HOW TO MAKE AN INFLATABLE CUFF FOR AN INTRATRACHEAL TUBE

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Received for publication December 16, 1948

Cuffs have been used on intratracheal tubes almost as long as the tubes themselves have been used. In 1871, Trendelenburg used an inflatable cuff attached to a tracheotomy cannula. Since that time, various types of inflatable cuffs have been devised for use with intratracheal tubes. Although cuffs on intratracheal tubes have proved very satisfactory under certain circumstances, a review of the literature has failed to disclose how a physician can make such a cuff without experiencing considerable difficulty in obtaining the necessary materials (1-3).

We recently have devised an inflatable cuff that can be made relatively easily from materials that are readily available. This cuff permits constant or intermittent pressure to be maintained within the balloon. The pressure is recorded on a water manometer.

The description which follows applies to the manufacture of an inflatable cuff for use with an intratracheal tube of average size, that is, 32 or 35 F. If the cuff is to be used with a larger or smaller tube, the size of the materials must be altered accordingly.

A firm rubber tube that has an outside diameter of 7/8 inch (1.6 cm.) and a length of 7 to 8 inches (18 to 20 cm.) is used for a form. A piece of 3/8 inch (0.9 cm.) Penrose tubing which is 6 inches (15 cm.) long is used as a foundation for the balloon. The Penrose tubing is placed on a hemostat (fig. 1a) and rolled into a roll (fig. 1b). The hemostat is attached to the form tube (fig. 1c). The Penrose tubing is rolled onto the end of the form tube and the hemostat is removed (fig. 1d). If the edges of the Penrose tubing are uneven, they should be trimmed with a scalpel or razor blade.

The balloon is made from an ordinary rubber condom. A round hole 1/4 inch (0.65 cm.) in diameter is cut in the end of the condom (fig. 1e), which is then placed on the form tube. The hole is spread by

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retracting the condom laterally with the fingers (fig. 1f). Care should be taken to prevent the condom from tearing while it is being placed on the form tube (fig. 1g). The form tube with the Penrose tubing upon it is carefully introduced into the hole in the condom. The condom is

![Diagram of the inflatable cuff process]

Fig. 1. Steps used in making the inflatable cuff described in text.

pulled halfway up onto the Penrose tubing (fig. 1g). A ring of commercial rubber cement ½ inch (1.3 cm.) wide is painted at one end of the Penrose tubing (fig. 1g). This is allowed to dry until it becomes tacky. The condom is drawn over this band of cement (fig. 1h). This must be done carefully because the condom may stick at undesired
points and may not be evenly cemented to the Penrose tubing. In the event that the condom does stick at an undesired point, it can be lifted up immediately but not if a few seconds are allowed to elapse or if pressure has been applied. After the condom has been placed properly, the edges of the condom are pressed down upon the cement (fig. 1h).

A piece of corresponding Penrose tubing ½ inch (1.3 cm.) long is rolled onto the form tube and past the cemented portion of the condom (fig. 1g, h and i). A ring of rubber cement is now placed on the condom where it is cemented to the Penrose tubing (fig. 1h and i). When the cement has become tacky, the small piece of Penrose tubing is unrolled onto the cement (fig. 1h and i). The cemented areas are compressed by digital pressure to insure total adherence of the cemented parts (fig. 1i). A small amount of talcum is dusted over the cemented area to prevent the other rubber parts from sticking to any wet cement that may be present.

The round end of an 8 F. urethral catheter is cut off at an angle of 60 degrees. One small hole is cut on each side of the catheter ½ inch (0.3 cm.) away from the bevel (fig. 1f).

The free end of the Penrose tubing is now folded back upon itself for ¾ inch (2 cm.) (fig. 1h). The surface of the folded section must be smoothed. The top ¾ inch layer of Penrose tubing is now rolled upon itself. A small hole, not greater than 1/16 inch (0.16 cm.) is cut in the single layer of Penrose tubing at the base of the rolled ring of ¾ inch (0.9 cm.) Penrose tubing (through which the catheter is introduced as in figure 1i). The beveled end of the cut catheter is now pulled through the hole for a distance of 1½ inches (3.8 cm.). It is important that the beveled end of the catheter be turned away from the form tube. This 1½ inches of catheter is now cemented to the Penrose tubing with a generous amount of cement (fig. 1i). A small section of ¼ inch Penrose tubing, about ½ inch (0.3 cm.) wide, is slipped over the end of the form and over the catheter (fig. 1i). This is cemented over the catheter close to the bevel to hold the catheter in place (fig. 1i). The purpose of this rubber band is to keep the catheter from slipping about after the cuff is finished. The areas of exposed wet cement about the rubber band should be dusted with talcum to prevent the balloon from sticking at undesired points.

A ¾ inch (2 cm.) band of rubber cement is painted around the Penrose tubing as shown in figure 1i and j. An excess of cement should be placed about the catheter. One jaw of an open hemostat is placed on each side of the catheter between the Penrose tubing and the form tube (fig. 1j). During this procedure, it is easy to puncture the Penrose tubing because it has been softened by the solvent in the rubber cement. The condom is now unrolled and is cut to a total length of 7 inches (18 cm.). When the rubber cement becomes tacky, the end of the condom is pulled over the form tube and molded by means of pleats to the cemented area. Small pleats are better than large ones because
a better seal is possible (fig. 1k). The pleated area is covered with rubber cement, which is worked down into the individual pleats. An excess of cement should be used around the upper border and catheter. As soon as the cement becomes tacky, the rolled Penrose tubing should be unrolled over the condom and the excess of cement should be removed. The hemostats are now closed (fig. 1k). Care should be taken not to pinch the catheter closed. The whole structure is now dusted with talcum. The balloon should be inflated but the rubber should not be stretched. This will loosen any portions of the balloon which may have become stuck at undesired points. If there is any tacky cement within the balloon, a small amount of talcum may be forced through the catheter. The talcum will adhere to the tacky cement.

The cuff should be permitted to dry undisturbed for twenty-four hours. At the end of this time, the cuff should be removed from the form. Certain definite steps must be taken to prevent damage to the cuff while it is being removed from the form tube. The hemostats should be unclamped and removed. All air should be removed from the balloon and the catheter should be clamped with a hemostat. If all the air is not out of the balloon, the balloon will burst as the cuff is removed from the form. The cuff should be rolled upon itself; one should start at the end opposite the catheter (fig. 1l) and roll the cuff off the form tube (fig. 1m). The catheter should be uncoiled from around the cuff and the cuff should be unrolled (fig. 1n, o, p).

There are some cardinal points to remember when making the rubber cuffs. The rubber solvent in rubber cement temporarily softens rubber which it comes in contact with. Thin rubber parts can best be cemented together if they are partly stretched. For example, the cuff which has been described is manufactured upon a larger form tube than the intratracheal tube the cuff is to fit. Rubber parts should be fitted prior to cementing. The rolling technic which has been described is important. Tackiness caused by an excess of cement can be eliminated by dusting with talcum.

The method of putting the intratracheal cuff on an intratracheal tube is as follows. A large smooth forceps is passed through the lumen of the cuff, toward the catheter end of the cuff. The cuff is dusted lightly with talcum, both inside and out. With the tips of the forceps, which just extend beyond the lumen of the cuff, grasp the beveled end of an intratracheal tube. The air must be completely exhausted from the cuff before the cuff is rolled onto the intratracheal tube. The cuff should be rolled onto the intratracheal tube 1 inch (2.5 cm.) further than the total length of the cuff. This rolling of the cuff onto the intratracheal tube causes several rolls of the catheter about the cuff. It will be necessary to unroll the catheter before the cuff is unrolled on the intratracheal tube. In doing this the cuff is elevated by placing the jaws of a hemostat between the cuff and the intratracheal tube and spreading the jaws (fig. 1o). This makes possible the un-
coiling of the catheter. Once the catheter is free, the cuff is unrolled toward the beveled end of the intratracheal tube. The balloon is tested by keeping it inflated a number of hours.

Sterilization is carried out by immersing the tube in a 1:1,000 aqueous solution of zephiran chloride for at least forty-five minutes. The tube then should be washed in sterile water. The cuff should be inflated and allowed to dry. The dry tube is then ready either for storage or use.

The tube should be lubricated with surfacaine cream [0.5 per cent of 3- (2-methylpiperidino)-propyl-para-cyclohexyloxy benzoate hydrochloride in polyethylene glycols and propylene glycol base]. This cream holds the folds of the balloon together and facilitates intubation. Petrolatum and similar substances have proved unsatisfactory because they attack the rubber. Jellies made of tragacanth are not sufficiently adhesive for this purpose. When such preparations are used, the folds of the cuff will tend to obstruct the physician’s vision.

The cuff is inflated after the tube has been introduced. The pressure is constantly maintained and recorded by a water manometer. This manometer can be made by a glass blower.* The manometer is constructed so that the highest possible pressure is 25 cm. of water. The average pressure within the balloon is maintained at from 6 to 10 cm. of water throughout the operation. Grimm and Knight suggested the use of a pressure of 15 to 18 cm. of water and the release of this pressure for one minute every fifteen minutes. We have not found this high pressure necessary and it has not been necessary to release the pressure which we have used. Since venous capillary pressure is 12 cm. of mercury (4), it was felt that a pressure of 6 to 10 cm. of water would not obstruct the circulation in the laryngeal mucosa.

**REFERENCES**


* If the services of a glass blower are not readily available, a satisfactory manometer can be made out of two small rubber-stoppered bottles and some glass tubing.