

The Role of Pulse Duration and Pulse Energy on Fiber Tip Degradation During High-Power Laser Lithotripsy

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Introduction

- High-power holmium lasers are becoming increasingly popular for ureteroscopic laser lithotripsy and dusting technique.
- Settings and power selection may impact fiber-tip degradation and lithotripsy efficiency.
- We investigated the effect of pulse duration and pulse energy on fiber-tip degradation when using high-power settings for popcorn laser lithotripsy.



Example of (A) normal fiber and (B) fiber burnback

Methods

Model:

- BegoStones were fragmented in a glass bulb to simulate renal calyx, using a 120W Ho:YAG laser.
- A 242 μm fiber was placed via the ureteroscope 2 mm distance from stones (popcorn model).

Pulse Duration and Energy:

- Long pulse (LP) and short pulse (SP) settings were compared at settings of 1.0Jx20Hz (20W), 0.5Jx70Hz (35W), and 1.0Jx40Hz (40W).
- 40W SP settings (0.5Jx80Hz, 0.8Jx50Hz, and 1.0Jx40Hz) were then tested.

Peak Power:

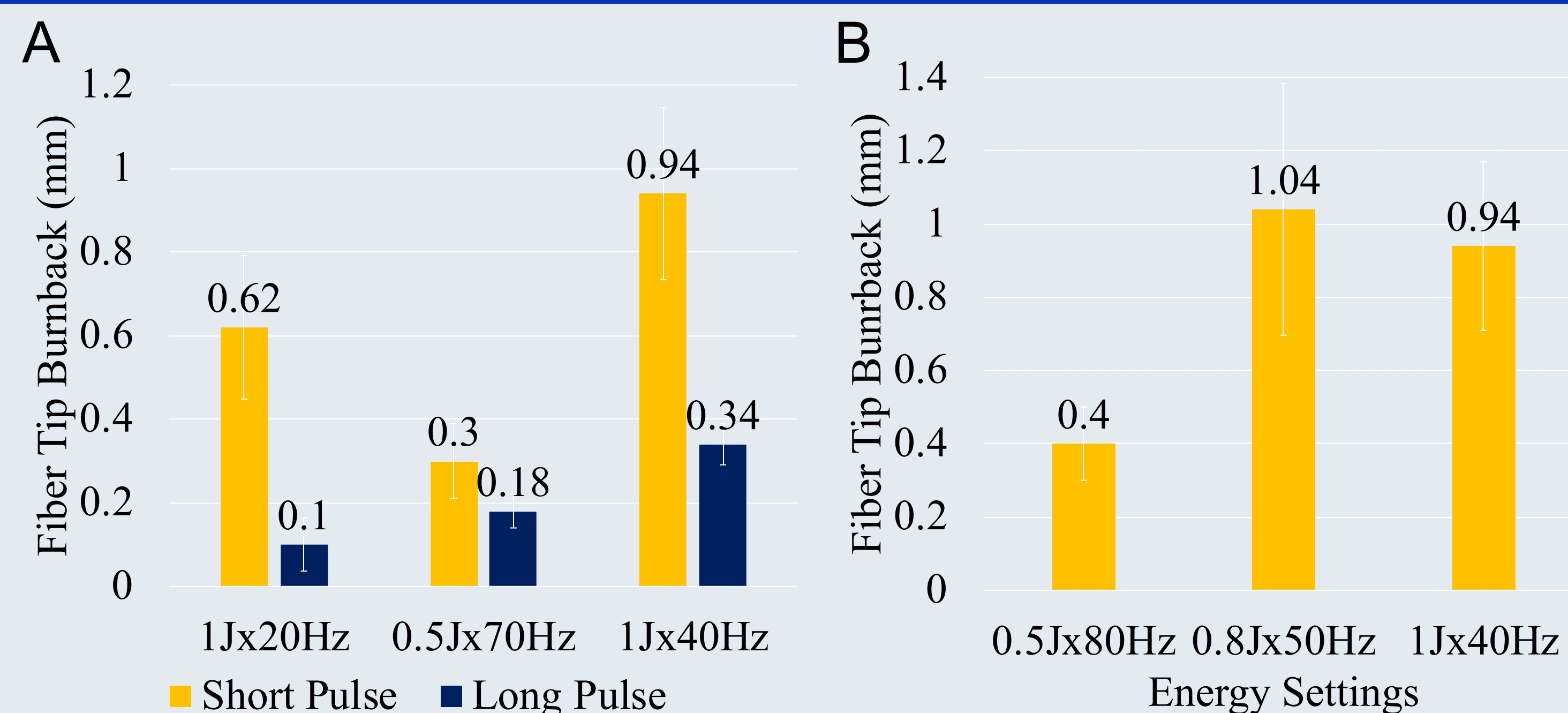
- Pulse duration was measured using a photodetector and peak power was then calculated using the pulse duration and pulse energy.

Outcome:

- Experiments were conducted for 4 minutes and fiber-tip length was measured before and after using a digital caliper.

Results

- Fiber-tip degradation was least when using LP for all settings tested ($p < 0.01$).
- For 40W settings, tip degradation was significantly lower when using a pulse energy of 0.5J compared to 0.8J or 1.0J ($p < 0.004$).



Laser fiber-tip degradation during popcorn laser lithotripsy in an *in vitro* model utilizing (A) Short and long pulse modes with varying power (20, 35 and 40W) settings. (B) Short pulse and varied 40W settings.

Pulse Energy	Pulse Duration (μs)		Peak Power (kW)	
	SP	LP	SP	LP
0.5J	206	244	2.4	2.0
0.8J	235	318	3.4	2.5
1.0J	265	390	3.8	2.6

Pulse duration and peak power values.

Conclusions

- LP mode results in less fiber burnback for all power settings tested.
- High-power 40W settings can be utilized with less burnback if low pulse energy (0.5 J) is used.
- Understanding these parameters can improve the longevity of the laser fiber and improve procedural efficiency.