ARTICULATED ENDOSCOPE WITH SPECIFIC ADVANTAGES FOR LARYNGOSCOPY

This is a continuation of application Ser. No. 08/473,756, filed Jun. 7, 1995, now abandoned.

FIELD OF THE INVENTION

This invention relates to a fiber optic endoscope particularly suited for use as a laryngoscope and including a number of structural features and manufacturing advantages directed to making the apparatus specially adapted for facilitating placement of an endotracheal tube in a human patient under the severe time pressure frequently associated with such a procedure.

BACKGROUND OF THE INVENTION

Placement of an endotracheal (breathing) tube in the larynx of a patient to secure an open airway, either prior to surgery or during emergencies, is often a highly stressful, traumatic, and occasionally unsuccessful procedure. This procedure, called "intubation", while frequently routine, is associated with a number of possible complications. The tube can be placed in the esophagus in error and, if this error is not noted, patient injury or death can result. In addition, placement is usually time critical, and failure to secure the airway in time in a non-breathing patient can also result in patient injury or death.

Correct placement of an endotracheal tube requires either visualization of appropriate anatomical landmarks to insure that the tube has entered the correct passageway (trachea rather than esophagus), or use of some auxiliary device that can guarantee correct placement regardless of a particular patient's deviation from normal due to anatomical variability, disease state, or traumatic injury. For the former, a wide variety of devices, generically called "laryngoscopes" have been described and patented. (See, for example, U.S. Pat. No. 4,905,669, granted Mar. 6, 1990 to Bullard et al. and references cited therein and U.S. Pat. No. 5,279,281, granted Jan. 18, 1994 to Harvey.) These optical devices are intended to permit visualization of appropriate anatomical landmarks (usually the vocal cords) in a wide variety of normal and abnormal circumstances. The latter devices, such as intubating stylets, guides, oral airways and the like, usually exploit some feature or shape of the anatomy to insure blind placement, and will not be described further here.

The prior art of laryngoscopes can be conveniently divided into rigid laryngoscopes, which may or may not have a fiber optic imaging means, and flexible endoscopes and bronchoscopes such as is shown in the patents first mentioned above and, for example, in U.S. Pat. No. 5,183,031 granted Feb. 2, 1993 to Rossoff which can be used for laryngoscopy. Some flexible bronchoscopes intended primarily for laryngoscopy may be sold as "fiber-optic laryngoscopes". All laryngoscopes also carry a source of light to illuminate the anatomy. To further confuse the nomenclature, many modern rigid laryngoscopes use fiber-optic illumination fibers to carry the illumination light from a light source mounted in the handle to the tip. These are also frequently called "fiber-optic laryngoscopes".

The trachea in humans begins just below the base of the tongue, and, because of its location and orientation—normally at a right angle to the longitudinal axis of the mouth—direct visualization into the trachea requires that the patient's neck be extended significantly, and that his or her tongue be compressed so that a direct line of sight can be established. Rigid laryngoscopes are designed either to provide this straight line of sight, or to provide some other means of seeing "around the corner". To achieve the latter, mirrors, prisms, and fiber-optic image guides have been used. Once the vocal cords or other landmarks are visualized, the distal end of an endotracheal tube is inserted into the trachea while observing that it passes into the correct opening and not into the esophagus.

A flexible fiber-optic bronchoscope or laryngoscope is used in a very different manner. In this device, a flexible fiber-optic image guide, incorporating an objective lens on the distal end, and an eyepiece on the proximal end, is used to observe the anatomy as the scope is advanced into the patient's mouth. As the base of the tongue is reached, a short, controllable segment at the tip of the scope is deflected anteriorly by means of a remotely controlled articulating mechanism towards the trachea and is advanced. As the scope is advanced further, it is directed by manipulation and modification of the deflection of the tip to pass through the vocal cords and into the trachea. The vocal cords are again the landmark indicating correct placement, but in this case they indicate that the tip of the bronchoscope has passed into the trachea.

Once the bronchoscope is correctly placed, a hollow endotracheal breathing tube, which was threaded over the bronchoscope before the start of the procedure, is slipped down the flexible bronchoscope shaft so that it passes into the trachea over the bronchoscope. This part of the procedure is performed blindly, but since the bronchoscope is in the trachea, the endotracheal tube is guided automatically there as well.

Correct placement of the flexible fiber-optic bronchoscope into the trachea is hampered by features of its customary design. In many cases, the articulation of the tip is in a single plane (two-way articulation). It is necessary to rotate the entire bronchoscope to observe or to advance the instrument to one side or the other off the midline. Since some patients have tracheas that are deviated to the side, this off-line insertion requires additional time and skill. In addition, the customary design of the flexible fiber-optic bronchoscope includes a bulky, heavy handle that is difficult to manipulate, particularly in the stressful environment in which intubation is generally performed.

Furthermore, the conventional flexible fiber-optic bronchoscope is a relatively complex structure, and is therefore expensive and difficult to clean. This makes the apparatus less available in emergencies, since it is unusual for a treatment facility to allocate sufficient resources to purchase more than a small number of instruments, and the few that are available may not be clean from their last use. The high cost of such apparatus is furthermore due to the complexity of the articulation mechanism employed and to the costly fiber optic image bundle. Conventional articulation mechanisms use a large number of discrete "vertebrae", which may or may not be hinged together, and which are threaded over one or more pull wires. When tension in a pull wire is increased by manipulation of the remote control handle, the vertebrae are forced together on the side associated with the particular wire, causing the assembly to bend in that direction. The labor necessary to assemble these individual vertebrae is a significant contributor to the high cost of such devices.

In addition, flexible fiber-optic bronchoscopes usually incorporate one or more internal passages ("working channels"). Sputum and other patient secretions can collect