4.

Guidelines on Tattoo Pigments

- Tattoo color is a pigment(s) suspended in a carrier or solvent (eg, water, ethyl alcohol, propylene glycol, glycerin).
- The FDA does not regulate tattoo color and pigments used to make the color; however, the FDA will investigate and take action if a safety problem is identified. Recently, tattoo infections due to *Mycobacterium chelonae*, which is present in contaminated tattoo color, have been reported.
- Yellow pigments are most common to result in phototoxic reactions.
- Red pigments are most commonly implicated in eczematous, lichenoid, and granulomatous allergic reactions but also can result in phototoxic reactions.

Abbreviation: FDA, US Food and Drug Administration.

Practice Questions

1. Which tattoo color is most commonly associated with allergic reactions that are eczematous, lichenoid, or granulomatous?

a. orange
b. purple
c. red
d. white
e. yellow

2. Which of the following lasers is the optimal device to use for tattoo removal?

a. argon laser
b. CO_2
c. intense pulsed light
d. pulsed dye laser
e. quality-switched ruby, alexandrite, or Nd:YAG laser

3. Which of the following is the most important treatment end point in tattoo removal?

a. edema
b. erythema
c. immediate darkening
d. immediate whitening
e. pinpoint bleeding

4. Which of the following organisms recently has been implicated in tattoo infections?

a. *Mycobacterium chelonae*
b. *Mycobacterium ulcerans*
c. *Pseudomonas aeruginosa*
d. *Staphylococcus aureus*
e. *Streptococcus pyogenes*

5. Darkening of which tattoo color(s) is the most frequently associated and worrisome side effect from a quality-switched laser?

a. light red
b. pink
c. white
d. a and b
e. a, b, and c

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