

## A New Pressure-sensitive Laryngoscope

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Injury to teeth is a complication of endotracheal intubation. The common injuries arise from pressure upon front teeth during laryngoscopy. The frequency of this complication varies, depending upon the patient population and the skill of the laryngoscopist. However, the literature indicates this is a constant problem.<sup>1</sup>

Several methods have been advocated to prevent such injury, including use of rubber or plastic guards,<sup>2</sup> tape, and blades with varying laryngoscope designs.<sup>3</sup> In this communication we describe a new adult laryngoscope blade,‡ designed to reduce the potential for tooth injury. The proximal portion of the blade flexes to relieve pressure on the teeth. This deformation of the blade occurs at pressures well below normal minimal mastication pressure.

Of the 50 blades manufactured and distributed, 10 are at Texas Tech University Health Sciences Center. Our anesthesia residents usually choose to use one of these instead of any of the other blades available for difficult intubations in the operating room and in the intensive care and emergency room setting. The blade has been used for over 2,000 successful intubations at our institution.

## CHARACTERISTICS

A modified straight blade is used (fig. 1). The vertical portion of the blade is hinged and maintained in this position by a spring. The spring is located at the proximal end of the blade outside the airway. During laryngoscopy, pressure on the teeth causes upward deflection of the hinged portion. Since the hinged portion can deflect only in an upward direction, lateral to the main section of the blade, pressure on the blade does

not obstruct the view. The hinged portion starts to bend at 0.68 kg (fig. 2A) and reaches maximum displacement at 1.8 kg. These pressure measurements were made by using a sponge scale with plaster denture molds mounted on top. Full displacement of the hinged part of the blade indicates that 1.8-kg pressure is being applied to the upper incisors and that a change in the direction of the force is needed to keep it in the safe range. Exposure of the larynx can be improved by tilting the handle of the laryngoscope to the left (fig. 2B). This movement may increase the pressure on the incisors and should only be made when intubation is not otherwise possible. Displacement of the hinged portion does not injure the tongue.

The hinged portion is concave along its length. The convexity of the main portion of the blade is slightly greater than it is in the Miller blade, so that vision is not impeded when the hinged portion is maximally displaced. This feature also prevents the light bulb from being covered by the base of the tongue. The blade length is 17 cm. In the absence of pressure displacement, the height is 2.5 cm and the width is 2.7 cm. The height with pressure displacement is 2 cm and the width is 3 cm. The surface that contacts the tongue is rough and unpolished to reduce slipping. Disassembly for cleaning is accomplished by removing the threaded shaft, which connects the two portions of the blade.

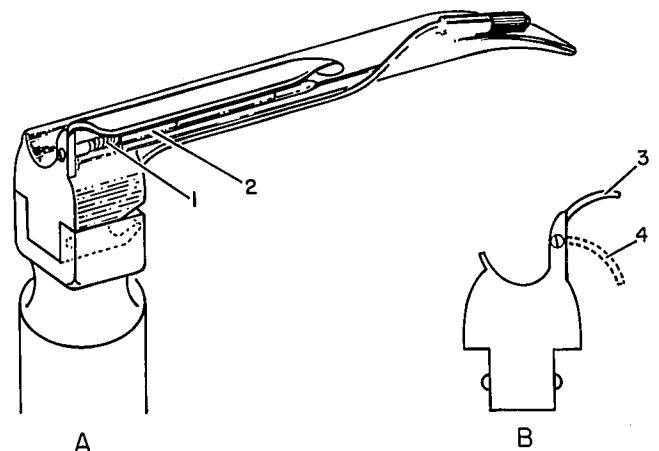


FIG. 1. Line drawing of the side (A) and back (B) views of the new blade: 1) spring, 2) threaded screw, 3) normal position, 4) full displacement of portion that flexes.

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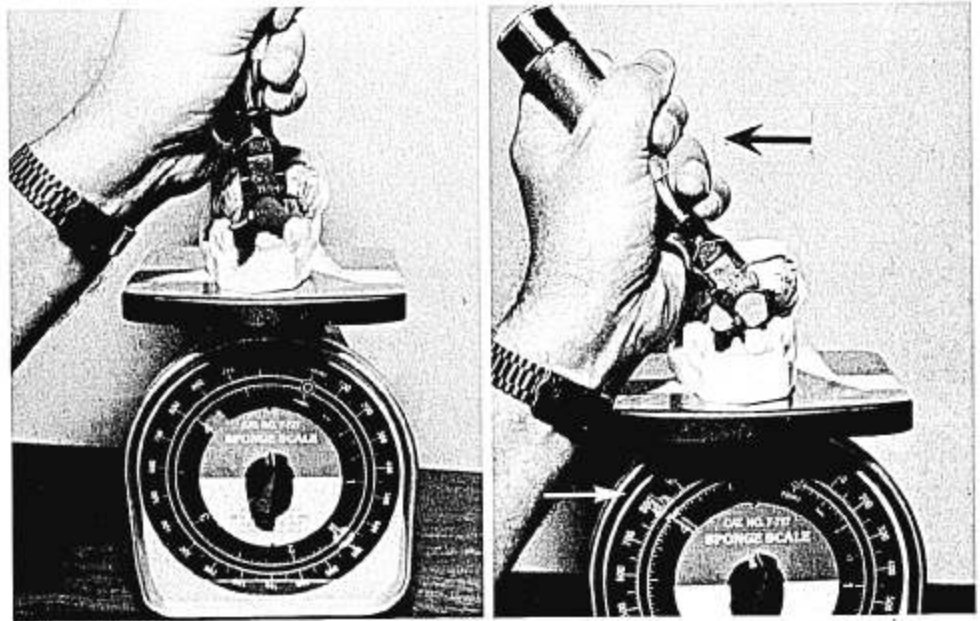
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FIG. 2. *A (left)*. Displacement pressure being tested on sponge scale. At 0.68 kg pressure on the upper incisors, the hinge starts to bend. *B (right)*. Leftward tilting of laryngoscope handle improves visibility and exposure—pressure on the upper incisor teeth still is 1.8 kg, as indicated by the white arrow.



The length of 17 cm was found, by subjective evaluation of prototype blades, to be the optimal length for reaching the larynx in difficult endotracheal intubations in patients with large heads. This length was not cumbersome in normal patients in whom a shorter blade would have sufficed.

DISCUSSION

The change in shape of the laryngoscope without loss of vision warns the endoscopist that pressure on the upper incisors is becoming excessive. The spring tension is below the lowest mastication pressure. Available information shows that static biting forces vary from 11.36 kg to 125.00 kg in different individuals, the average force being 77.27 kg.<sup>4</sup> This is equivalent to 1,981.28 kg/cm<sup>2</sup>, since the area of the cusp is approximately 0.039 cm<sup>2</sup>.<sup>4</sup>

Comparative measurements demonstrate size differences of the new and commonly used straight and curved blades (table 1). With conventional curved blades,

the height and length may create problems during difficult intubations. Curved blades need substantial opening of the mouth, prisms, mirrors, or fiberoptic methods to allow vision around the curve of the blade. On the other hand, straight blades are too narrow and the length is either too short or too long. The light also may be covered up by the base of the tongue.

In summary, we describe a new straight laryngoscope blade designed to reduce injury to front teeth during laryngoscopy. It has a concave portion that deflects upward when 1.8 kg of pressure is applied to it. This part is joined to the horizontal portion of the blade with a spring hinge. The pressure at which deflection occurs is considerably less than mastication pressure. The shape and length enhance vision during difficult endotracheal intubations.

Completion of this project was possible because of the support of Tom Barford of North American Drager Inc., and A. R. Salerno of Anesthesia Medical Specialties was helpful with the early prototypes.

TABLE 1. Comparative Measurements of the New Blade and the Most Commonly Used Adult Blades

	Length	Height	Height with Pressure Displacement	Width	Width with Pressure Displacement
New blade	17 cm	1.7 cm	1.2 cm	2.7 cm	3 cm
Macintosh 3	13 cm	3 cm	NA	3 cm	NA
Macintosh 4	16 cm	3.5 cm	NA	3 cm	NA
Miller 2	15.8 cm	1.1 cm	NA	1.5 cm	NA
Miller 3	20 cm	1.2 cm	NA	1.7 cm	NA

NA = not applicable, teeth break before displacement occurs.

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## Intrathecal Morphine Tolerance: Use of Intrathecal Clonidine, DADLE, and Intraventricular Morphine

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Continuous intrathecal morphine infusion provides a new approach to provide analgesia for the terminally ill patient in pain. Unfortunately, tolerance to morphine given intrathecally may predate death from the tumor. With such tolerance, the pain again can become unbearable unless permanent neurolysis or neuroablative surgery succeeds.<sup>1</sup>

One approach to overcoming the tolerance is to "rest" the mu opiate receptors while activating alternate receptor systems known to mediate antinociception. Yaksh *et al.*<sup>2</sup> demonstrated both adrenergic and serotonergic descending inhibitory systems in the spinal cord. Activation of postsynaptic adrenergic receptors at the spinal level with either the lipophilic alpha agonist clonidine or its more polar analogue ST-91 yields a potent and prolonged antinociception as measured by the shock titration paradigm in monkeys.<sup>3</sup> Alternatively, activation of delta opiate receptors in the dorsal horn

produces analgesia in various laboratory models.<sup>4-6</sup> A third approach to overcoming tolerance to narcotics given intrathecally is to administer morphine into the cerebral ventricles (ICV). Theoretically, this might increase morphine availability at opiate receptors modulating pain at higher levels of the cerebrospinal axis. Lobato *et al.*<sup>7</sup> and Leavens *et al.*<sup>8</sup> reported analgesia in humans with this route of morphine administration.

We report temporary control of cancer pain during chronic intrathecal infusion of clonidine in a patient with metastatic rectal adenocarcinoma, already tolerant to high doses of morphine administered systemically and intrathecally. We also report lack of analgesia following intrathecal administration of the specific delta agonist Da La<sup>2</sup> D-Leu<sup>5</sup> enkephalin (DADLE). Additionally, the ineffectiveness of high-dose ICV morphine was noted in this same patient. Finally, 3 months after intrathecal neurolysis, spinal opiate receptor sensitivity to low-dose intrathecal morphine reemerged.

### MATERIALS AND CASE REPORT

**Drug Delivery System.** The drug delivery system consisted of a subcutaneously implanted Infusaid® Model 400 reservoir pump (Infusaid Corp., Norwood, Massachusetts) with a constant flow rate (4 ml per day) connected in series with an L1-2 intrathecal Silastic® catheter. Detailed descriptions of this system are reported elsewhere.<sup>9</sup> Drug dosages were varied by changing the concentration of the drugs in the pump reservoir. If needed, bolus intrathecal doses were given via the auxiliary port of the reservoir.

Prior to human use, compatibility and stability of clonidine HCl were tested *in vitro* in a reservoir maintained at 37° C in a water bath for 56 days via serial

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