Evaluating the Effects of a 532nm Fiber-based KTP Laser on Transoral Laser Surgery Supplies
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Abstract

Objective: This study evaluates the effects of the KTP laser on surgical supplies, which has not been previously examined.

Methods: An Aura XP 532 nm KTP laser with a 600 nm fiber was used in pulsed and continuous modes. The beam was focused at the shaft and balloon of three "laser safe" endotracheal tubes (ETTs), a PVC ETT, and a Codman surgical patty. Time to penetrate was noted.

Results: The KTP laser beam was unable to penetrate any of the laser resistant ETTS. It did react with the black number markings on the PVC ETT by producing sparks. The KTP laser was nonreactive with all ETT cuffs except the outer balloon cuff of a Rusch Lasertubus ETT in one trial. The KTP laser caused the production of a flame upon contact with the blue radiopaque strip of the surgical patty, even when the patty was wet.

Conclusion: This study demonstrates that there are a number of safe ETT options that may be used during transoral laser microsurgery with a KTP laser. Codman surgical patties are shown to be a significant fire risk in KTP surgical laser.

Introduction

The introduction of lasers revolutionized otolaryngology - head and neck surgery by allowing the surgeon to use energy to precisely cut and coagulate tissue. Unfortunately it was soon realized that the risks of using lasers could be devastating, particularly in the case of an airway fire. For an airway fire to occur, all three components of the “fire triad” must be present: an oxidizer, an ignition source, and fuel. In transoral laser surgery, the oxidizer can include oxygen and anesthetic gases, the laser itself supplies the ignition source, and fuels include endotracheal tubes (ETTs) and sponges in the airway.

To avoid fire, laser-resistant ETTS and Codman surgical patties are commonly used in transoral laser surgery. In addition, new protocols have been initiated to raise awareness of laser and fire safety during the mandatory time-out at the start of every procedure.

Multiple studies have been performed to evaluate the effect of patties as a safety buffer to protect the airway and ETT during carbon dioxide laser surgery, but the interaction of ETTS and patties with the KTP laser has not been assessed.

Methods and Materials

Laser Source: An Aura XP 532 nm KTP laser (American Medical Systems, Minnetonka, MN) with a 600 nm fiber was used in pulsed and continuous modes. In the pulsed mode, the laser was set at 35 watts with a 15 ms pulse width and 5 pulses/s. In continuous mode the laser was set at 8 watts. Targets: Four laser-safe ETTS were tested: 1) Xomed Laser-Shield II (Medtronic #7060300, Jacksonville, FL); 2) Mallinckrodt Laser Oral/ Nasal Tracheal Tube (Covidien #86398, Mansfield, MA); 3) Rusch Lasertubus (Teleflex #102004060, Research Triangle Park, NC); and 4) Hudson RCI Sheridan Laser-Trach (Teleflex H5-20612, Research Triangle Park, NC)32. A “standard” Mallinckrodt Hi-Lo PVC ETT (Covidien #86448, Mansfield, MA) was also tested. All tubes were 6.0 in. size. The handheld KTP laser was held 0.5 cm from the target. A white note card was placed behind the target or within the ETT and the time to penetration of the card was measured. Three trials were performed.

Two laser-safe ETTS and a standard PVC ETT were tested in 3 trials each. In addition, 1/2” x 3” Codman surgical patties were examined in dry and soaked conditions. The white cottonoid portion and blue radiopaque blue strip of the patty were independently exposed to the laser.

Results

Endotracheal Tube Shafts: None of the ETTS shafts were perforated by the KTP laser in either mode. The laser was able to perforate the outer absorbent layer of the Sheridan Laser-Trach, Xomed Laser-Shield II, and Rusch Lasertubus instantaneously, but was unable to perforate the metallic layer of these tubes. The beam did react with the black number markings on the PVC ETT by producing a spark.

Endotracheal Tube Cuffs: The KTP laser was nonreactive with all ETTS except the Rusch Lasertubus outer cuff which was perforated at 29s in one trial. The interaction between Codman surgical patty & KTP laser.

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<th>KTP Continuous Mode</th>
<th>KTP Pulsed Mode</th>
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Interactions between Codman surgical patty & KTP laser.

Discussion

The Aura KTP laser was introduced to laryngologic surgery in 2003 and is commonly used in many medical centers. However, the effects of the 532 nm KTP laser on surgical supplies has not yet been tested.

In this study, the bodies of all ETTS were found to be resistant to the laser beam. Only the black markings on the shaft of the PVC ETT and the absorbent sponge on the surface of the Xomed Laser-Shield II, Rusch Lasertubus, and Sheridan Laser-Trach tubes were found to react with the laser. Intraoperatively care should be taken to ensure that the underlying metallic layer is not exposed to prevent the laser beam reflecting towards unintended targets.

These findings are consistent with Pandit et al. in which a KTP laser reacted with solely the black markings of an LMA, causing an instant flare that produced a “crater filled with silica ash.” The laser was ultimately unable to penetrate the LMA tube. These findings are in agreement with our own: though a spark was ignited, the tube was not penetrated.

The ETT cuffs appear to be similarly resistant to the KTP laser. The KTP laser was resistant to all ETTS including the PVC cuff filled with air. The lone exception was one trial with Rusch Lasertubus in which the outer cuff was perforated but the inner cuff was left undisturbed.

It was interesting to note that each portion of the surgical patty interacted differently with KTP laser energy. The white absorbent sponge was slow to interact with the laser, especially when saturated with saline. The radiopaque blue strip, however, quickly reacted with laser energy with an instantaneous flame in all trials, even when wet. This blue strip can present a serious fire hazard in laser surgery.

Conclusions

The fiber-based 532 nm KTP laser may be used safely with a number of laser-safe ETTS. The black number markings on a standard PVC ETT are the only areas that were noted to interact with the laser in this study. Care should be taken with use of surgical patties, as a fire may occur if they are not maintained wet or if the laser beam is aimed towards the blue radiopaque strip.

References


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Figure 1. Xomed Laser-Shield II, Rusch Lasertubus, and PVC ETts

Figure 2. Perforation of a dry surgical patty