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## Anterior Laryngotracheoplasty Using Costal Cartilage Graft (Single Stage)



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## Disposable Items You Will Need

### MEDICATIONS

- Akmezine
- Normal saline bag (3)

### SHARPS

- 16- or 18-Gauge angiocatheter (1)
- 25-Gauge Butterfly needle (1)
- 27-Gauge angiocatheter (1)
- 2-0 Silk suture (7)
- 3-0 Polyglactin (Vicryl) suture (5)
- 4-0 or 5-0 Polydioxanone (PDS)  
OR Polypropylene (Prolene) suture on  
RB-1 tapered needle (8)
- 4-0 Poliglecaprone (Monocryl) suture on  
P-3 reverse cutting needle (2)
- #15 Blade (1)
- #10 Blade (1)

### OTHER

- 10 mL syringe (1)
- Intravenous tubing (1)
- 6.0 or 6.5 Cuffed endotracheal tube (1)
- Gloves (2 pairs)
- Strip of material (30 cm)
- Absorbent pad (1)
- Rope (180 cm)
- Marking pen (1)
- Ruler (1)
- Green towel (8)
- Penrose drain (2)

### OPTIONAL

- None

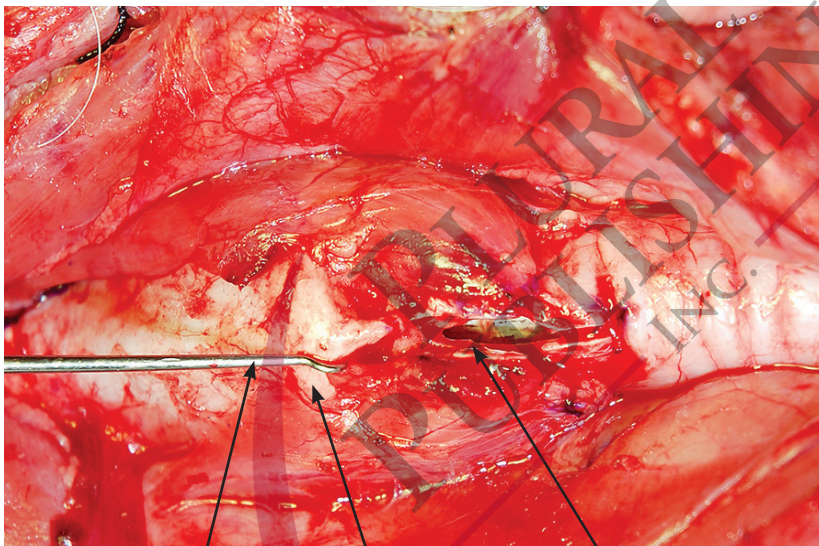
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Follow the steps outlined in “Exposure and Anatomy of the Pig Airway: Comparison with the Human Airway,” “Anterior Cricoid Split,” and “Harvest of Costal Cartilage Graft” prior to performing this procedure.

**KEY POINTS**  
Extend the anterior cricoid split inferiorly  
Measure the length of the defect

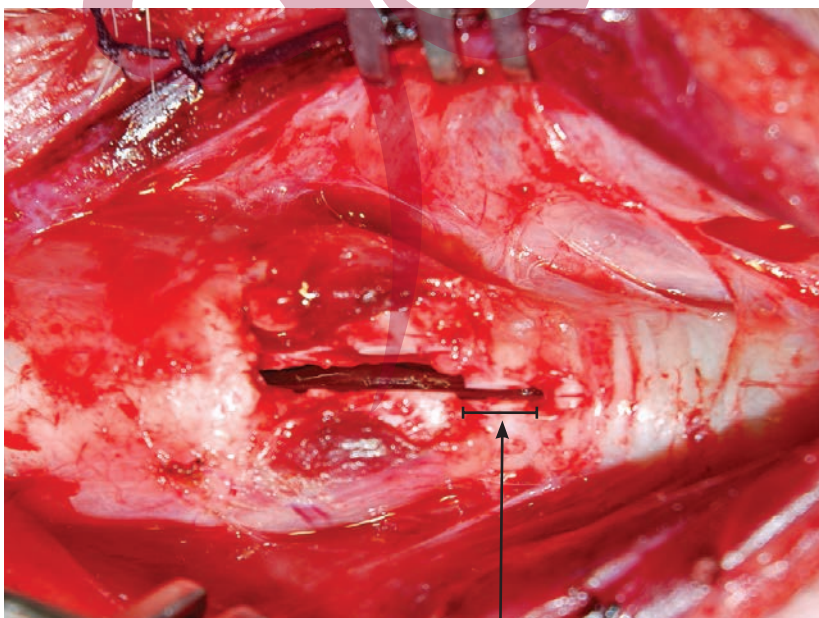
**Step 1** Extend the anterior cricoid split inferiorly by dividing an additional one to two tracheal rings inferiorly in the midline. This will allow you to practice suturing a graft into a larger defect.

**Anterior Cricoid Split**



**Cricoid hook    Thyroid cartilage    Divided cricoid**

**Extended Anterior Cricoid Split**



**Additional tracheal rings divided**

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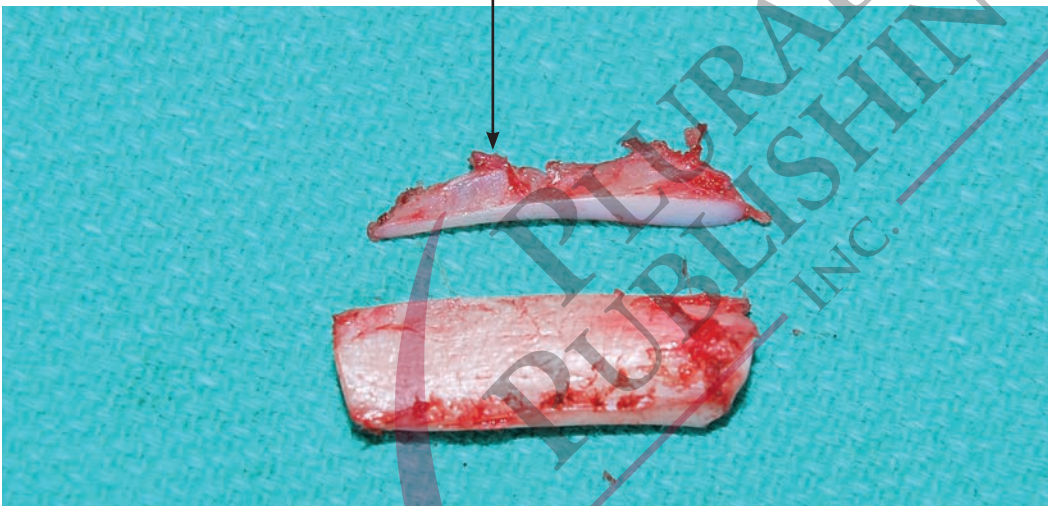
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- Step 2** Use a caliper or ruler to measure the length of the defect and write this number down.
- Step 3** *The rib in the pig is much thinner superiorly than it is in humans.* Cut off the thin superior edge of the graft to make it easier to carve flanges.

### KEY POINTS

Cut off thin edge of graft in pig

Cut thin superior edge



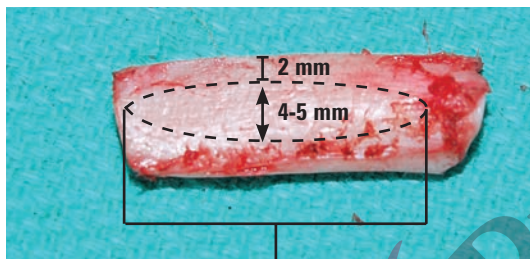
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**Step 4** Use a marking pen to draw an ellipse on the anterior surface of the graft that still has perichondrium on it. The length should match the measured length of the extended anterior cricoid split. The width should be as large as possible while allowing flanges to be carved, which in the pig is approximately 4 to 5 mm (5–6 mm in humans). The flanges around the edges will be approximately 2 mm wide. Draw a line on the side of the graft denoting half the thickness of the graft.

## KEY POINTS

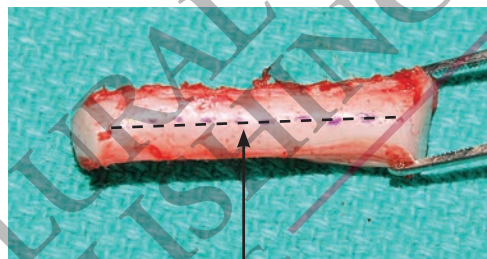
- Draw ellipse
- Balance between large width for maximal distraction and wide flanges
- Draw line denoting half the thickness
- Incise along side of graft
- Incise around ellipse

**Anterior Surface of Rib Graft**



Length of extended anterior cricoid split

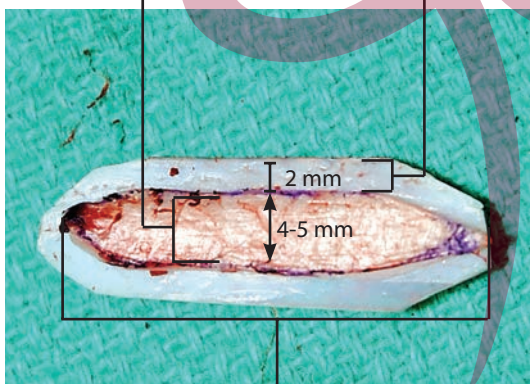
**Side of Rib Graft**



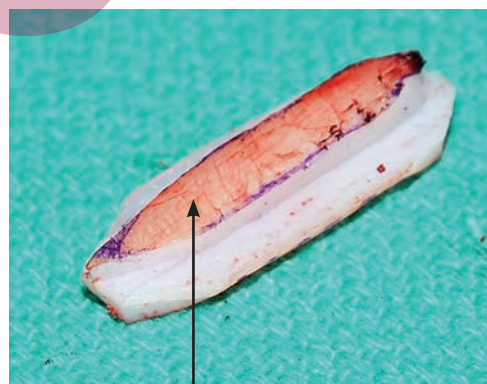
Line denoting half of the thickness

**Step 5** Use a #10 scalpel to incise along the line denoting half the thickness of the graft to a depth of 2 mm. Repeat on the other side of the rib graft. Incise along the marked ellipse on the anterior surface of the rib graft down to the level of the lateral cuts.

Amount of distraction      Width of flange



Length of graft



Perichondrium

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**Step 6** Suture the graft into the defect using either 4-0 or 5-0 sutures made of polydioxanone (PDS) or Prolene. The benefit of the 4-0 suture is that it is less likely to break. Benefits of the PDS suture are that it has a bit of stretch to it that decreases the likelihood it will break when tying knots, and that it eventually resorbs after several months. The graft can be sutured with horizontal mattress sutures or simple interrupted sutures. We describe here the horizontal mattress suture technique.

- Pass the needle through the tracheal cartilage from outside to inside, coming out submucosally on the luminal side.
- Pass the suture through the right angle formed by the flange and the graft.
- Exit through the midline of the graft.
- Pass the suture back through the graft and exit through the right angle formed by the flange and the graft.
- Enter the tracheal cartilage submucosally passing from medial to lateral.

Snap the suture ends together. Try to make these suture ends equal in length by adjusting the suture length after each pass through cartilage rather than after passing through all of the cartilages. Pulling the suture through after passing through all cartilages risks tearing the cartilage.

### KEY POINTS

Suture the graft using 4-0 or 5-0 sutures

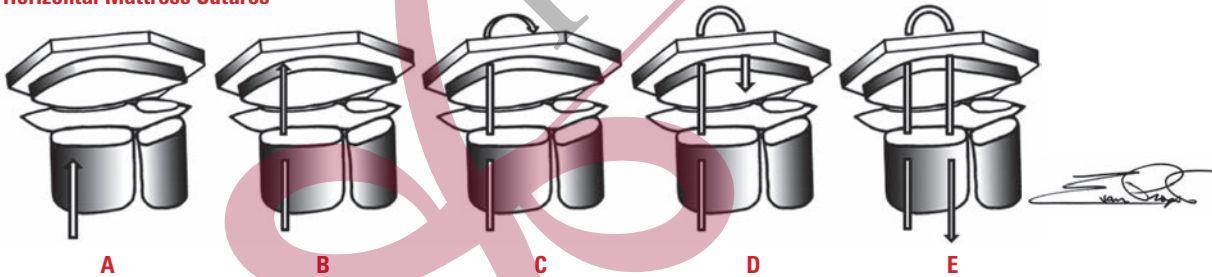
Horizontal mattress or simple interrupted sutures

Sutures pass through luminal side submucosally

Sutures pass through right angle formed by graft and flange

Pull suture through after each pass through cartilage

### Horizontal Mattress Sutures



Proponents of horizontal mattress sutures believe that placing the suture knots laterally allows for the strap muscles to directly contact the new graft anteriorly for better revascularization. If you do not believe this theory, then you may use simple interrupted sutures to suture the graft in place.

Try to minimize the number of needle passes through the cartilage because each needle pass injures the chondrocytes in the graft. Each suture is pulled through until the two suture ends are even and a snap is placed to keep them together (tying the knots as you go makes it difficult to place additional sutures).

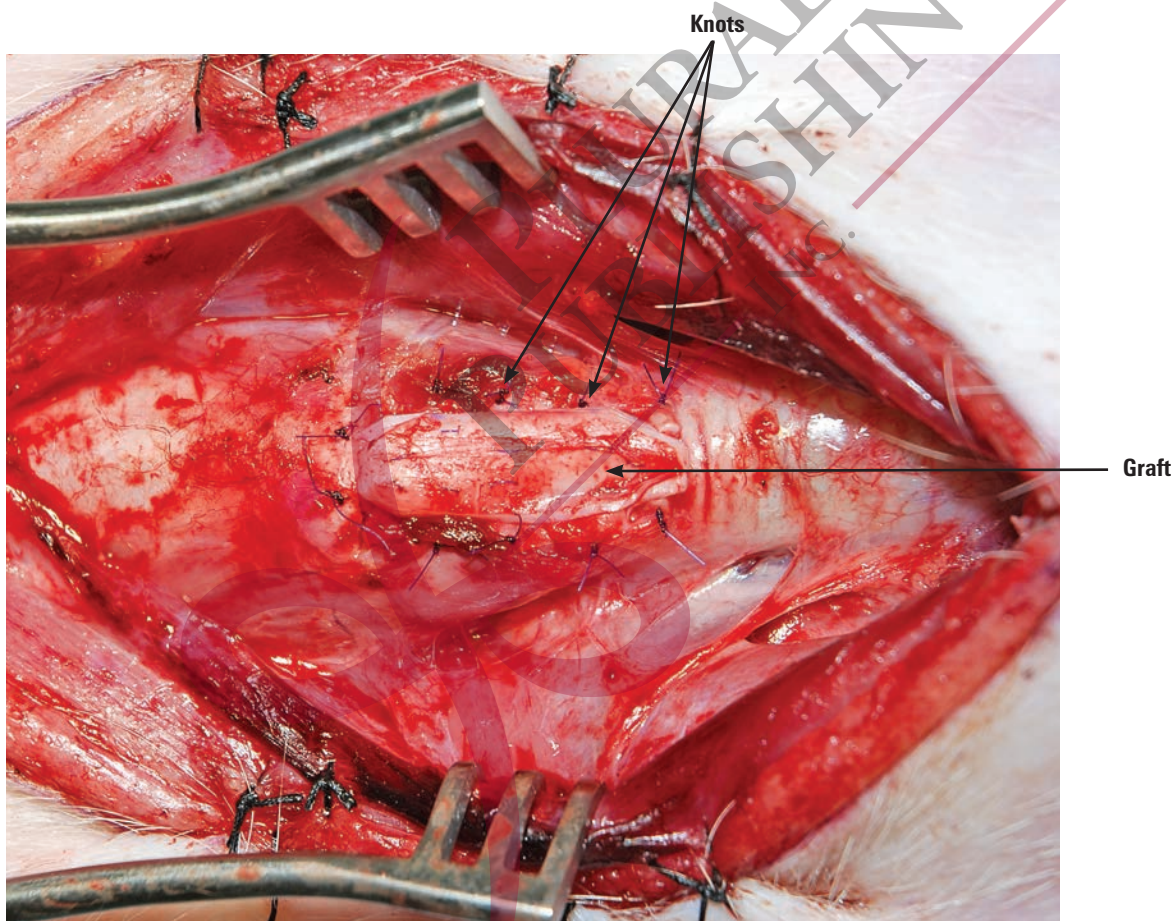
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- Step 7** Place sutures along both sides of the graft as well as superiorly and inferiorly to prevent an air leak. It is important to prevent an air leak in single-stage procedures. In double-stage procedures, the air is more likely to leak around the tracheotomy tube than above it through a gap in the reconstructed airway.
- Step 8** Arrange the “snapped” ends of the sutures neatly from superiorly to inferiorly. As one surgeon tightens each set of sutures from superiorly to inferiorly, the other surgeon allows the graft to “parachute” down into the defect. Tie the sutures with five to six knots.

### KEY POINTS

- Place sutures laterally, superiorly and inferiorly
- Parachute the graft down and tie each suture pair with 5 to 6 knots
- Check for air leak



- Step 9** Fill the wound with saline and perform a Valsalva maneuver to check for an air leak (demonstrated by bubbles in the saline). If a leak is present, additional simple interrupted sutures can be placed. *In humans, tissue glue can be used around the edges of the wound. However, we do not recommend wasting tissue glue while practicing on this porcine model.* If there is no leak, suture the muscles closed using 3-0 Vicryl sutures and the skin with a 4-0 running Monocryl suture. Suture a Penrose drain in the lateral corner of the wound with a 2-0 silk suture.

