

Histochemical Analysis of a Split Region Treatment of the Fraxel® SR1500 Laser and the Palomar® Lux1540 Laser

Vic A. Narurkar, MD, University of California at Davis, Davis, CA
Steven K. Struck, MD, Struck Plastic Surgery, Atherton, CA
Vikramaditya P. Bedi, MS, Reliant Technologies, Inc., Mountain View, CA
Kin F. Chan, PhD, Reliant Technologies, Inc., Mountain View, CA

INTRODUCTION

Nonablative fractional resurfacing involves the creation of microscopic islands of damage, while allowing the majority of the epidermis to stay intact¹. The Fraxel® laser (Reliant Technologies, Inc., Mountain View, CA) is widely recognized as the gold standard of nonablative fractional resurfacing²⁻⁵, and employs a 1550 nm fiber laser while utilizing an Intelligent Optical Tracking™ System to deliver a random pattern of microthermal injury. The Palomar Lux1540 laser employs a stamped pattern of injury. The goal of this study was to compare the two technologies with histochemical analysis. A side by side clinical study with the two devices is also underway and correlation of clinical outcomes with histology will be the ultimate goal of the study.

MATERIALS AND METHODS

A pre-abdominoplasty patient was selected for the study. The abdominal tissue which was to be excised within 24 hours was cleansed with alcohol, and a mixture of 7% lidocaine and 7% tetracaine was applied without occlusion for one hour. The topical anesthetic was removed and the skin was cleansed and prepped for treatment. An optical blue tint was applied to one half of the abdomen (to be treated with the Fraxel SR1500 laser). This half of the abdominal skin was treated with the Fraxel SR1500 laser at 10, 15, 20, 25, 30, 35 and 40 millijoules with four passes at treatment level 7 (46 to 294 MTZ/cm²/pass), with per pass fluence limited to 3.0 joules/cm². The contralateral abdominal skin was treated with the Lux1540 laser with a single stamping treatment at 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95 and 100 mJ*, with per stamp fluence ranging from 3 to 10 J/cm². Zimmer® cooling at Z=3 was used with both devices for patient comfort.

The patient underwent abdominoplasty at 1-day post treatment during which the skin treated with both devices was excised. The treatment sites were identified accordingly to their corresponding parameters and device and the skin samples were further excised and frozen-embedded in OCT. Continuous and sequential vertical sections (20 µm per section up to 200 µm consecutive sections) were performed to optimally identify and record the deepest part of each micro-lesion. The sections were stained with nitro-blue tetrazolium chloride (NTBC) for cell viability through lactate dehydrogenase (LDH). Each microscopic treatment zone (MTZ) was identified as a quasi-columnar zone with absence of NTBC stain, with the deepest and widest part of each lesion designated as the lesion depth and lesion width, respectively². The same lesions were also evaluated using cross-polarized microscopy for accurate demarcation of the denaturation zone through loss of collagen birefringence.

* The Palomar Lux1540 laser is only FDA-cleared up to 70 mJ.

RESULTS

Figure 1 shows the results of lesion depth as quantified with NTBC stain for loss of cell viability within each MTZ. At equivalent pulse energy levels, the Fraxel SR1500 lesion depths were approximately two times the depths of the Lux1540 lesion depths, and, the average lesion depth of the Fraxel SR1500 laser at 40 mJ was deeper than that of the Lux1540 at 100 mJ.

Lesion width analysis showed the Fraxel SR1500 laser produced a 30% larger cross sectional width compared to the Lux1540 at similar pulse energy levels (**Figure 2**). The Fraxel SR1500 laser employs adjustable optical spot sizes for optimization of lesion depths while simultaneously varying the corresponding spot density to achieve similar percentage coverage at each treatment level. The Lux1540 employs a fixed optical spot size without density adjustment capabilities, thereby increasing percentage coverage with increasing pulse energy per stamp delivery.

Figure 1. Lesion depths of SR1500 vs. Lux1540 micro-lesions created in vivo and excised 1-day post-treatment, as quantified through loss of cell viability by NBTC stain.

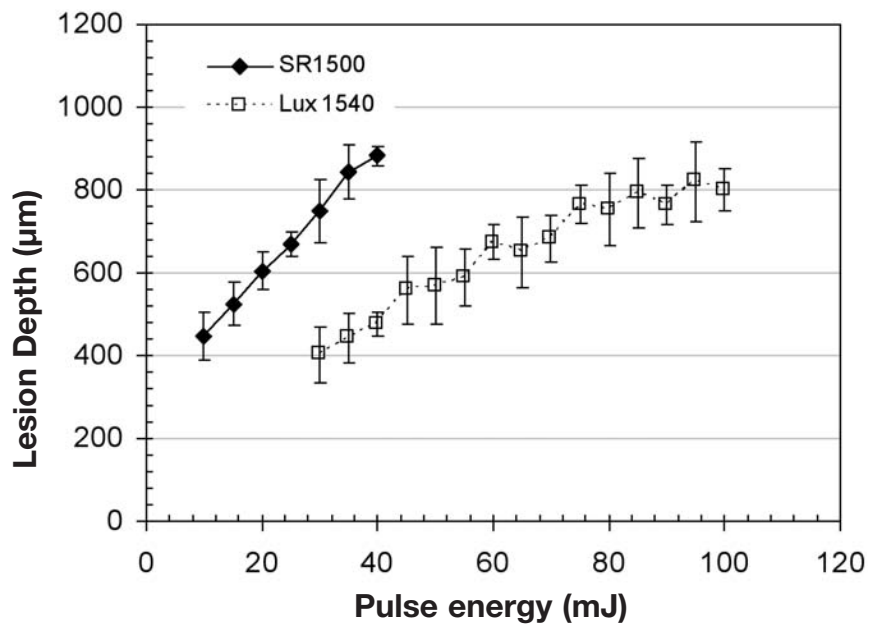


Figure 2. Lesion widths of SR1500 vs. Lux1540 micro-lesions created in vivo and excised 1-day post-treatment, as quantified through loss of cell viability by NBTC stain.

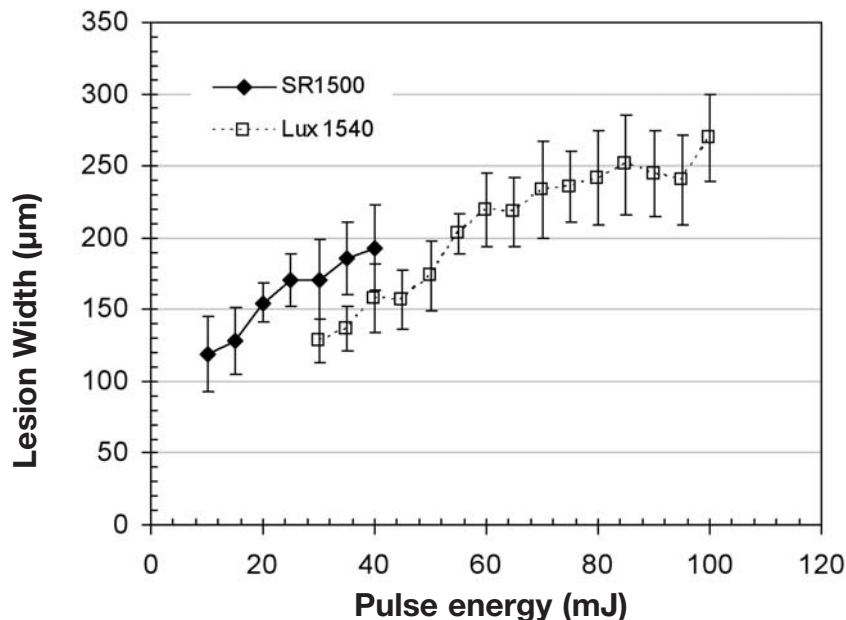


Figure 3 illustrates micro-lesions stained with NBTC for loss of cell viability. Figure 3a demonstrates a typical 40 mJ lesion produced by the Fraxel SR1500 laser. The corresponding MTZ created by the Lux1540 laser is shown in Figure 3b and demonstrates approximately 50% less penetration at the same pulse energy. Figures 3c and 3d describe progressively deeper penetration of thermal damage at 70 mJ and 100 mJ, respectively, with the Lux1540 laser. A typical MTZ produced by the Lux1540 laser at 100 mJ remained slightly shallower than the MTZ created by the Fraxel SR1500 laser at 40 mJ.

Figure 3. NBTC staining of loss of cell viability (LDH) within micro-lesions created in vivo and excised 1-day post-treatment with the (a) Fraxel SR1500 laser at 40 mJ and the corresponding (b) Lux1540 laser at 40 mJ, (c) Lux1540 laser at 70 mJ, and (d) Lux1540 laser at 100 mJ.

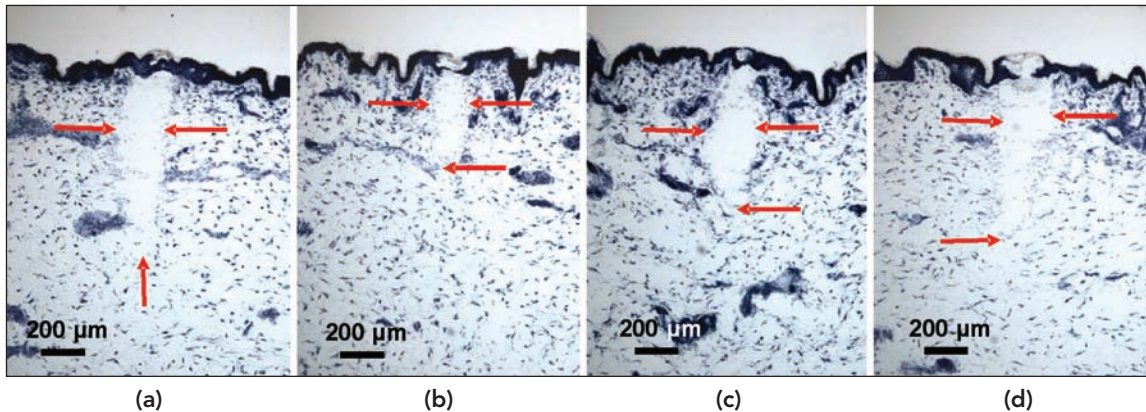
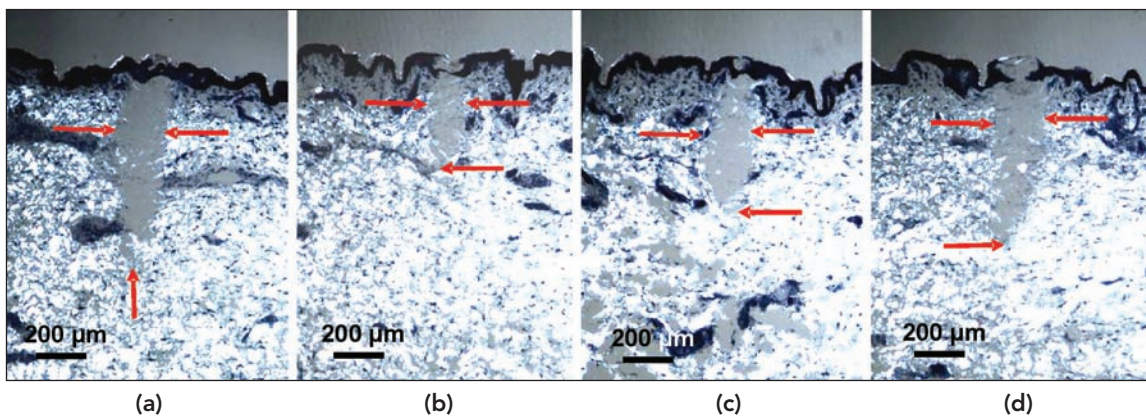


Figure 4 demonstrates the corresponding micrographs viewed under cross-polarized microscopy. Loss of collagen birefringence indicated within each micro-lesion demarcates collagen denaturation as a result of thermal damage. The extent of collagen denaturation represented a similar trend to those in **Figure 3**, where the Fraxel SR1500 laser produced deeper penetration at 40 mJ than that of the Lux1540 laser at both 40 mJ and 100 mJ.

Figure 4. Cross-polarized microscopy for loss of collagen birefringence (demarcates collagen denaturation) within the same micro-lesions created in vivo and excised 1-day post-treatment with the (a) Fraxel SR1500 laser at 40 mJ and the corresponding (b) Lux1540 laser at 40 mJ, (c) Lux1540 laser at 70 mJ, and (d) Lux1540 laser at 100 mJ.



DISCUSSION

There is much confusion in the term "fractional resurfacing." Many devices employ the term "fractional" purely as marketing without supporting histologic studies. True nonablative fractional resurfacing employs mid infra-red wavelengths, of which the Fraxel SR1500 laser has been the gold standard, as demonstrated by clinical experience, peer reviewed studies and histology²⁻⁵. The only other mid infra-red nonablative fractional device with supporting clinical and histologic evidence is the Palomar Lux1540 laser. This study was undertaken to compare histochemically the micro-lesions created by the two devices on the same patient in vivo. This is part of a larger unsponsored clinical split face study with the two devices.

The Fraxel SR1500 laser has an optical spot size which is adjusted at each pulse energy level for optimizing depth of thermal damage. On the same donor tissue, MTZs produced by the Fraxel SR1500 laser were approximately twice as deep as those of the Lux1540 at similar pulse energy levels. The Lux1540 laser did not produce deeper lesions because it has a fixed spot size which does not promote efficient use of energy for dermal coagulation, and the per pass fluence increases with pulse energy level with possibility of creating bulk heating and increased discomfort. Overall, lesion depths by both the Fraxel SR1500 laser and Lux1540 laser may be sub-optimal as the patient's abdomen was exposed to room temperature for a long period of time with topical anesthetic and then treated with Zimmer cooling. Still, this is a pivotal study as it is the first of its kind to truly compare two devices on the same patient histochemically. A larger clinical study is currently underway which uses both devices in a split face fashion, with analysis of the photographs performed by a blinded investigator who is unaware of which device was used on which side of the face. It is critical that these studies be conducted as it will clarify the confusion that exists between "true" nonablative fractional resurfacing versus "quasi" nonablative fractional resurfacing, which is merely marketing without science.

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