TRACHEOSTOMY MANAGEMENT

From device selection to definitive hemorrhage control

Paul Wisniewski, DO

CEO, Cutting Edge Surgical Medical Group

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Disclosures and learning objectives

DISCLOSURE

I have no disclosures.

IDENTIFY AND DIAGNOSE

Identify tube types and recognize obstruction, malposition, cuff failure and bleeding.

ACT

Select troubleshooting techniques and execute anatomy-specific rescue maneuvers.

The clinical sequence

DEVICE → PROCEDURE

What is the tube? How is it selected and placed?

DYSFUNCTION → RESCUE

Why is ventilation failing? Which airway route remains usable?

REHABILITATION → SPECIAL ANATOMY → BLEEDING

Speaking valves, total laryngectomy, and definitive hemorrhage control.

Each decision depends on anatomy, physiology and time since placement.

A tube is a temporary interface with a surgical airway



Manufacturer photography: Medtronic, Shiley Flex. Left 4UN65A; right 4CN65A.

PROXIMAL

Connector, flange and inner cannula determine circuit compatibility and cleaning.

DISTAL

Shaft curvature, length and cuff determine fit and seal.

REMOVABLE

The obturator guides insertion; remove it before ventilation.

(Hess & Altobelli, 2014; Medtronic; ICU Medical, device specifications)

Classify the tube before touching it

Design	Clinical purpose	Important limitation
Cuffed	Positive-pressure seal	Does not eliminate aspiration
Cuffless	Selected spontaneous breathing	No reliable cuff seal for ventilation
Fenestrated	Upper-airway airflow in selected use	Granulation / false tract / cuff interactions
Extended length	Deep neck or distal pathology	Proximal and distal extension differ
Adjustable flange	Individualize insertion depth	Secure lock; verify temporary-use IFU

Record manufacturer, exact model, dimensions, cuff medium and inner cannula.

(Hess & Altobelli, 2014; Medtronic; ICU Medical, device specifications)

Nominal size is not the internal diameter

Shiley Flex model	Nominal size	Tube ID	With inner cannula	OD / length
4CN65R	4	6.5 mm	5.5 mm	9.4 / 62 mm
6CN75R	6	7.5 mm	6.5 mm	10.8 / 74 mm
8CN85R	8	8.5 mm	7.5 mm	12.2 / 79 mm

Choose by ID, OD, length and curvature—not the number printed on the flange.

(Medtronic, Shiley Flex adult specification table; Hess & Altobelli, 2014)

Shiley 4, 6 and 8: the model matters

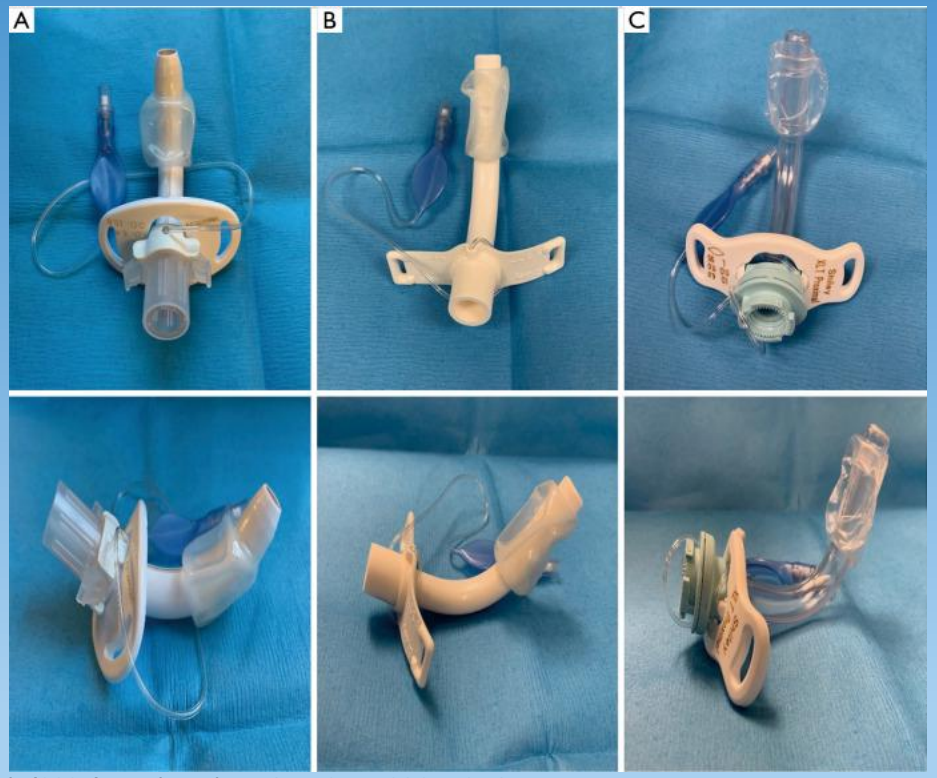


Figure 4, Ghattas et al. (2021), unaltered. A: 6PERC; B: 8SCT; C: 6XLT.

SIZE 4

Flex 4CN65A / 4UN65A shown on the device-anatomy slide.

SIZE 6

Published photograph: 6PERC, ID 6.4 mm; OD 10.8 mm; length 74 mm.

SIZE 8

Published photograph: 8SCT, ID 8.0 mm; OD 10.9 mm; length 89 mm.

(Ghattas et al., 2021, Figure 4; Medtronic)

Shiley versus Bivona: compare designs, not brand names

Feature	Shiley adult examples	Bivona adult examples
Material	Many PVC-based designs	Silicone-based designs
Lumen	Inner cannula on many models	Often single lumen; model dependent
Cuff	Typically air-filled	Aire-Cuf air; TTS sterile water per IFU
Size	Nominal number may differ from ID	Nominal often tracks ID in mm
Geometry	Standard; proximal / distal XLT	Fixed or adjustable flange / reinforced

(Hess & Altobelli, 2014; Medtronic; ICU Medical, device specifications)

Deep neck: reinforced Bivona with adjustable flange



ICU Medical manufacturer photo: adult Aire-Cuf adjustable-neck-flange Hyperflex.

DEPTH

Extra proximal length bridges thick pretracheal soft tissue.

REINFORCEMENT

Wire-reinforced Hyperflex shaft resists kinking; verify model MRI labeling.

FLANGE

The flange slides along the shaft; lock and verify depth endoscopically.

The flange is adjustable; the tube does not telescope.

(ICU Medical, Aire-Cuf Hyperflex IFU; El Solh & Jaafar, 2007)

Cuff management is a diagnostic skill

ROUTINE AIR CUFF

Measure pressure; commonly target 20–30 cm H_2O and reassess after position changes.

PERSISTENT LEAK

Consider cuff failure, undersizing, shallow placement, tracheal dilation or high airway pressure.

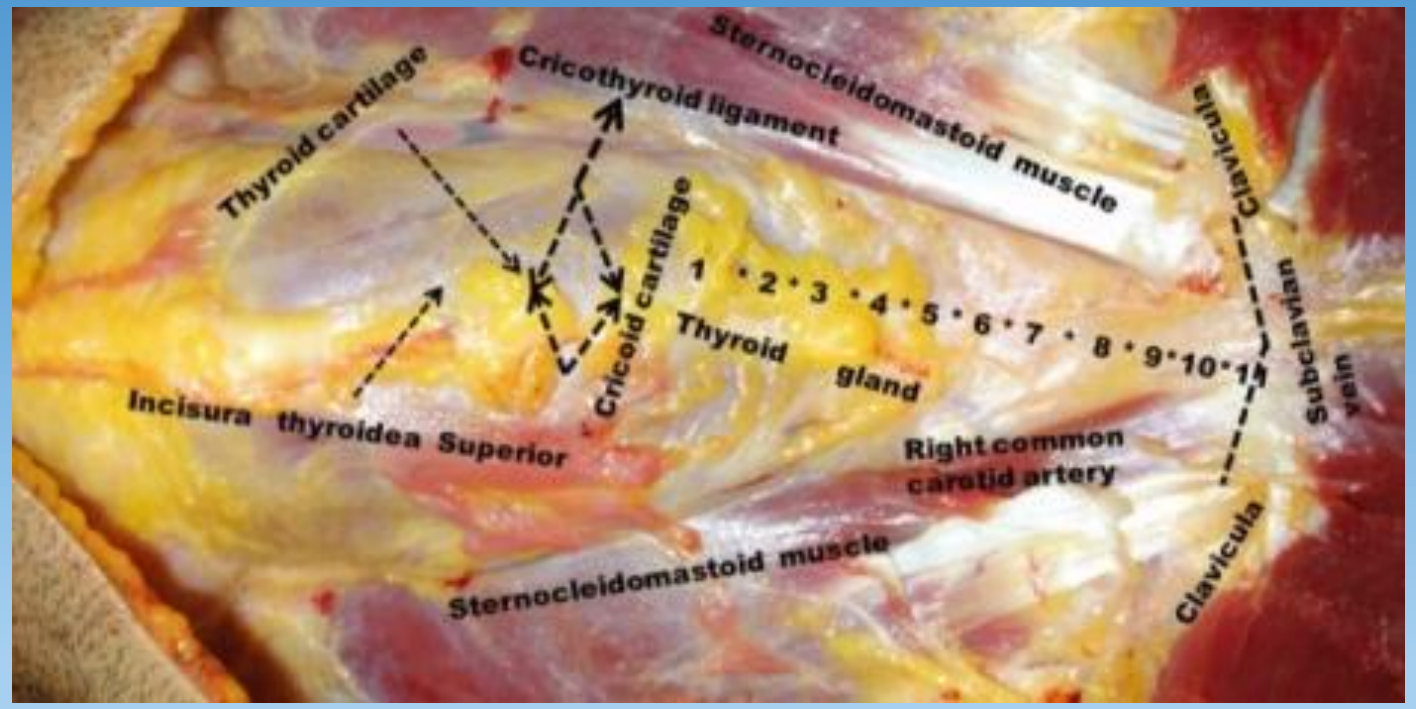
ESCALATING VOLUME

Inspect position and cuff integrity before repeatedly adding air.

A normal cuff pressure does not prove correct tube position.

(Lewith & Athanassoglou, 2019; Hess & Altobelli, 2014)

The anterior neck defines the operation



Cadaveric neck dissection: Gulsen et al., Figure 2; © Korean Neurosurgical Society.

IDENTIFY

Larynx, cricoid, tracheal rings and pretracheal depth.

PROTECT

Thyroid vessels, posterior membranous wall and adjacent esophagus.

PLAN

Avoid high cricoid injury and excessively low vascular exposure.

(Gulsen et al., 2010, Figure 2; Cipriano et al., 2015)

Choose an approach the team can rescue

OPEN IS ATTRACTIVE

Distorted anatomy, difficult landmarks, need for controlled exposure or surgical hemostasis.

PERCUTANEOUS IS ATTRACTIVE

Selected intubated ICU patient, favorable anatomy and experienced bedside team.

EITHER NEEDS A BACKUP

Equipment, skilled airway operator, bleeding plan and explicit conversion trigger.

(Brass et al., 2016; Ghattas et al., 2021; Mitchell et al., 2013)

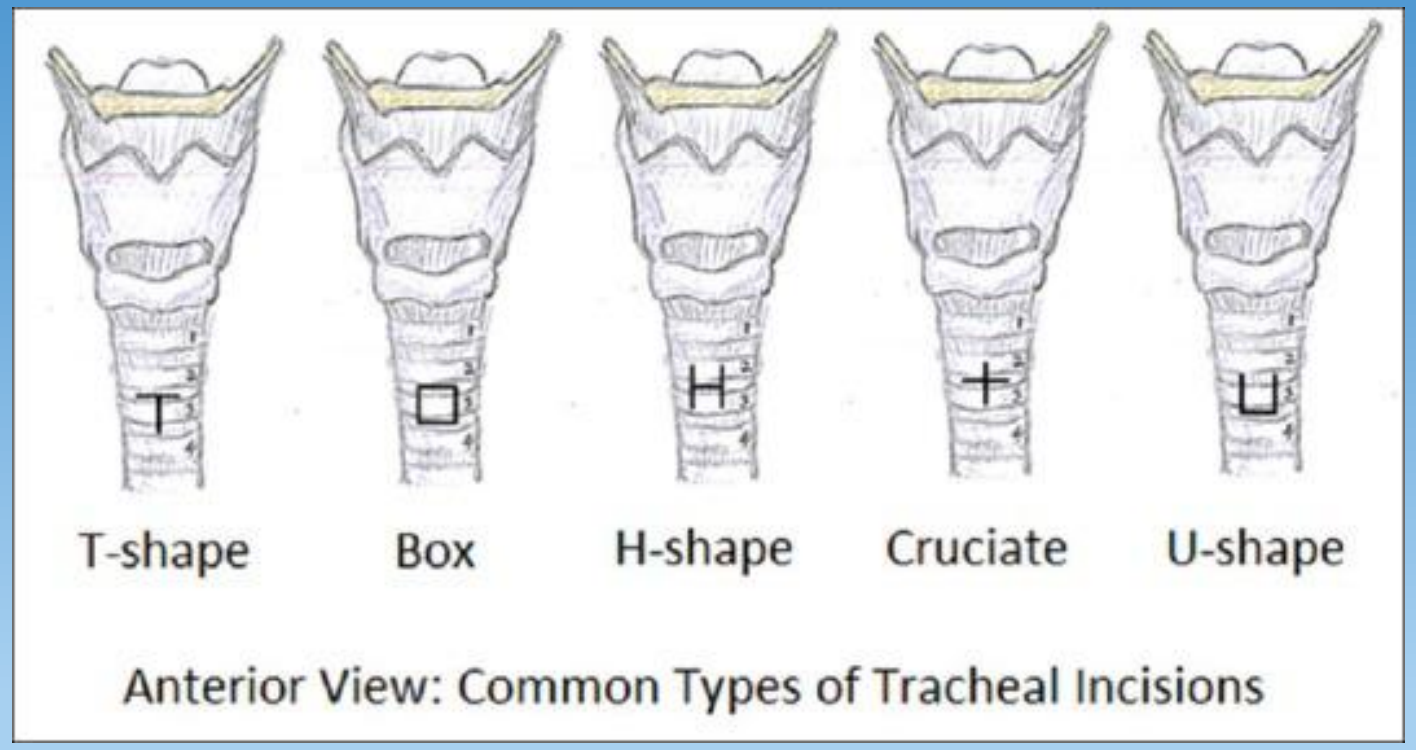
What the comparative literature supports

Evidence	Finding	Interpretation
Cochrane 2016 20 studies; 1,652 adults	Fewer wound infections with PDT	No established mortality advantage
Putensen 2014 14 RCTs; 973 adults	Infection OR 0.22; technical difficulty OR 4.58	Efficiency trades against technical challenge
Delaney 2006 17 RCTs; 1,212 adults	Wound infection OR 0.28 (0.16–0.49)	Predominantly selected ICU populations

Technique selection is an anatomy-and-expertise decision; mortality superiority is unproven.

(Brass et al., 2016; Putensen et al., 2014; Delaney et al., 2006)

Tracheal entry: deliberate level, controlled incision



Tracheal-entry techniques: Cipriano et al., Figure 1. CC BY-NC-SA 3.0.

LEVEL

Commonly the second–third ring region; account for patient anatomy.

DESIGN

Vertical slit, window or flap reflects surgeon preference and context.

CONTROL

Preserve cartilage and avoid posterior membranous injury.

(Toker et al., 2020, Figure 2; Cipriano et al., 2015)

Open pitfalls: recognize the mechanism early

BLEEDING OBSCURES THE FIELD

Control vessels under exposure; avoid a blind, deep dissection through blood.

LOSS OF THE ORAL AIRWAY

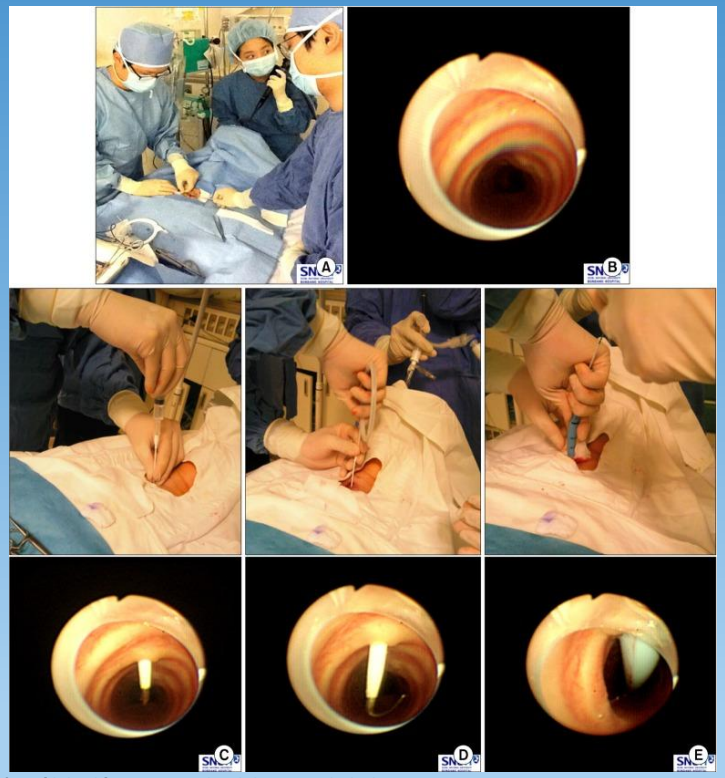
Stop; restore ETT ventilation before proceeding when possible.

DIFFICULT TUBE PASSAGE

Reassess trajectory, opening, tube length and soft-tissue depth; do not force.

(Cipriano et al., 2015; Toker et al., 2020; Iowa protocols)

Percutaneous placement: a controlled Seldinger sequence



Original clinical photographs: Cho (2012), Figure 9. CC BY-NC 3.0.

ACCESS

Map vessels and rings; stabilize trachea; withdraw ETT above entry.

WIRE

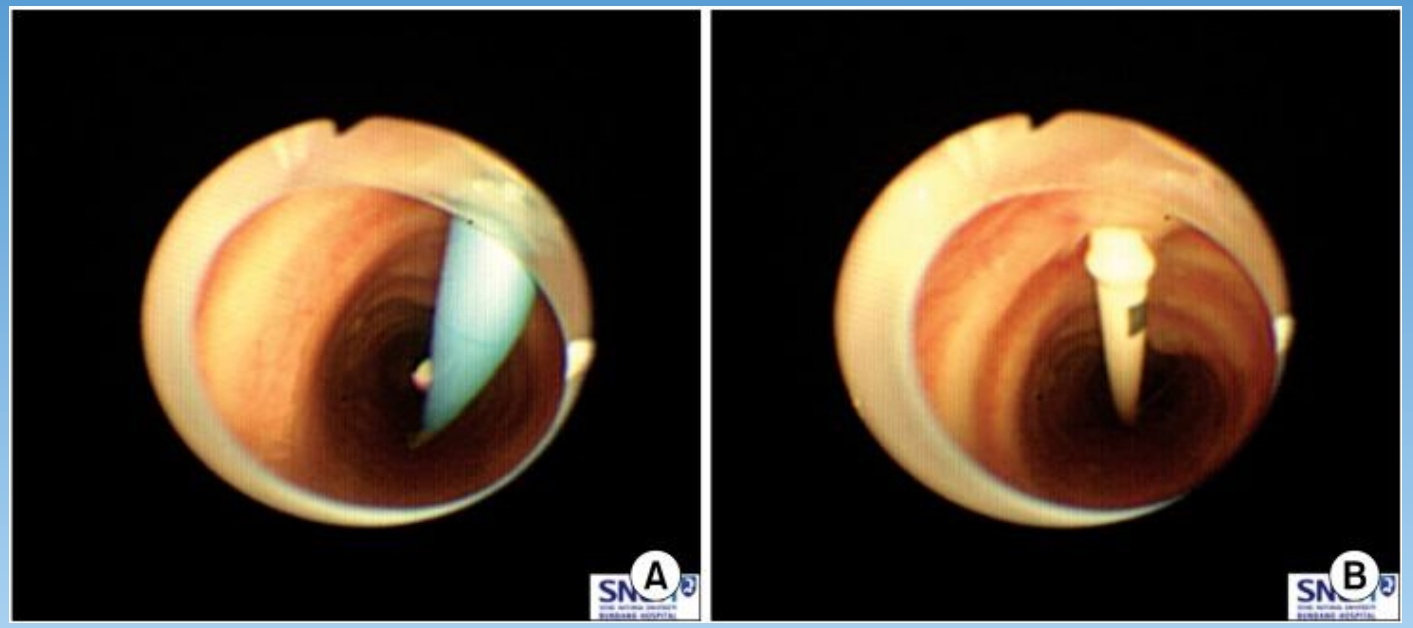
Visualize needle and wire entering the lumen; maintain wire control.

DILATION

Dilate along the tract, then insert the loaded tube without excessive force.

(Cho, 2012, Figure 9; Ghattas et al., 2021)

Dilation: the wire is a guide, not an anchor



Bronchoscopic dilation views: Cho (2012), Figure 10. CC BY-NC 3.0.

STABILIZE

Maintain midline and countertraction without displacing the trachea.

WATCH

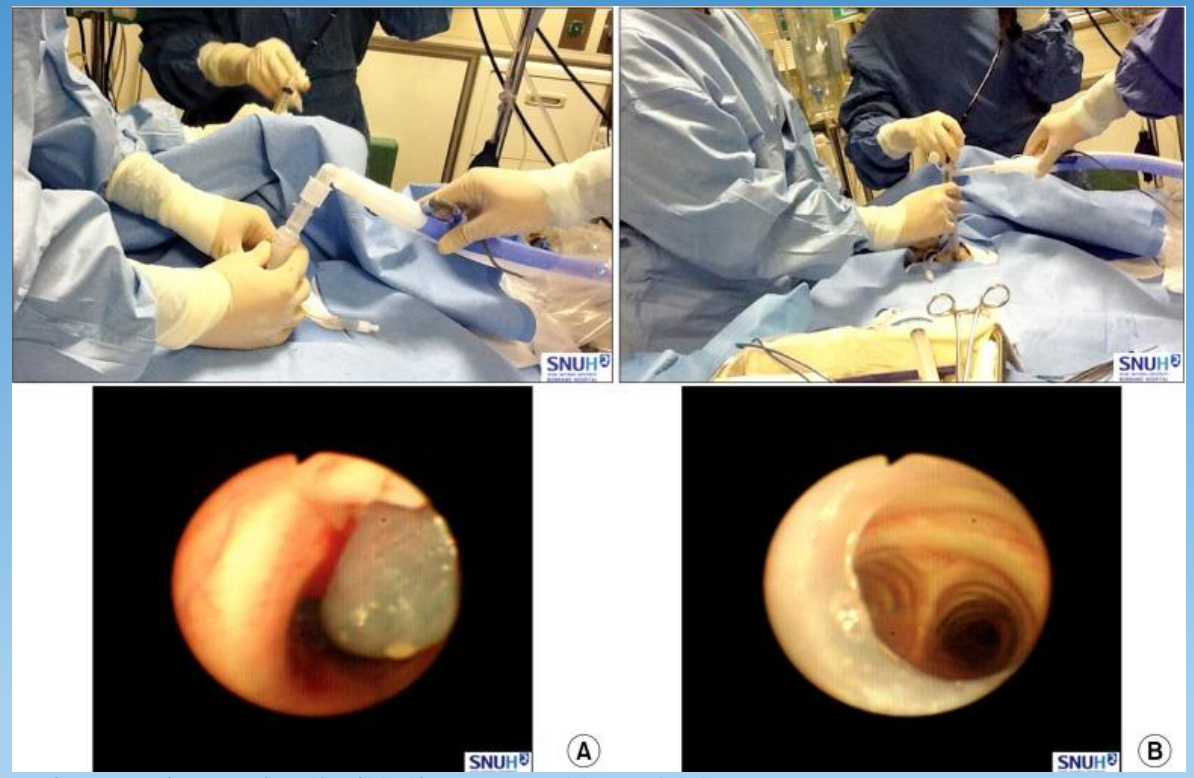
Posterior-wall contact, wire kinking and loss of luminal access.

STOP

If the tract or guidewire is uncertain, recover ventilation and reassess.

(Cho, 2012, Figure 10; Rashid & Islam, 2017)

Verify from above and through the new tube



Original bronchoscopic photographs: Cho (2012), Figure 11. CC BY-NC 3.0.

PROXIMAL VIEW

Confirm cuff and tube are within the trachea.

DISTAL VIEW

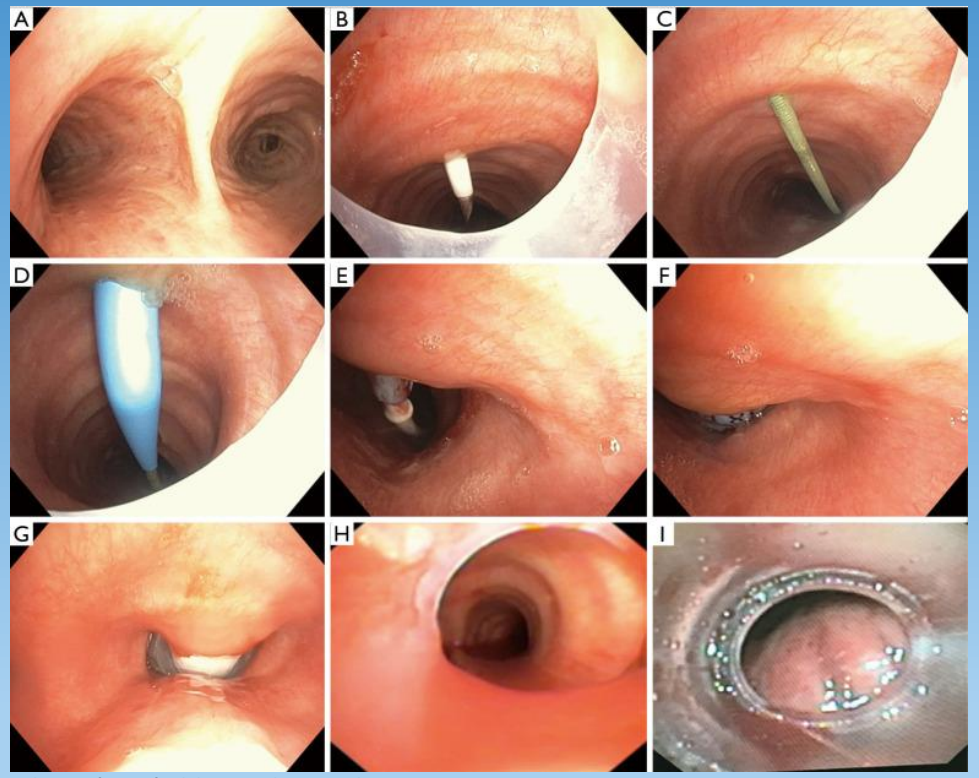
Inspect tip, posterior-wall relationship, carina and blood/secretions.

PHYSIOLOGY

Require sustained exhaled CO_2 and effective ventilation.

(Cho, 2012, Figure 11; Lewith & Athanassoglou, 2019)

Nine endoscopic checkpoints during percutaneous placement



Ghattas et al., Figure 8, unaltered. CC BY-NC-ND 4.0.

A–C: ACCESS

Orient the carina; visualize anterior needle entry and intraluminal wire.

D–H: PLACEMENT

Observe dilation, guide assembly, cuff and coaxial tube tip.

I: PITFALL

Posterior-wall-facing tip can cause intermittent obstruction.

(Ghattas et al., 2021, Figure 8)

Bronchoscopy guidance: the 2026 evidence update

SEVEN RANDOMIZED TRIALS; 639 PATIENTS

Bleeding RR 0.57 (95% CI 0.37–0.88).

PLACEMENT AND INJURY

Misplacement RR 0.17 (0.06–0.49); posterior-wall injury RR 0.08 (0.02–0.32).

LIMITS

Moderate certainty for these events; selected populations and heterogeneous techniques.

Guidance improves procedural information; it does not eliminate procedural risk.

(Dong, Guan & Zhu, 2026)

PDT pitfalls: separate access, ventilation and hemorrhage

ACCESS FAILURE

Wrong ring, off-midline puncture, posterior-wall injury, wire loss or false passage.

VENTILATION FAILURE

ETT cuff puncture, excessive withdrawal, scope obstruction or inadvertent extubation.

HEMORRHAGE

Compress/control promptly; convert when visualization or hemostasis is inadequate.

(Ghattas et al., 2021; Rashid & Islam, 2017; Cipriano et al., 2015)

Antithrombotics: a risk tradeoff before placement

DUAL ANTIPLATELET THERAPY

PDT bleeding OR 2.05 (95% CI 1.18–3.56) in a 2025 meta-analysis.

UNCERTAINTY

Single-agent and therapeutic-anticoagulation estimates were imprecise; study quality poor.

DECISION

Individualize holding/reversal against stent, thrombotic and procedural urgency risks.

(Brown et al., 2025)

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A functioning tracheostomy can become an airway emergency

CLINICAL SIGNALS

Dyspnea, agitation, desaturation, rising CO_2, reduced chest rise or unexpected leak.

CIRCUIT SIGNALS

High pressure, low tidal volume, absent capnogram or inability to pass suction.

ANATOMICAL SIGNALS

Tube movement, new emphysema, stoma distortion or fresh bleeding.

(McGrath et al., 2012; NTSP, adult emergency guidance)

Pressure and flow guide the differential

Finding	Mechanism to consider	Useful next assessment
High peak; plateau similar	Resistance: tube/secretions/bronchospasm	Catheter, inner cannula, endoscopy
Peak and plateau elevated	Reduced compliance / severe lung process	Examination; imaging if stable
Low volume with leak	Cuff, connection or displacement	Circuit inspection; cuff and tip position
Absent CO_2 / poor chest rise	Disconnection, obstruction, displacement or low flow	Rapid bedside airway assessment

(Hess & Altobelli, 2014; Lewith & Athanassoglou, 2019)

First bedside actions: remove avoidable resistance

CALL AND OXYGENATE

Call experienced airway help; give oxygen to face and stoma while anatomy is clarified.

REMOVE ACCESSORIES

Remove speaking valve, cap, HME and suspect circuit components; remove inner cannula.

TEST PATENCY

Gently pass an appropriate suction catheter; suction accessible secretions.

A catheter that cannot pass is a warning; never force it.

(McGrath et al., 2012; NTSP, adult emergency guidance); (Blakeman et al., 2022)

If obstruction or displacement persists, remove the failed tube

CUFF DEFLATION

Deflate the cuff and reassess airflow around the tube and through the upper airway.

FAILED VENTILATION

If the tube remains blocked/displaced and the patient does not improve, remove it.

RE-OXYGENATE

Use face and/or stoma techniques based on anatomy; progress to definitive rescue.

Avoid repeated bagging through a tube whose position is uncertain.

(McGrath et al., 2012; NTSP, adult emergency guidance)

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A passable catheter does not exclude malposition

TIP ABUTMENT

A short or poorly curved tube can intermittently contact the posterior wall.

CUFF HERNIATION

A shallow cuff can partly obstruct the lumen or fail to seal.

DISTAL PROBLEM

Blood clot, mucus, stenosis or bronchial intubation can persist beyond the catheter.

(Lewith & Athanassoglou, 2019; Ghattas et al., 2021)

Fresh tract: recannulation can create a false passage

MATURITY IS VARIABLE

First-week tracts are usually high risk; age alone does not prove a mature tract.

DO NOT FORCE

Stop repeated blind attempts, particularly with a deep obese neck.

USE DIRECT INFORMATION

Skilled endoscopic or surgical guidance; immediately pursue another airway if failing.

(McGrath et al., 2012; Mitchell et al., 2013; El Solh & Jaafar, 2007)

Case: day 2 dislodgement after turning an obese patient

PRESENTATION

Low tidal volumes, absent CO_2, enlarging neck emphysema; catheter will not pass.

FIRST DECISION

Remove accessories/inner cannula, call help and oxygenate both routes.

CRITICAL PIVOT

Do not persist with blind reinsertion; remove the failed tube and restore another airway.

The objective is oxygenation—not replacing the same tube at any cost.

(McGrath et al., 2012; NTSP, adult emergency guidance)

The tracheostomy does not prohibit oral intubation

IDENTIFY CONTINUITY

Ordinary tracheostomy usually leaves larynx and trachea connected.

CHECK THE INDICATION

Upper-airway tumor, stenosis or prior difficult intubation may limit that route.

ACT EARLY

If recannulation fails and the upper airway is usable, intubate from above.

Total laryngectomy is the essential exception: the mouth cannot reach the lungs.

(McGrath et al., 2012; NTSP, adult emergency guidance); (Cook et al., 2011)

Temporize oxygenation while preparing the definitive airway

FACE ROUTE

If upper airway is patent, use jaw thrust and bag-mask ventilation; occlude a leaking stoma.

STOMA ROUTE

Use a small mask or suitable supraglottic interface over the neck opening.

CONFIRM EFFECT

Chest rise, oxygenation and waveform CO_2 guide effectiveness; avoid excessive pressure.

(McGrath et al., 2012; NTSP, adult emergency guidance)

Oral rescue: cuff beyond the stoma, tip above the carina

PREPARE

Use the appropriate difficult-airway strategy, skilled assistance and continuous oxygen delivery.

POSITION

Advance the oral ETT so its cuff seals distal to the tracheostomy opening.

VERIFY

Sustained waveform CO_2; confirm depth endoscopically when feasible and avoid mainstem placement.

Cuff-distal-to-stoma is a geometric goal; confirmation is essential.

(McGrath et al., 2012; NTSP, adult emergency guidance); (Lewith & Athanassiou, 2019)

Stomal intubation: short airway, substantial depth risk

SELECT

Skilled guided insertion through the stoma when that route is appropriate.

ADVANCE CAUTIOUSLY

A cuffed ETT can serve as a rescue tube; avoid oral-depth assumptions.

CONFIRM AND SECURE

Capnography plus endoscopic tip position; stabilize the tube against migration.

(McGrath et al., 2012; NTSP, adult emergency guidance)

After rescue: correct the cause before the next tube change

DEFINE

Obstruction, device mismatch, insecure fixation, tract disruption or airway pathology.

RESELECT

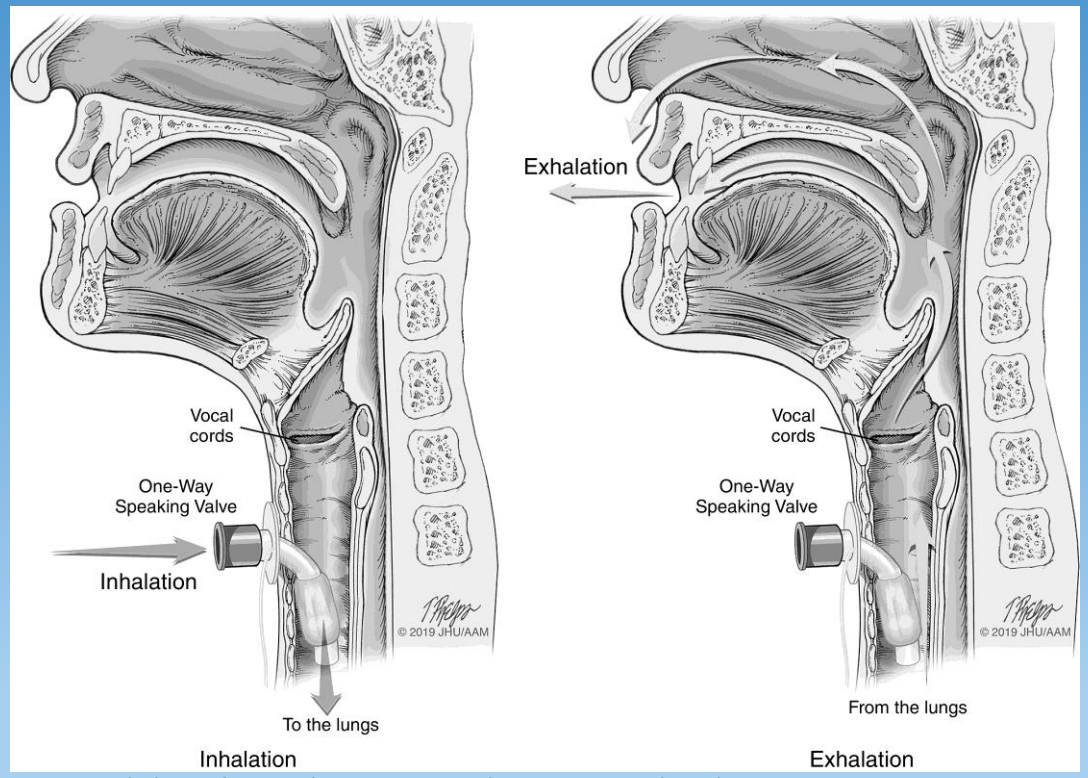
Choose geometry based on neck depth and endoscopic position in neutral posture.

HAND OVER

Document upper-airway accessibility, device details and the next emergency plan.

(Mussa et al., 2021; Mitchell et al., 2013; Hess & Altobelli, 2014)

Speaking valve: inspiration through the tube, expiration above it



Medical illustration: Tim Phelps, Johns Hopkins; Martin et al., Figure 1, unaltered.

ONE-WAY VALVE

Opens on inspiration and closes on expiration.

EXPIRATORY ROUTE

Flow passes around the fully deflated cuff toward the larynx.

PREREQUISITE

A patent upper airway and sufficient space around the tube.

Never place a speaking valve on an inflated cuff.

(Martin et al., 2021, Figure 1; Hess & Altobelli, 2014)

PMV readiness: evaluate a physiological pathway

BEFORE TRIAL

Assess consciousness, secretion handling, respiratory stability and upper-airway patency.

PREPARE

Fully deflate cuff; clear secretions; confirm tube size permits expiratory airflow.

MONITOR

Observe effort, voice, respiratory rate, oxygenation and CO_2; remove valve for distress.

(Mussa et al., 2021; Martin et al., 2021; Johnson et al., 2009)

Speaking-valve intolerance: localize the expiratory resistance

Mechanism	Evidence to seek	Response
Cuff not fully deflated	Pilot balloon / cuff check	Remove valve immediately; fully deflate
Tube OD too large	Little expiratory airflow around tube	Reassess geometry; consider downsizing
Upper-airway obstruction	Stridor, edema, stenosis or immobile cords	Endoscopic assessment
Secretions / limited reserve	Cough burden, effort, gas exchange	Treat cause; shorten / defer trial

(Hess & Altobelli, 2014; Johnson et al., 2009)

Earlier speaking valves: feasibility is not universal safety

RANDOMIZED FEASIBILITY TRIAL

20 selected patients after percutaneous tracheostomy.

SEPARATION ACHIEVED

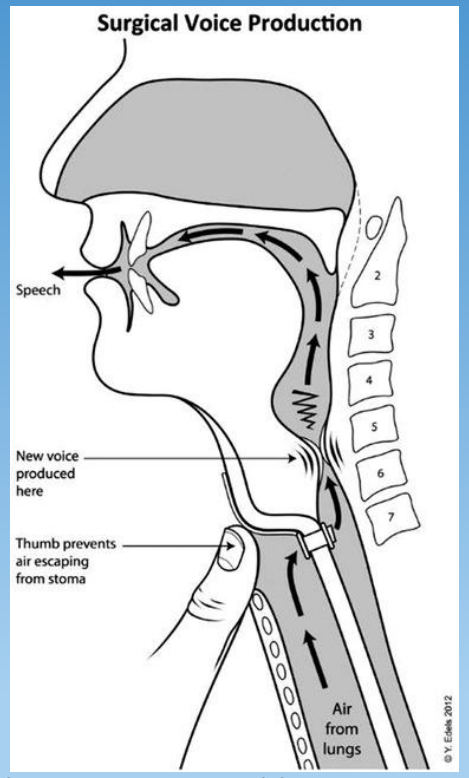
Median first placement: 22 hours versus 45.5 hours.

INTERPRETATION

No valve-related aspiration/hypoxemia safety events observed; insufficient size for rare harm.

(Martin et al., 2021)

Total laryngectomy: the airway is permanently disconnected



Published anatomical figure: Govender et al., Fig. 1; courtesy Y. Edels.

ANATOMY

The trachea terminates at the neck stoma; the larynx has been removed.

CONSEQUENCE

Oral or nasal oxygen cannot reach the lungs.

RESCUE

Oxygenate, ventilate and intubate through the stoma.

A total laryngectomy patient is a neck-only breather.

(McGrath et al., 2012; NTSP, adult emergency guidance); (Govender et al., 2021, Figure 1)

Laryngectomy obstruction: treat the stoma as the airway

EXPOSE AND CLEAR

Remove HME and removable stoma attachments; assess patency and suction gently.

VENTILATE THE NECK

Small mask over stoma; proceed to guided cuffed ETT if required.

PROTECT ANATOMY

Do not remove a tracheoesophageal voice prosthesis as if it were an inner cannula.

(McGrath et al., 2012; NTSP, adult emergency guidance)

Case: “trach patient” with failed oral intubation

CLUE

Permanent stoma, no upper-airway airflow, history of laryngeal cancer surgery.

DIAGNOSIS

Total laryngectomy: an oral ETT can enter the pharynx without reaching the trachea.

ACTION

Stop relying on facial ventilation; clear, ventilate and intubate the stoma.

(McGrath et al., 2012; NTSP, adult emergency guidance)

Bleeding: severity and source drive the response

SUPERFICIAL POSSIBILITY

Skin edge, venous oozing, granulation or suction trauma after assessment.

HIGH-RISK PATTERN

Recurrent unexplained bleeding, brisk bright blood, pulsatility or intraluminal hemorrhage.

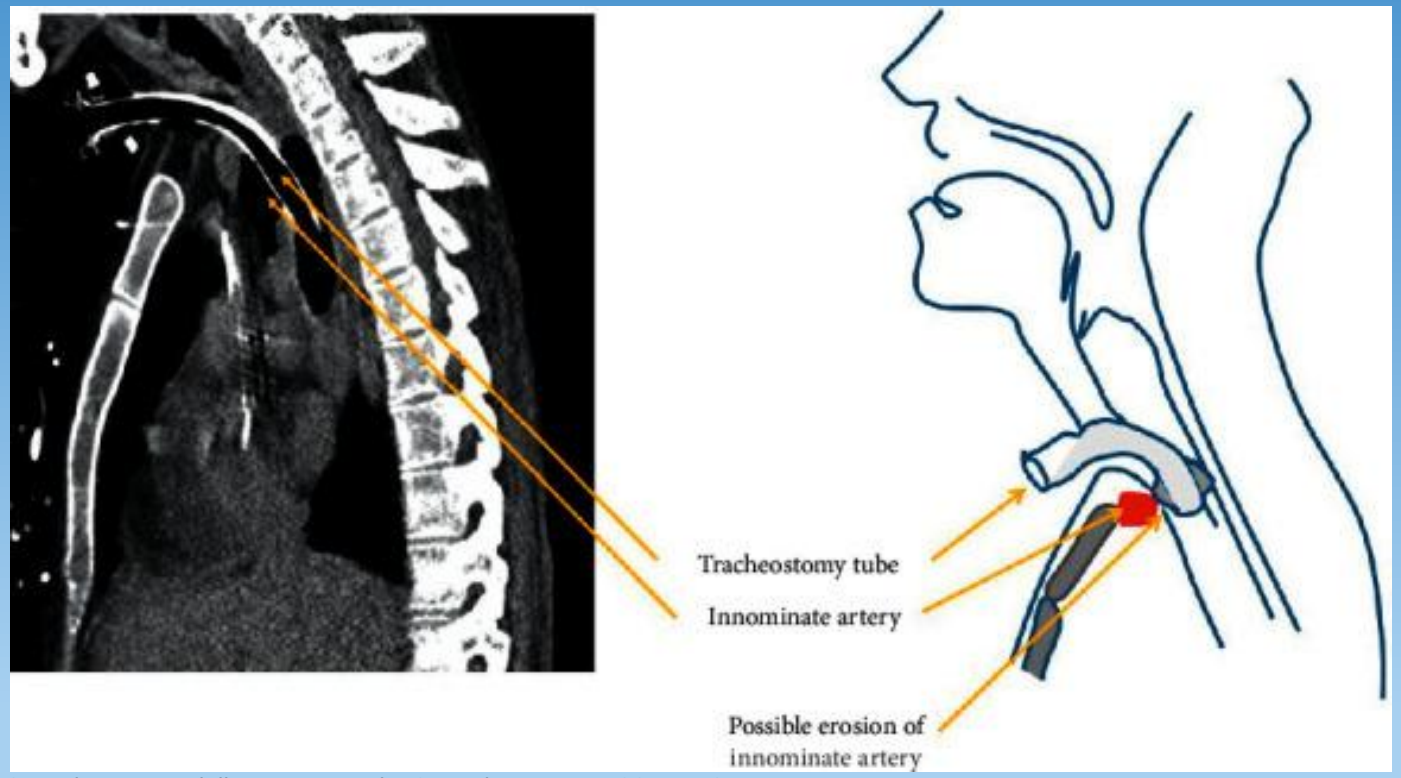
CONSEQUENCE

Assume possible tracheo-innominate fistula until urgently evaluated when suspicion exists.

A small sentinel bleed can precede catastrophic hemorrhage.

(Joshi et al., 2025; Donaldson & Raper, 2019; Cipriano et al., 2015)

Tracheo-innominate fistula: anterior trachea against an artery



CT and anatomical illustration: Nadar & Banik, Figure 1. CC BY 4.0.

CONTACT

Tube tip, elbow or cuff can create focal pressure near the crossing innominate artery.

RISK

Low entry, malposition, tissue injury and excessive pressure increase concern.

PRESENTATION

External bleeding and/or airway flooding; warning bleeding may temporarily cease.

(Nadar & Banik, 2020, Figure 1; Joshi et al., 2025)

TIF evidence: late presentations matter

2025 SYSTEMATIC REVIEW

148 published cases across 113 articles; median time to fistula 79.5 days.

WARNING BLEED

Sentinel bleeding was reported in 43.9% of cases.

TAMPONADE

Cuff overinflation alone controlled hemorrhage in 70.6% of reported instances.

Time since tracheostomy cannot safely rule out a fistula.

(Joshi et al., 2025)

Major hemorrhage: mobilize airway and vascular control together

ACTIVATE

Airway expert, surgeon, operating room / hybrid capability and massive-transfusion resources.

OXYGENATE

100% oxygen, high-capacity suction, monitor CO_2 and protect distal airway from flooding.

RESUSCITATE

Blood products, vascular access and targeted reversal as indicated—while control proceeds.

Unstable suspected arterial bleeding requires definitive control without diagnostic delay.

(Donaldson & Raper, 2019; Nadar & Banik, 2020)

Cuff tamponade: an exception to the obstruction algorithm

PRESERVE WORKING TAMPONADE

Do not reflexively deflate or remove a tube whose cuff is controlling major bleeding.

HYPERINFLATE FOR CONTROL

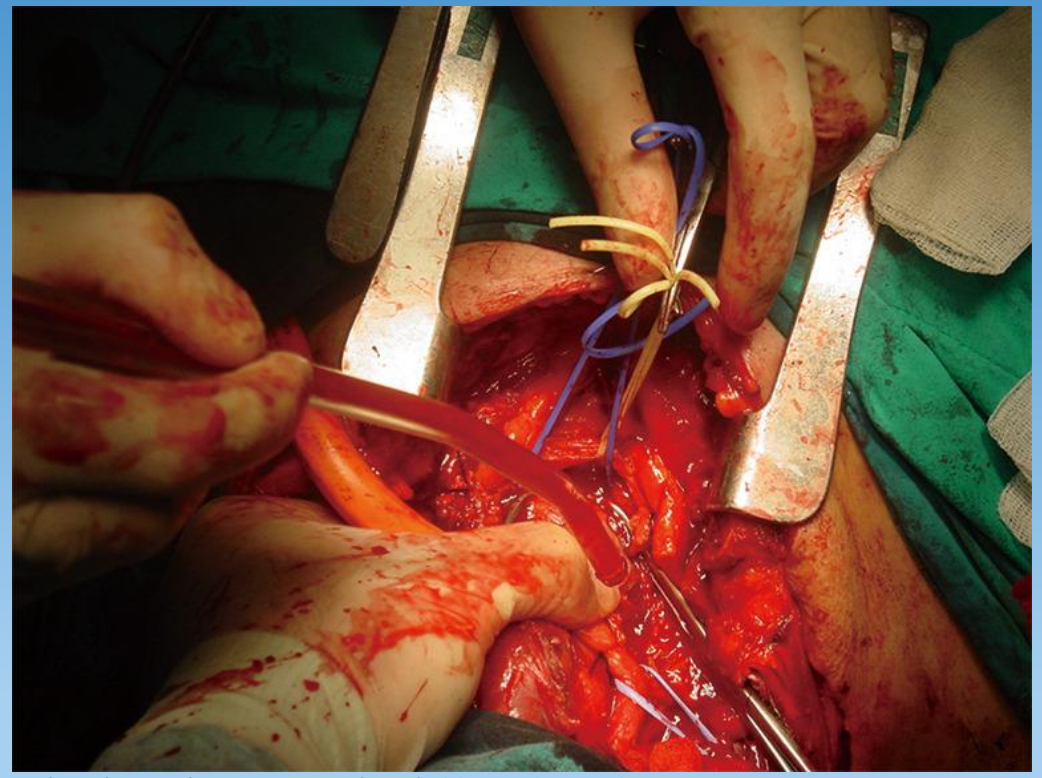
Carefully add air to an air-filled cuff while assessing hemorrhage and ventilation.

SECURE THE NEXT STEP

Immediate surgical response; controlled tube exchange only with an airway/control plan.

(Joshi et al., 2025; Donaldson & Raper, 2019)

Digital compression: bridge to definitive vascular control



Operative photograph: Toker et al., Figure 4, unaltered. CC BY-NC-ND 4.0.

IF TAMPONADE FAILS

An experienced operator obtains digital control while airway rescue proceeds.

ANATOMICAL DIRECTION

Finger in the pretracheal plane compresses innominate artery against posterior sternum.

MAINTAIN

Continue compression during transfer and operative exposure until vascular control.

Correct compression is artery-to-sternum—not pressure on the posterior tracheal wall.

(Toker et al., 2020, Figure 4; Donaldson & Raper, 2019)

Airway flooding: plan the exchange before moving the tube

CONNECTED AIRWAY

Oral ETT may protect ventilation with cuff distal to the bleeding site when anatomy permits.

NECK-ONLY AIRWAY

Laryngectomy requires stomal airway control; oral intubation cannot rescue ventilation.

CONTROLLED EXCHANGE

Keep suction and hemorrhage control active; confirm cuff position and distal ventilation.

(Nadar & Banik, 2020; Donaldson & Raper, 2019; McGrath et al., 2012)

Definitive treatment: secure proximal and distal control



Operative photograph: Toker et al., Figure 5, unaltered. CC BY-NC-ND 4.0.

OPEN

Exposure with proximal/distal vascular control; ligation/division or reconstruction as appropriate.

ENDOVASCULAR

Selected stent-graft treatment or bridge when anatomy and expertise permit.

FOLLOW THROUGH

Address airway defect, contamination, recurrent bleeding and infection risk.

(Toker et al., 2020, Figure 5; Joshi et al., 2025)

Stable sentinel bleed: urgent evaluation still applies

SPECIALIST REVIEW

Engage the responsible surgical team; reassess tube level, cuff pressure and airway.

IMAGING / ENDOSCOPY

CTA and selective endoscopy may help in stable patients with a coordinated plan.

LIMITATION

A negative or temporarily normal evaluation does not eliminate recurrent arterial bleeding risk.

(Joshi et al., 2025; Donaldson & Raper, 2019)

Case: day 40 bright blood, then apparent spontaneous resolution

DANGEROUS ASSUMPTION

"Too late for a fistula" or "only suction trauma."

IMMEDIATE PLAN

Urgent surgical evaluation, monitored setting, airway and hemorrhage-control readiness.

IF BLEEDING RECURS

Cuff tamponade when applicable, airway protection, MTP and immediate definitive control.

(Joshi et al., 2025; Donaldson & Raper, 2019)

The durable takeaways

DEVICE AND PROCEDURE

Select by geometry and actual dimensions; verify placement anatomically and physiologically.

RESCUE

Stop repeated blind recannulation. Oral intubation remains an option if the upper airway is usable.

SPECIAL PATHWAYS

PMV requires cuff deflation; laryngectomy requires neck ventilation; major bleeding requires control.

(McGrath et al., 2012; Hess & Altobelli, 2014; Joshi et al., 2025)

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