Histological Investigations and Comparative Analysis of a Novel 455nm Blue Light Laser

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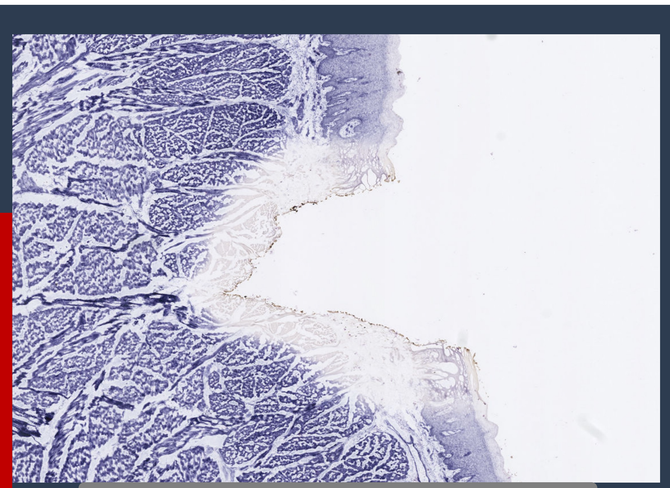
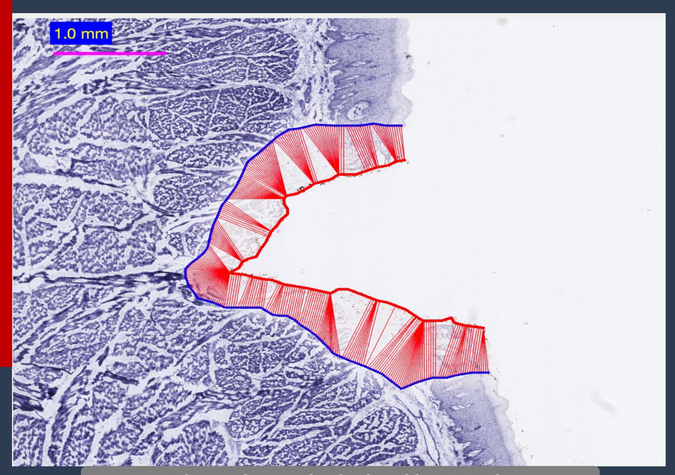
Introduction

- Carbon dioxide (CO2) lasers are the traditional workhorse of laryngology, with a 10,600nm wavelength, the chromophore is absorbed by water which gives it a scalpel-like cutting property.[1]
- Photoangiolytic lasers, with a wavelength similar to hemoglobin's chromophore, have been developed to maximize coagulation at the expense of tissue cutting.[2]
- A novel 455nm blue light laser has been developed to serve as both a photoangiolytic and cutting laser.
- This is the first histological comparative analysis of the 445nm blue light laser and the 10,600nm CO2 laser.

Figure 1

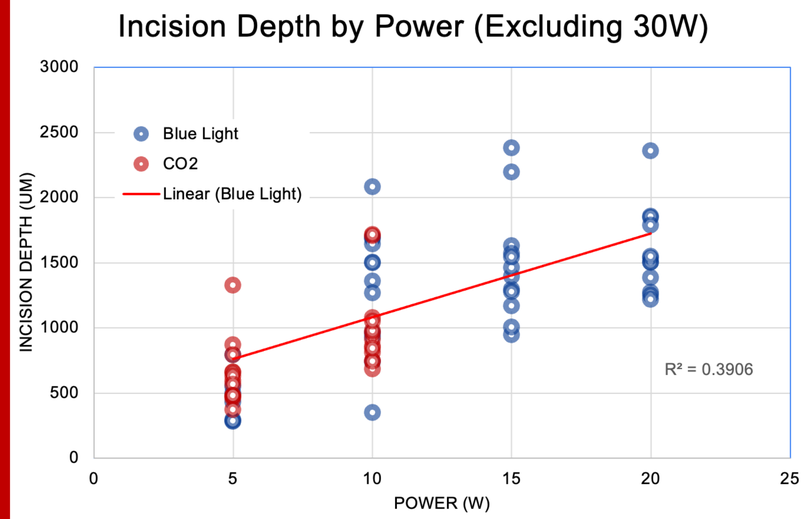


H&E stain of tongue incised with 445nm laser



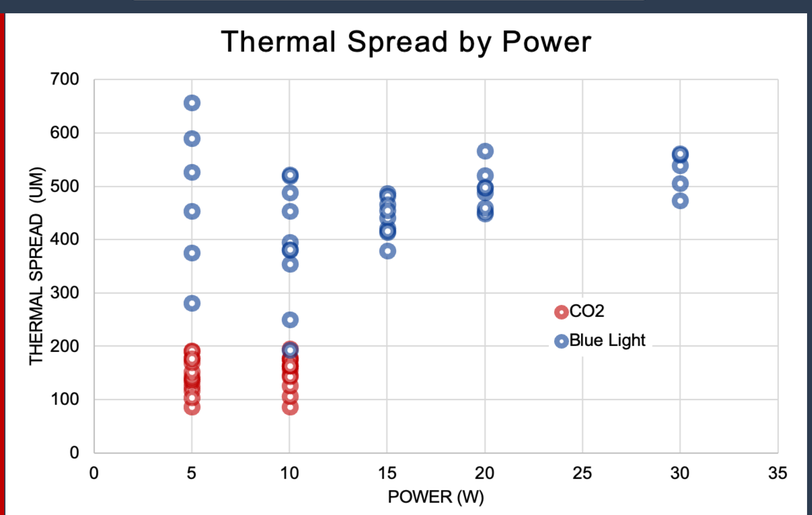
Thermal spread calculated by MatLab

Figure 2



Comparison of incision depth by power

Figure 3



Comparison of thermal spread by power

Methodology

- Comparative medical device study evaluating tissue cutting and ablation effects of a novel 455nm laser and 10,600nm fiber-based CO2 laser
- Both lasers were secured at specific distances (1-5mm) from ex-vivo bovine tongue tissue using 300µm and 500µm fibers (455nm)
- Tissue was moved at of 2mm/second and lasers incised tissue at specific powers, range: 5-20W.
- Histological analysis included staining with hematoxylin and eosin (H&E) and lactate dehydrogenase (Figure 1).
- Incision depth and thermal spread were calculated with proprietary MatLab programming (Figure 1) and compared between laser wavelengths, powers and tissue distance.

Results

• 5W - Average incision depth for 455nm laser was 448µm vs 643 µm for the 10,6000nm laser (p=0.0872)

• 10W - Average incision depth for 455nm laser was 1007µm vs 1309µm for 10,6000nm laser (p=0.0903).

• Increasing power of 455nm laser increased incision depth: 5W:448 µm vs 20W: 1588 µm, p<0.0001 (Figure 2)

• Fiber distance from tissue did not impact incision depth

• Thermal spread: 455nm laser averaged 470µm vs 150µm for 10,600nm laser (p<0.0001) (Figure 3).

• Thermal spread did not change significantly with power for 455nm or 10,6000nm LASER (Figure 3).

Discussion

- The 455nm laser had increased thermal spread compared to CO2 laser at all powers and distances (Figure 3).
  - Thermal spread can be used as a proxy for photocoagulation. Increased thermal spread can be a useful property when ablating a vascular lesion.[3]
- The 455nm laser had similar incisional depth to the CO2 laser.
  - Traditional ablative lasers, such as the 532nm KTP are less effective for sharp tissue dissection, necessitating the use of CO2 or comparable cutting laser.[2]
  - The 455nm has the capability to act as both a cutting and ablative laser in one device
- Increased power of the 455nm laser created a deeper incision without increased thermal damage (Figure 2 and Figure 3).
  - A surgeon may increase the power with less concern of excess damage to the surrounding tissue.
- Distance from tissue did not significantly affect the incisional depth and thermal damage when using the 455nm laser.
  - Consistent effects on tissue despite small variations in laser distance is ideal for in-office procedures which are inherently less precise.[4]

Future Directions

- Similar comparative analyses of this novel 455nm laser can be performed with KTP and 445nm blue light lasers to better understand the advantages, disadvantages, and ideal use cases of this novel laser.

References

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