Thermally Confined Micropulsed 1444-nm Nd:YAG Interstitial Fiber Laser in the Aging Face and Neck: An Update

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KEYWORDS

• Laser • Lipolysis • Facial • Neck • Contouring • Facelift • Thermal confinement • Thermal diffusivity

KEY POINTS

- The micropulsed 1444-nm Nd:YAG interstitial fiber laser enables precision contouring of the mid- and lower face and the neck, both as stand-alone procedures (laser-assisted facial contouring [LAFC] and laser-assisted neck contouring [LANC]) and as an adjunct during aging face surgery (laser-assisted facelift [LAFL]).
- Use of the 1444-nm Nd:YAG interstitial fiber laser requires knowledge regarding how to maintain safe clinical thermal confinement during treatment.
- Integrating this technology with facelift surgery facilitates elevation of (extended, if desired) cervicofacial rhytidectomy flaps, enables percutaneous release of major fascial retaining ligaments in the mid- and lower face, may obviate open submentoplasty and platysmaplasty in some patients, and facilitates greater posterior and superior repositioning of flaps for improved outcomes.

INTRODUCTION

Although the use of Nd:YAG fiber lasers in aesthetic surgery has been traditionally referred to as *laser lipolysis*, it is now evident that subcutaneous fat may not or need not be the primary laser target. As such, the use of Nd:YAG fiber lasers has evolved to include ablation and emulsification of subcutaneous fatty tissue, fibrolysis, and shrinkage of fine skin ligaments (ligamentae retinacula cutis) and more dense structural osseocutaneous anchoring ligaments (eg, zygomatic- and mandibular-cutaneous ligaments) as well as postulated direct tissue effects that may contribute to tightening of the skin and of the platysma muscle. Because the use of Nd:YAG fiber lasers goes beyond direct treatment of subcutaneous fat, some laser surgeons now advocate the term, *interstitial laser*, in lieu of laser lipolysis when referencing the use of these devices.

Subcutaneous Nd:YAG fiber laser tissue interaction is influenced by a variety of factors, including laser wavelength, power, pulse duration and total energy applied, target tissue composition, and relative amounts of exogenous water added to the treatment area. Collectively these factors influence opposing characteristics of fiber laser tissue interaction, termed *thermal confinement* and *thermal diffusivity* (discussed later), whereas related clinical implications affect subcutaneous Nd:YAG fiber laser treatment protocols and safety and immediately observed and late tissue effects.

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Evaluation of absorption spectra for Nd:YAG fiber lasers reveals absorption in fat and water is greatest in the mid–1400-nm range, intermediate at 1320 nm, and least at 1064 nm.[1] The relative absorption is on the order of 1 magnitude higher for fat but many orders of magnitude higher for water in the mid–1400-nm range versus 1320 nm and 1064 nm.[1] A minor anhydrous collagen absorption peak present in the mid–1400-nm range may also influence laser energy absorption and laser tissue interaction.[2] Comparison of direct tissue effects reveals that fatty tissue ablation crater depth and fatty tissue ablation efficiency are greatest at 1444 nm, intermediate at 1320 nm, and least at 1064 nm.[2] Differences in tissue absorption and laser tissue interaction among Nd:YAG fiber lasers are summarized in **Table 1**.

Thermal confinement and thermal diffusivity are opposing characteristics of fiber laser tissue interaction that are of critical importance for exerting desired laser tissue effects while avoiding undesired complications. Thermal confinement refers to spatial limitation of tissue heating relatively near the tip of the laser fiber or more broadly within the desired tissue treatment area whereas thermal diffusivity refers to heat distribution away from the source or tip of the laser fiber via conduction.[2] Although the 2 phenomena are simultaneously present, the relative proportions are influenced by laser wavelength, power, and pulse duration as well as target tissue composition, tissue water content, and total laser energy applied to the treatment area—their differential effects on thermal confinement and diffusivity are summarized in **Table 2**.

Thermal imaging studies among the Nd:YAG fiber laser wavelengths demonstrate that thermal confinement is greatest at mid–1400 nm, intermediate at 1064 nm, and least at 1320 nm.[2] Clinically, improved thermal confinement translates to a longer lag period or larger therapeutic window that precedes significant heat accumulation in the larger laser treatment area. The ability of the tissue and exogenous water in the treatment area to maintain thermal confinement is exceeded at the far side of the therapeutic window where thermal diffusivity then prevails with more rapid tissue heating from that point forward. Various tissues have specific tolerances to prolonged heating—irreversible coagulation of the skin may occur with heating to 59°C for as little as 1 second.[3] Excessive thermal diffusion leading to irreversible tissue injury indicates a clinical failure of thermal confinement.

Native target tissue composition affects Nd:YAG fiber laser tissue interaction. Although relative adipocyte may not able to be estimated versus fibrous tissue content prior to laser treatment, this can be inferred based on the tissue response. If the tissues soften during treatment, significant fat emulsification and liquefaction have generally occurred. Significant firming and tightening of the tissues suggest a greater fibrous tissue content with contraction of collagen containing structures; significant fat emulsification and liquefaction may still have occurred despite the firmness but greater mechanical effort may be required for its removal during lipoaspiration.

INTERSTITIAL ND:YAG FIBER LASER–ASSISTED FACIAL CONTOURING

Interstitial Nd:YAG fiber LAFC may be used as a stand-alone percutaneous sculpting procedure for the midface, lower face/jawline, and the female round Asian face.[1] LAFC of the mid- and/or lower face as a stand-alone treatment is generally more successful in female patients. Volumetric sculpting of the mid- and/or lower face (ie, soft tissue reduction) with LAFC complements well-established procedures for soft tissue augmentation and enables synergy through a proportionally greater effect with soft tissue augmentation. Appropriate patient selection should include those with mild to moderate fullness and readily palpable subcutaneous fat but without excessive skin laxity. Patients with skin laxity but no significant subcutaneous fat are not appropriate candidates for the LAFC procedure. Patient age is not a major determining factor with regard to successful outcomes—very good LAFC results have been obtained with patients into their early 70s.

Table 1
Differences in tissue absorption and laser tissue interaction among Nd:YAG fiber lasers

	Mid–1400 nm	1320 nm	1064 nm
Water absorption	Highest[a]	Intermediate	Lowest
Fat absorption	Highest[a]	Intermediate	Lower
Collagen (anhydrous) absorption	Low[a]	—	—
Fatty tissue ablation efficiency	Highest	Intermediate	Least

[a] Absorption peaks for water, fat, and collagen occur in the mid–1400-nm range.