Performance and Safety of Holmium:YAG Laser Optical Fibers

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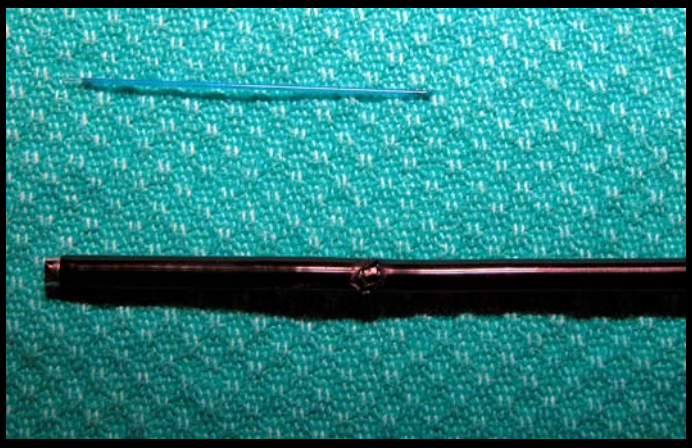
Research Objectives

- Are holmium:YAG laser fibers breaking during ureteroscopy and contributing to ureteroscope damage?
- Is there a difference in performance and safety among different manufacturers?

Introduction

- Small caliber, flexible ureteroscopes have facilitated the treatment of lower pole calculi
- High cost of flexible ureteroscope repair is a major issue
- Holmium:YAG laser may be contributed to ureteroscope damage

Damaged DUR-8 Elite Secondary to Holmium:YAG Laser Fiber



Methods

Series of experiments:

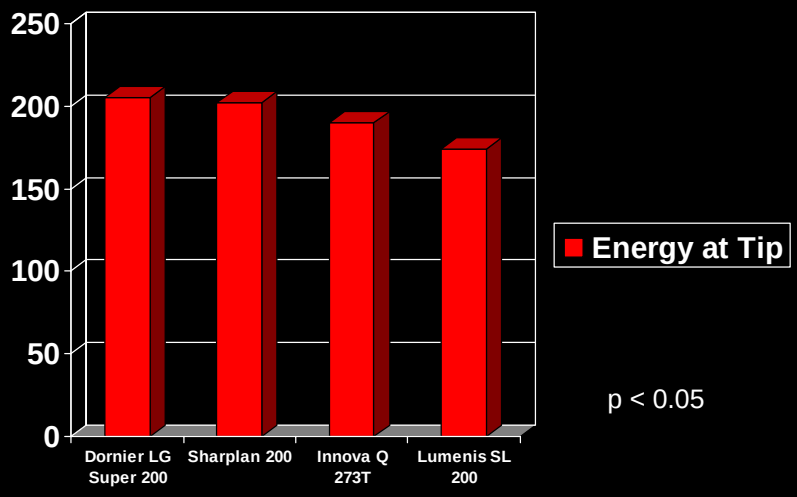
1. Energy transmission
2. True diameter
3. Flexibility
4. Fiber destruction testing

Methods

- Lumenis 80 W holmium:YAG laser utilized

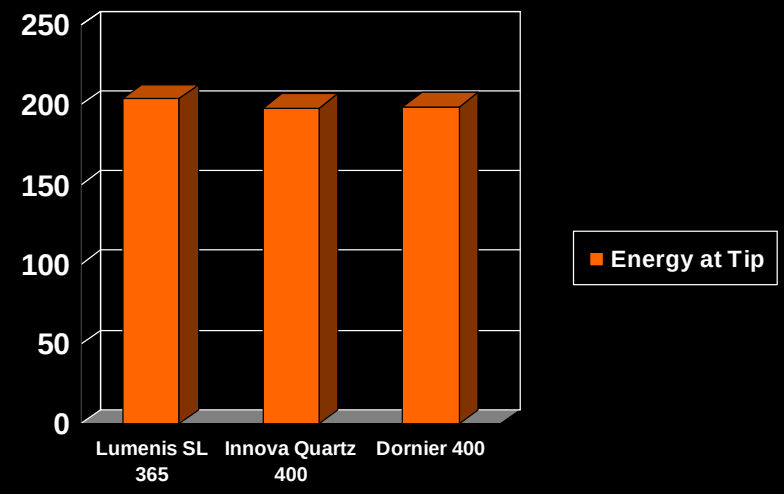
Small Fibers	Medium Fibers
Sharplan 200	Lumenis Slimline 365
Lumenis Slimline 200	Innova Quartz 400
Dornier Lightguide Super 200	Dornier 400
Innova Quartz 273T	

1. Energy Transmission (mJ) 200 mJ Pulse - Small Fibers



$p < 0.05$

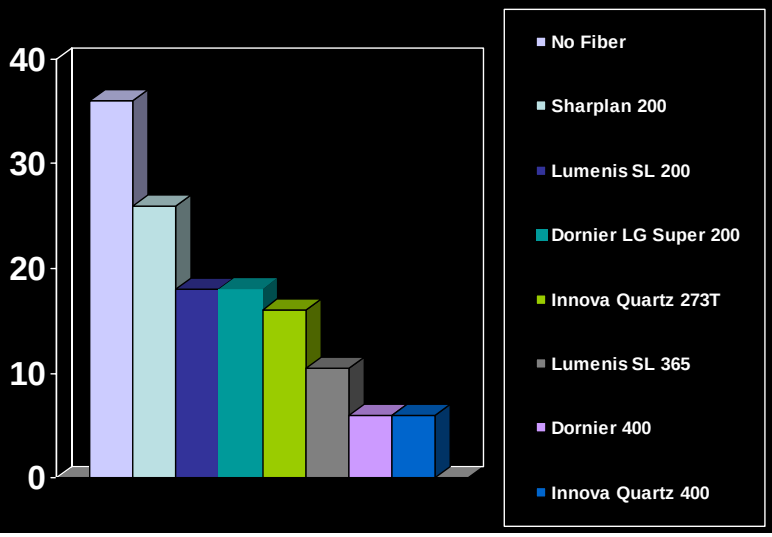
Energy Transmission (mJ) 200 mJ Pulse - Medium Fibers



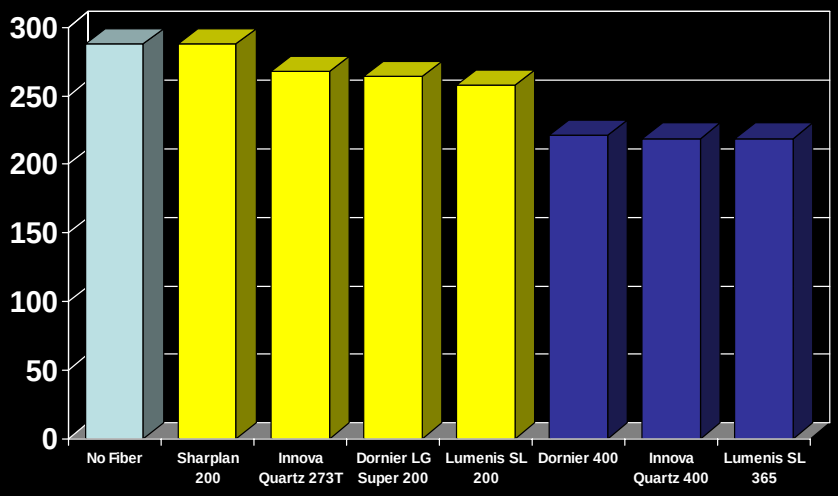
2. “True” Fiber Diameter

	Diameter (µm)
Sharplan 200	238
Dornier LG Super 200	390
Lumenis SL 200	407.5
Innova Quartz 273T	422
Lumenis SL 365	520
Dornier 400	717
Innova Quartz 400	719

Flow Rate Through ACMI DUR-8 Elite (mL/min)



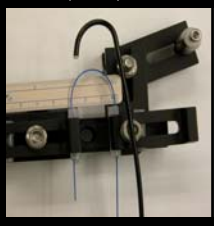
3. Maximal Deflection of DUR-8 Elite With Fiber in Channel

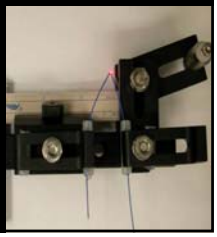


4. Fiber Destruction Testing – 180° Bent

Fiber Destruction Testing at 180° Bend	Bend Diameter (cm)	Pulse Energy to Break Fiber (mJ)
Innova Quartz 273T	1	200
Sharplan 200	1	600
Lumenis SL 200	1	4000
Dornier LG Super 200	2	200
Lumenis SL 365	3	200
Dornier 400	3	200
Innova Quartz 400	-	Did not break at max energy with 1cm diameter bend

~ 2.8 cm





Discussion

- Diameter of bend critical to holmium:YAG laser optical fiber thermal breakdown
- Pulse energy contribute to damage
- Energy transmission shifting from core into cladding with bending is damaging fibers and ureteroscopes

- Small Diameter Fibers:
  - Dornier LG Super 200 lowest threshold for thermal breakdown (2 cm diameter)
  - Sharplan 200, Lumenis SL 200, Innova Quartz 273T required bend with 1 cm diameter to breakdown
- Medium Sized Fibers:
  - Innova Quartz 400 was the only fiber that did not fracture
  - Lumenis SL 365 and Dornier 400 both underwent thermal breakdown with a 180° bend and diameter of 3 cm and therefore lower pole ureteroscopy not recommended with these fibers

Conclusion

- Optical performance and safety varies amongst fibers
- Risk of thermal breakdown occurs with tight bends
- Raising the energy increases this risk