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Too Hot to Handle—A Laryngoscope Malfunction

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Malfunction of a laryngoscope may produce patient injury[1] or interfere with expeditious airway management.[2] This report demonstrates that placing a laryngoscope blade and handle in an improper position may render them impossible to use. This problem was reproduced and investigated in the laboratory.

REPORT OF A CASE

A 15-week-old, 6-kg infant was scheduled for a cleft lip repair under general anesthesia. An uneventful halothane-nitrous oxide-oxygen inhalation induction was accomplished. The trachea was intubated easily with a 3.5-mm endotracheal tube and surgery commenced. Approximately 2 h later the endotracheal tube was accidently pulled out of the trachea by the surgeons. The problem was immediately recognized by the anesthesiologist (JKG) who picked up a large-handle laryngoscope with a Macintosh 2 blade attached and went to the infant's head. Within a few seconds he realized that the laryngoscope handle and blade were hot enough to burn his hand. The laryngoscope was dropped into a basin of water. Another laryngoscope was not immediately available for use. A quick repeat attempt to use the laryngoscope confirmed that the unit was still too hot to hold. It was also obvious that use of the unit would probably result in an oral burn to the infant. Since approximately 30 s had elapsed since the extubation, attention was directed to the infant's airway. Over the next minute or two, successful ventilation *via* mask with oxygen was accomplished. Reintubation was then easily accomplished with another laryngoscope and the operation proceeded uneventfully. The infant left the hospital without sequelae.

An investigation was undertaken to determine the etiology of the laryngoscope malfunction. An immediate investigation of the anesthesia machine failed to reveal any cause for the heating of the laryngoscope. The laryngoscope had been lying wrapped in a towel on top of the anesthesia machine with the blade partially attached. It had been undisturbed for 90 min. After attempting to reproduce the problem, it was discovered that any laryngoscope handle (with the exception of fiberoptic laryngoscopes) could be short circuited with the blade partially attached (fig. 1). We investigated the phenomenon in the laboratory.

METHODS

Two laryngoscope handles (chrome-plated brass and steel) were each evaluated with two different blades (MacIntosh 3, Miller 0) for the temperature change produced by blade malpositioning. Two fresh 1.5-V alkaline batteries (size C, E93, Eveready) were inserted before each trial. For each trial, a type K NiCr-NiAl thermocouple probe (Keithley) was taped to the surface of the middle of the laryngoscope handle. The temperature probe was connected to a digital thermometer (Keithley 870 with 8701 thermocouple adapter). The laryngoscope and handle were placed on a towel and temperature was recorded at 1-min intervals for at least 50 min. At the conclusion of each test period an investigator attempted to hold the handle. The digital thermometer was calibrated with a mercury thermometer (Universal Enterprises, L14-007) in a water bath over the range 20–95° C.

RESULTS

The surface temperature of the laryngoscope handle rose rapidly immediately after malpositioning of the blade (fig. 2). The rate of temperature rise was greater with the steel handle than with the chrome-plated brass handle. The selection of blade did not affect the temperature profiles. The handle felt warm when the surface temperature reached 45° C. With a surface temperature of 60° C, the handle could be grasped for no more than 2.5 s. The handle could be held for only a fraction of a second when the surface temperature reached 80° C. Calibration of the digital thermometer with the mercury thermometer revealed agreement within 1° C.

DISCUSSION

Malposition of the blade on the laryngoscope handle produces a short circuit which leads to rapid heating of the handle. Heat is produced by the dissipation of electrical energy through the metal handle and by the exothermic electrochemical reaction of the battery. In the laboratory investigation, the surface temperature of the steel handle increased much more rapidly than that of the brass handle. The specific heat, density, and resistivity are comparable for these two metals.[3] The internal resistance of the battery is large (0.3 Ω at room temperature) compared with the resistance of the handles;‡ thus, the difference in the rate of change of temperature is pri-

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‡ Eveready Battery Company, Eveready, E93, Form BF-250: 1–5, St. Louis, Missouri, 1987.

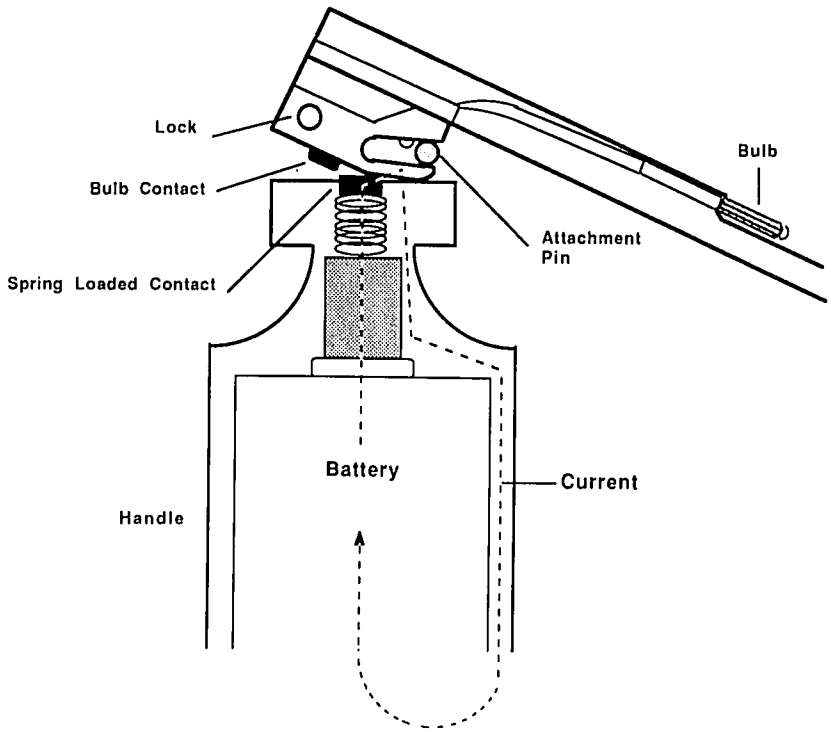

FIG. 1. Improper attachment of the blade to the laryngoscope handle produces a short circuit of the battery. Contact occurs through the base of the blade rather than through the bulb contact as occurs during normal operation.

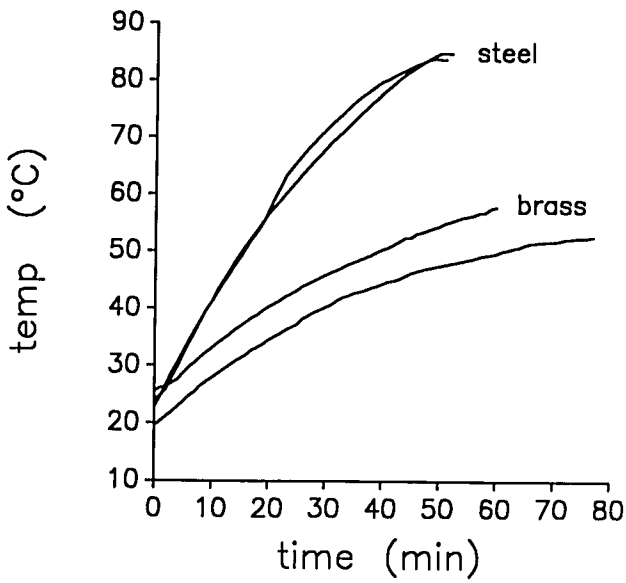

FIG. 2. The surface temperature is shown for two laryngoscope handles (steel and chrome-plated brass) with two blades (MacIntosh 3, Miller 0) following blade malpositioning at time 0. The steel handle temperature increased by more than 1° C per min.

marily dependent upon the greater volume and mass of the brass handle as compared with the lighter, thinner steel handle.

The heat produced when a laryngoscope is short circuited by misapplication of the blade may produce delays in patient care and could lead to a serious burn of a patient or practitioner. Explosion of the handle is theoretically possible as the design is analogous to that of a pipe bomb.

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