Immediate skin responses to laser and light treatments

Therapeutic endpoints: How to obtain efficacy

Molly Wanner, MD, MBA,[a] Fernanda H. Sakamoto, MD, PhD,[a,b] Mathew M. Avram, MD, JD,[a,b] Henry H. Chan, MD, PhD,[c] Murad Alam, MD, MBA,[d] Zeina Tannous, MD,[e] and R. Rox Anderson, MD[a,b]
Boston, Massachusetts; Pokfulam, Hong Kong; Chicago, Illinois; and Beirut, Lebanon

Learning objectives
After completing this learning activity, participants should be recognize therapeutic endpoints for different laser applications; detail the laser tissue interaction underlying these responses; and optimize treatments based on the choice of the appropriate endpoints.

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Clinical endpoints are immediate or early tissue reactions that occur during laser treatment. They can guide the laser surgeon in delivering safe and effective laser treatment. Some endpoints act as warning signs of injury to the skin; others can indicate a therapeutic response. The first article in this series reviewed undesirable and warning endpoints, and this article focuses on desirable and therapeutic endpoints and their underlying mechanisms in laser surgery. We will also review treatments without clinical endpoints. (J Am Acad Dermatol 2016;74:821-33.)

Key words: endpoint; immediate skin responses; laser; light; skin; therapeutic.

INTRODUCTION

Key points

- **Immediate or short-term tissue reactions, called endpoints, can provide a reliable indication of treatment response**
- **Different endpoints correlate with different underlying mechanisms**
- **Some—but not all—lasers elicit specific therapeutic endpoints**

Abbreviations used:

μm:	micrometer
IH:	infantile hemangioma
IPL:	intense pulsed light
KTP:	potassium titanyl phosphate
Nd:YAG:	neodymium-doped yttrium aluminum garnet
PDL:	pulsed dye laser
RF:	radiofrequency

From the Department of Dermatology[a] and the Wellman Center for Photomedicine,[b] Massachusetts General Hospital, Harvard Medical School, Boston; Department of Medicine,[c] University of Hong Kong, Pokfulam; Department of Dermatology,[d] Northwestern University, Chicago; and the Lebanese American University School of Medicine,[e] Beirut.

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Reprint requests: Molly Wanner, MD, MBA, Department of Dermatology, Massachusetts General Hospital, 50 Staniford St, Ste 200, Boston, MA 02114. E-mail: mwanner@partners.org.

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Table I. Therapeutic endpoints*

Target	Device	Endpoint
Port wine stain	PDL, KTP, Nd:YAG, and alexandrite	Purpura†
Hemangioma	PDL	Subtle, transient purpura
Telangiectasia, veins	PDL, KTP, Nd:YAG, and IPL	Vessel disappearance or transient vessel graying
Hair removal	Alexandrite, ruby, IPL, Nd:YAG, and diode	Perifollicular edema with or without erythema‡
Lentigines	Q-switched lasers (eg, alexandrite, ruby, and Nd:YAG)	Immediate whitening
	Long pulsed lasers (eg, PDL and 532-nm) or IPL	Subtle darkening; ash gray appearance (PDL)
Nevus of Ota	Q-switched and picosecond lasers	Immediate dermal whitening
Tattoo	Q-switched and picosecond lasers	Immediate dermal whitening

IPL, Intense pulsed light; *KTP*, potassium titanyl phosphate; *Nd:YAG*, neodymium-doped yttrium aluminum garnet; *PDL*, pulsed dye laser.
*Level IV evidence.
†Purpura may not be possible at safe fluences with devices with longer pulse widths.
‡May be difficult to appreciate in patients with dark skin.

How does one know that a therapeutic "dose" of energy is being delivered? Lasers usually elicit immediate or short-term responses of the skin. These laser–tissue reactions are "endpoints," and they can provide a reliable indicator of treatment response. The clinical endpoint depends on both the laser or light treatment used and the target of the laser.

Specific clinical endpoints are seen when a laser or light source has a specific histologic target. These light-absorbing targets or chromophores include blood vessels, pigmented cells, hair follicles, and tattoo ink. Based on the theory of selective photothermolysis, chromophores can be targeted with minimal damage to the surrounding skin using pulses of light from lasers or flashlamps (IPL)—that is, pulses of light from lasers or flash lamps. Selective photothermolysis treatments for hair removal, tattoo removal, and vascular and pigmented lesions have distinct endpoints.

In addition, the clinical endpoint depends on the mechanism of interaction between a histologic target and a specific laser. The photothermal, photomechanical, and photochemical effects of light pulses and the nature of the target impact the endpoint. Long-pulsed and Q-switched lasers of the same wavelength have different endpoints for the same lesion.

For ablative and nonablative lasers that use water as a chromophore, the response endpoints are less specific. These treatments generally heat the epidermis or dermis in various patterns to create either thermal coagulation/protein denaturation or ablation (ie, tissue vaporization).

Although therapeutic endpoints do not guarantee a clinical response, specific therapeutic endpoints, with a few important exceptions, are a useful tool for setting proper laser or IPL dosimetry (Table I). Careful observation of therapeutic endpoints (in the absence of a warning endpoint) is more reliable than using "recommended" or "preset" laser settings as the primary guide during treatment. This is because the endpoints relate directly to an intended laser–tissue interaction regardless of the variations between individual patients and individual laser devices.

The previous article in this series reviewed laser–tissue interactions and "warning endpoints"—that is, endpoints suggestive of tissue injury—and also discussed laser safety, which is crucial to the use of these endpoints. The clinical endpoints associated with vascular lesions, hair removal, tattoo removal, and pigmented lesion removal will be reviewed in this article. Fractionated and mid-infrared lasers that that target water as the chromophore will also be reviewed.

THERAPEUTIC ENDPOINTS

Key points

- **Endpoints depend on multiple factors, including laser wavelength, pulse width, target, fluence, and skin type**
- **If an endpoint is not achieved, increasing the fluence may not be the solution—always look carefully for warning endpoints**
- **Achieving a therapeutic endpoint does not guarantee the absence of side effects**

Our collective clinical observations of therapeutic endpoints appear below. The endpoint depends on a variety of factors, including wavelength, target, pulse width, and fluence. In general, the safest and most efficacious approach is to use the lowest fluence possible to obtain the therapeutic endpoint in the absence of a warning endpoint. If an endpoint is not achieved, increasing the fluence may not be the solution. Adjustment of other features may be necessary, such as wavelength, pulse width, or evaluation of the health status of the patient.