Anesthesiology
V 75, No 3A, Sep 1991

POSTER SESSION XVII

A500

TITLE: EVALUATION OF A NEW CERAMIC ENDOTRACHEAL TUBE FOR LASER AIRWAY SURGERY

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In an effort to produce a laser-safe endotracheal tube, Fuji systems has recently introduced a new silicone endotracheal tube containing ceramic particles for laser use. We compared it to conventional polyvinylchloride (PVC) endotracheal tubes and foil wrapped endotracheal tubes in this investigation.

Size 8.0 mm internal diameter Phycon endotracheal tubes (Fuji Systems, Tokyo, Japan) were compared to 8.0 mm internal diameter PVC endotracheal tubes (Mallinckrodt, Hi-Lo, Argyle, New York). The PVC endotracheal tubes were studied as received from the manufacturer and after wrapping them with 0.25 inch wide 1 mil thick copper foil tape (Venture Tape Corp., Rockland, Massachusetts). This tape was applied in a continuous overlapping spiral manner starting just above the cuff using a single piece of foil tape. The endotracheal tube under study was placed on a wet towel in air and had 5 $L \cdot min^{-1}$ of oxygen flowing through it. The endotracheal tubes were subjected to either continuous laser radiation at 30 watts from a Sharplan CO_2 laser positioned perpendicularly 17.5 cm above the endotracheal tube or 34 watts of continuous output from a Nd-YAG laser delivered through a fiber bundle. The laser's output was continued until a blow-torch fire occurred or 60 or 95 seconds had elapsed for the CO_2 and Nd-YAG studies respectively.

All five trials with the CO_2 laser directed onto the Phycon tubes resulted in blowtorch ignition of the endotracheal tubes after 35.98 $\pm$ 5.93 seconds (mean $\pm$ S.D.). None of the copper foil wrapped PVC tubes was affected by 60 seconds of continuous CO_2 laser radiation. All of the five plain PVC tubes subjected to CO_2 laser radiation were ignited and blow-torch fires occurred after 1.24 $\pm$ 0.40 seconds. The times to ignition of the Phycon endotracheal tubes by the CO_2 laser were significantly greater than those for the plain PVC endotracheal tubes ($P < 0.001$ as determined by the Student's t-test).

Nd-YAG laser radiation initiated blowtorch combustion of the five Phycon tubes studied after 46.67 $\pm$ 26.16 seconds. None of the shafts of the copper foil-wrapped tubes was affected by 95 seconds of continuous Nd-YAG laser fire. The application of Nd-YAG laser radiation onto the shafts of the bare PVC endotracheal tubes resulted in blowtorch ignition after 1.70 $\pm$ 0.55 seconds. The times to Nd-YAG laser ignition of the Phycon endotracheal tubes were significantly ($P < 0.01$) greater than that for the plain PVC tubes.

Laser-induced endotracheal tube fires have been shown to be the most common serious complication of laser airway surgery[(1)]. The seriousness of this problem has led to the use of special techniques and equipment to reduce the risk of combustion. The Fuji Phycon endotracheal tube is fabricated from ceramic particles that are extruded into a silicone matrix. Unlike foil wrapped endotracheal tubes, the Phycon endotracheal tube has a smooth, nontraumatic exterior and a thinner wall thickness. It has been approved for CO_2 laser use and comes in a prepackaged, ready to use, sterile form. Our study shows that the Phycon tube, although combustible, is less susceptible to the effects of the CO_2 and Nd-YAG lasers than were the plain PVC endotracheal tubes. The shafts of the copper foil wrapped endotracheal tubes, however, showed the greatest resistance to the lasers.

Reference: 1. Fried MP: Arch Otolaryngol. 110:31-34, 1984.

A501

TITLE: EVALUATION OF FOIL COVERINGS FOR PROTECTING ENDOTRACHEAL TUBES FROM THE KTP LASER

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Endotracheal tube fires have been shown to be the most common serious complication of laser airway surgery.[(1)]. The dangers of a catastrophic laser induced endotracheal tube fire during airway surgery necessitate the use of special anesthesia techniques. This study was undertaken to determine whether self-adhesive metallic foil tapes or the Laser-Guard™ protective coating could adequately protect polyvinylchloride (PVC) endotracheal tubes from the potassium-titanyl-phosphate (KTP) laser. This laser is being used increasingly in otolaryngologic surgery of the upper airway and consequently, in common with the CO_2 and Nd-YAG lasers, it might ignite an endotracheal tube and cause serious burns to the patient.

A Laserscope (San Jose, California) model CE 3924 KTP laser was set to its maximum output of 18 watts in the continuous mode of operation. The laser's output was propagated via a fiberoptic bundle and directed perpendicularly at Mallinckrodt (Argyle, New York) size 8 mm internal diameter "Hi-Lo" PVC endotracheal tubes which had 5 $L \cdot min^{-1}$ of oxygen flowing through them. The laser was actuated until combustion occurred or 1 minute had elapsed. The endotracheal tubes were surrounded by air and rested on wet towels during the experiment. Seven endotracheal tubes were studied. Five were wrapped with 0.25 in. self-adhesive metallic foil tapes in an overlapping spiral manner with a single piece of foil starting just above the endotracheal tubes's cuff. The tapes used were: 1) Radio Shack (Tandy Corp., Fort Worth, Texas) No. 44-1155; 2) Venture (Rockland, Massachusetts) 1 mil thick copper foil tape; 3) 3M (St. Paul, Minnesota) No. 433; 4) 3M No. 1430; and 5) 3M No. 425. The Laser-Guard™ (Merocel Corp., Mystic, Connecticut) protective coating was also applied to a PVC endotracheal tube and its exterior foam layer was moistened with water according to the manufacturer's instructions before testing it with the laser. Finally, a plain, unprotected (bare) PVC endotracheal tube was studied as a control. The adhesive side of the foil tapes was also tested by wrapping an endotracheal tube with the foil tape adhesive side outward.

The plain unprotected PVC endotracheal tube started burning after 14 sec of laser contact. Laser application to the non-adhesive side of the five tapes studied had no affect after 1 min; however, when the laser was fired at the adhesive side of the Radio Shack tape, flames were seen after 7 sec and the tape broke apart. Laser impact on the adhesive side of the 3M No. 1430 tape caused the endotracheal tube to melt under the tape by 6 sec. For the other tapes, the endotracheal tubes melted by 60 sec. The Laser-Guard™ protected endotracheal tube was unaffected by laser contact, but its foam coating was noted to be missing at the site of laser contact. However, the underlying embossed silver foil layer was unaffected.

The KTP laser produces radiation with a wavelength of 532 nanometers which has a green color. It is readily absorbed by hemoglobin and consequently has an intrinsic hemostatic effect. Its degree of tissue penetration and scattering is intermediate between that of the CO_2 and Nd-YAG lasers. Unlike the CO_2 laser, it can be propagated via a fiberoptic bundle. This study shows that in common with other lasers used for airway surgery, the KTP laser is capable of causing a catastrophic airway fire. The Laser-Guard™ protective coating afforded the best protection of PVC endotracheal tubes from the KTP laser of all the foil wraps tested.

Reference:1. Fried MP: Ann Otolaryngol 110:31-34, 1984.