

# Cricothyroidotomy: When, Why, and Why Not?

Ashley Anders Schroeder, MD, LCDR, MC, USNR

A 25-year-old, otherwise healthy, active duty Navy male patient was referred from a ship with persistent pneumonia despite intravenous antibiotics administered by the ship's medical officer. He was admitted to the intensive care unit, rapidly developed adult respiratory distress syndrome (ARDS), and required airway support. However, the anesthesiologist on call was unable to successfully translaryngeally intubate the patient; as the patient's oxygen saturation began to drop rapidly, it was clear that a surgical airway was going to be necessary. The senior surgical resident performed a cricothyroidotomy, placed a #6 cuffed endotracheal tube through the incision, and ventilated the patient, who responded well with rapid return of good oxygen saturation. When things had settled down, the senior resident turned to me and asked what I, the otolaryngologist-to-be, thought we should do next. I realized I really did not know a good answer to his question, but my impression was that otolaryngologists rarely perform cricothyroidotomies because we are able to perform an emergency tracheotomy in about the same time. I also thought that the risk of subglottic stenosis was our reason for being so reluctant to perform cricothyroidotomy, but I was not certain where I had learned this "dogma." That is why I chose this topic to review and discuss with you.

I will first review the history of cricothyroidotomy and the surgical technique. Next, I will discuss the indications and contraindications and then compare the complications of cricothyroidotomy with tracheotomy. Most importantly, I will

review selected data that have surrounded the recent debate regarding the use of cricothyroidotomy. I will conclude with some general guidelines that I propose based on my review of the literature. I endeavor to provide a good overview and then discuss some specific areas that I found particularly interesting in researching this topic for you to consider. I am not trying to convince you that we otolaryngologists should all be doing cricothyroidotomies instead of tracheotomies. However, perhaps I will help us reconsider our thinking on the subject, particularly with regard to when (or whether) to convert a cricothyroidotomy to a tracheotomy.

## BRIEF HISTORY

Before Chevalier Jackson's time, tracheotomy began to be used to manage laryngeal obstruction from many causes but with high morbidity and mortality as high as 50% from the procedure itself. In 1909, Jackson described the first systematic approach to tracheotomy, emphasizing meticulous dissection with proper planning and instrumentation, and devised nonirritating and appropriately shaped tubes.<sup>1</sup> He was able to reduce mortality from the procedure to approximately 3%.<sup>2</sup> In 1921, he then described his care of more than 200 patients with chronic subglottic stenosis and summarily condemned "high tracheotomy" stating "... there should be taught only one tracheotomy and that should be 'low.'"<sup>3</sup> Since that landmark paper, we have generally continued to condemn cricothyroidotomy because of the impression that it inevitably leads to subglottic stenosis. This was also extrapolated to imply that any cricothyroidotomy performed should be converted to a tracheotomy in as expedient a fashion as possible. However, several points should be made about Jackson's patient population: (1) many of his patients were children in whom the

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From the Department of Otolaryngology—Head and Neck Surgery, Naval Medical Center, Portsmouth, VA.

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Address reprint requests to Ashley Anders Schroeder, MD, LT, MC, USNR, Department of Otolaryngology—Head and Neck Surgery, Naval Medical Center, Portsmouth, VA 23708-5100.

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cricoid cartilage is known to be the narrowest portion of the airway<sup>4</sup>; (2) all patients were referred from other surgeons, so there was no standardization of technique; (3) most cricothyroidotomies were performed for inflammatory processes such as diphtheria, tuberculosis, and epiglottitis, and (4) most of the patients had "high tracheotomies," which actually divided the cricoid and/or the thyroid cartilages.<sup>4,5,6</sup> I propose to you that these points would suggest that perhaps we should not extrapolate from Jackson's patient population to the patients we see today. Nonetheless, certain principles from his observations are useful, such as avoiding cricothyroidotomy in patients with inflammatory processes and avoiding division of the cricoid and/or thyroid cartilages.

## TECHNIQUE

The basic steps in performing the procedure are well known to you all, so I will only very briefly discuss them and point out a few specific issues to consider. The most basic steps are to identify the cricothyroid membrane and stabilize it with 1 hand, make an incision through it, dilate the incision, and place a tube through it. Some extra steps that are useful depending on the urgency of the situation are preparing the site with an antiseptic solution, local anesthesia, using a trousseau dilator to dilate the incision, and using scissors to extend the incision laterally as necessary. The finer points in technique involve being mindful to angle the scalpel inferiorly as the incision is made in order to avoid injury to the vocal cords, which are .5-2 cm above the cricothyroid membrane.<sup>7,8</sup> Also, the intent with incising and with spreading should be to separate the thyroid cartilage from the cricoid cartilage—not to incise or fracture either one.

## INDICATIONS

Some of the standard indications for cricothyroidotomy include oral and maxillofacial trauma, suspected cervical spine injury, and inability to perform endotracheal intubation because of profuse oral hemorrhage, emesis, or anatomy that obscures visualization of the vocal cords.

However, there are some not-so-standard indications that have been proposed for cricothyroidotomy or for maintaining an existing cricothyroidotomy. The relative ease with which a cricothyroidotomy can be performed (relative to a tracheotomy) with minimal training makes it the emergency surgical airway access procedure of choice for nonphysicians or nonsurgeons. It has been shown to be a reliable means of airway access, with emergency medical technicians achieving tracheal intubation in 87% of attempts, flight nurses in 96%, and "young physicians-in-training" being successful in 92% of attempts.<sup>10</sup> Masseter spasm after succinylcholine is another somewhat specialized indication.<sup>11</sup> Altered anatomy that precludes tracheotomy is another indication. Examples would include large goiters or anomalous vessels that would make standard tracheotomy less reliable and more risky.

Perhaps the most interesting of the less conventional indications for cricothyroidotomy is in patients who have median sternotomies. Some surgeons have identified that these patients often require prolonged tracheal access for pulmonary toilet or ventilation postoperatively but desire to separate the airway incision (and subsequent secretions) from the median sternotomy incision to reduce the risk of mediastinitis.<sup>6</sup> This is actually where the debate about the use of elective cricothyroidotomy began. Morain suggested the same advantage in patients requiring neck dissections.<sup>8</sup> He performed cricothyroidotomy whenever tracheotomy was indicated in 16 head and neck cases, including 9 with composite resections, and felt it was "superior to traditional tracheotomy." He observed that it better separated the airway incision and secretions from the neck wound and therefore reduced the incidence of sinus communication between the trachea and neck dissection incision, especially with the McFee incision. This was not a randomized, controlled prospective study and the numbers were too small to draw any significant conclusions. However, I find this proposal interesting.

## CONTRAINDICATIONS

The single most important contraindication for cricothyroidotomy is laryngeal pathology. Specifically, conditions that cause inflamma-

tion are contraindications including trauma, infection, and translaryngeal intubation.<sup>12</sup> This latter condition is one of the most interesting parts of the debate in the last several years. Another relative contraindication is in children in whom it is generally felt to be contraindicated because of the possible increased risk of subglottic stenosis and the fact that, with their smaller airway diameter, even minor stenosis is relatively more physiologically significant.

## THE DATA

Table 1 is a very broad overview of a variety of studies related to this issue. The first thing I should point out is that there are a number of factors that complicate drawing conclusions from the literature regarding the use of cricothyroidotomy. Perhaps the greatest deficiency in the literature is the absence of a randomized study comparing cricothyroidotomy with tracheotomy for a given population. All of the studies that were reviewed performed cricothyroidotomy instead of tracheotomy and com-

pared the results with historical tracheotomy data. Obviously, each study aimed to investigate a slightly different aspect of the problem. Therefore, there was great variability in method of and vigilance in monitoring for sequelae. There were a wide variety of definitions of complications (eg, chronic subglottic stenosis being separated from other laryngotracheal injuries or stenoses that require further intervention). The patient populations were often very different, which is why I noted the percentage of the patients who had emergent cricothyroidotomy and the percentage survival. Emergency cricothyroidotomy has a higher complication rate than elective just as is the case with tracheotomy. The survival data is important because it reflects that patients who need surgical airway access are often very sick patients and, therefore, a large amount of data is lost when subjects die of their primary disease.

Nonetheless, some observations can be made. The overall rate of complications was from 0% to 52%, which is not different from

**TABLE 1.** Cricothyroidotomy Study Statistics

Author	Year	No. of Cricothyroidotomies	Emergent Cricothyroidotomies (%)	Survival (%)	Complications (%)	Chronic SGS Development (%)
Brantigan <sup>6</sup>	1976	655	0	68	6.1	0
Greisz <sup>13</sup>	1982	61	0	50	8	0
Boyd <sup>5</sup>	1979	147	10	71	10.5	1
Morain <sup>9</sup>	1980	16	2.5		0	0
Weymuller <sup>14</sup>	1982	15	0	100	33	0†
Brantigan <sup>15</sup>	1982	15*				
McGill <sup>11</sup>	1982	38	100	31	39	NR
Sise <sup>4</sup>	1984	76	1	39	37	6.5
Gleeson <sup>16</sup>	1984	24	0	50	37	0‡
O'Connor <sup>17</sup>	1985	49	0	48	14	0§
Esses <sup>7</sup>	1987	78	49	59	28	2.6
Cole <sup>12</sup>	1988	4	0	75	33	0
Kuriloff <sup>8</sup>	1989	48	0	64	52	50
Miklus <sup>18</sup>	1989	20	100	35	0	0
DeLaurier <sup>19</sup>	1990	34	100	59	40	0¶
Holst <sup>20</sup>	1990	54	1	54	20	0
Spaite <sup>21</sup>	1990	16	100	18	31	NR
Nugent <sup>10</sup>	1991	55	100	27	28	3
Salvino <sup>22</sup>	1993	30	100	50	13	6.6
Isaacs <sup>23</sup>	1997	65	100	41	26	0

Abbreviations: SGS, subglottic stenosis; NR, not reported.

\*A review of 15 cases of cricothyroidotomy which resulted in subglottic stenosis which all were attributed to prior intubation or other contraindication for cricothyroidotomy; †4/15 patients had subglottic granulation requiring bronchoscopic resection; ‡1/24 had subglottic granulation requiring bronchoscopic resection; §3/49 developed tracheal stenosis at level of endotracheal tube cuff requiring tracheal resection; ||¼ developed acute subglottic stenosis which resolved spontaneously; ¶1/34 developed tracheal stenosis requiring resection, 1/34 developed tracheal granulation which required bronchoscopic resection.

the reported rates for tracheotomy. Kuriloff<sup>8</sup> discovered a statistically significant increase in the number of complications in patients with diabetes mellitus in his study of 48 cricothyroidotomies performed electively in patients who needed tracheotomy for perioperative pulmonary or ventilator management. However, the one thing that has been the most consistent historical objection to prolonged cricothyroidotomy has been the perceived risk for subglottic stenosis. In reviewing the above data, Salvino<sup>22</sup> reported a 1.6% rate in a review of 1,014 elective cricothyroidotomies, and a rate of 1.5% in a review of 127 emergent ones. Cole<sup>12</sup> found a rate of 1.9% in 205 elective cricothyroidotomies. If we combine all of the studies I reviewed for this presentation (1,628 cricothyroidotomies, 20% emergency), the rate of strictly chronic subglottic stenosis was 1.7%, but with a 3.9% rate of all types of laryngotracheal sequelae requiring treatment. The risk, therefore, does certainly exist but is not the inevitable consequence of cricothyroidotomy, which is what Jackson suggested.

What about the effects of cricothyroidotomy on the voice? Again, there is great variability in reporting, follow-up, and definitions. In the 11 studies above that mentioned vocal sequelae, 0% to 75% of patients had transient changes and 0% to 32% had permanent changes.<sup>4,5,6,7,13,16,20,21</sup>

There were 2 studies that rigorously examined the voice effects. Gleeson et al<sup>16</sup> reviewed 24 patients who had cricothyroidotomy performed electively as the method of choice for surgical airway access for respiratory management (prolonged ventilator dependence, pulmonary toilet, etc), and only 8 were available at up to 4 years after decannulation for follow-up. The patients were cannulated for 2 to 99 days (mean = 30d) and had been orally intubated for 1 to 13 days (mean = 5d) before decannulation. They were followed by history, indirect laryngoscopy (IDL) (plus xeroforms if the subglottis could not be adequately assessed by IDL), objective vocal assessments, and laryngographs. Seventy-five percent had subjective and objective voice changes. The objective changes were usually a narrowing of the range favoring lower frequencies. On examination, they visualized scarring at the stoma with distortion of the anterior commis-

sure in 37%. Therefore, they concluded that there was a significant risk for vocal impairment and that they would only use cricothyroidotomy in emergencies and would convert it expeditiously to a tracheotomy.

Holst et al<sup>20</sup> reported on 54 cricothyroidotomies performed for similar indications. Nineteen of the patients were able to be assessed after decannulation. Their patients were orally intubated for 0 to 9 days before cricothyroidotomy (mean = 2.4d) and were cannulated for 1 to 28 days (mean = 11.4d). Those who were available for follow-up were assessed at 6 months after decannulation using history, indirect laryngoscopy, flexible fiberoptic examination, videostroboscopy, fundamental frequency evaluation, phonetograms, a perceptual analysis of voice quality, and laryngeal electromyography in most cases. To simplify the results, 63% were not satisfied with their voice at 6 months, and 21% had evidence of cricothyroid muscle dysfunction. They did not find a correlation between duration of intubation or cannulation and voice changes. They did find that most of the patients who had voice complaints or abnormalities were also smokers or were older. Of those with complaints, 10 actually had normal laryngeal examinations, 10 had normal laryngeal electromyographs, and 3 had a narrower vocal range, whereas 4 had a wider range. Perhaps most importantly, none of the changes that were encountered interfered with the patient's functional status. Their conclusions were that the voice changes were not exclusively related to the cricothyroidotomy, and that it is a good alternative to tracheotomy unless the patient uses their voice professionally.

What about the impact of prior translaryngeal intubation? This has been another area of some debate. There seems to be general agreement, with exceptions, that prior intubation for an as-of-yet-undefined length of time is a contraindication to cricothyroidotomy. Boyd et al<sup>5</sup> performed 132 elective cricothyroidotomies instead of tracheotomies in patients with recent median sternotomy incisions who needed surgical airways. All of the patients had been intubated before the procedure. Of the 105 long-term survivors, 2 had laryngeal (glottic and subglottic) stenosis. Both of those patients had been intubated for more than 22 days. They pointed out that glottic stenosis

has been described after endotracheal intubation for as short as 48 hours and that it is usually when intubation is followed by tracheotomy. They felt that the endotracheal tube ulcerates the cords, then the tracheotomy diverts the airflow, thereby allowing the cords to remain in apposition and, thus, to scar together. These investigators concluded that cricothyroidotomy is a useful and safe means of surgical airway access but is contraindicated in patients who were intubated for more than 7 days before or in patients with airway obstruction after removal of an endotracheal tube. Brantigan and Grow<sup>2</sup> had similar conclusions after their review of 15 patients with chronic subglottic stenosis caused by cricothyroidotomy performed after translaryngeal intubation.

Weymuller and Cummings<sup>14</sup> designed a study to look specifically at this matter by performing cricothyroidotomy whenever tracheotomy was indicated in 2 groups of patients. Group 1 patients were already intubated but were going to need prolonged ventilator use. Group 2 consisted of head and neck cancer patients who needed a tracheotomy for airway management (ie, were *not* already intubated). They aborted the study at 19 patients when they found a strikingly increased risk of stenotic complications in previously intubated patients. Along the same lines though, McGovern et al<sup>24</sup> found that the frequency of laryngotracheal stenosis doubled when tracheotomy followed intubation. This implies that the stenotic complications are problems related more to obtaining a surgical airway in a previously intubated patient than to the method of surgical airway access.

Certainly, some investigators would disagree. For example, Sise et al<sup>4</sup> found no significant difference between patients with and without complications or pathological changes in regards to length of translaryngeal intubation before cricothyroidotomy. This study was a report on 76 patients who had cricothyroidotomy performed as the procedure of choice for elective surgical airway access on the trauma and general surgery services.

Nonetheless, there does appear to be a lot of evidence that translaryngeal intubation causes laryngeal trauma, which we all agree is a contraindication for cricothyroidotomy in the first place.

## ADVANTAGES

Some potential advantages of cricothyroidotomy versus tracheotomy, if we accept that their general complication rate is roughly the same (6% to 52% for cricothyroidotomy v 6% to 65% for tracheotomy) are: (1) a cricothyroidotomy is faster, certainly in the hands of a non-surgeon; (2) the landmarks may be easier to identify; (3) less risk of pneumothorax; (4) less bleeding; (5) less risk of a tracheoinnominate fistula; and (6) less risk of a tracheoesophageal fistula. Cervical hyperextension is not as important for success in cricothyroidotomy, a fact that is obviously useful in patients with either preexisting limitation of neck motion or with suspected c-spine injury. With cricothyroidotomy, the tube is easier to reinsert if it is removed or dislodged early in the healing process, with less risk of creation of a false tract with reinsertion. Finally, there is better separation of the surgical airway wound and secretions from the primary surgical incision, which is of particular importance in cases that require median sternotomy. As mentioned above, 1 investigator even proposed that this latter advantage might extend to head and neck cases that require a neck dissection.<sup>9</sup>

## GUIDELINES

Based on this review of the literature, I would propose several guidelines. First, "airway" is always the first priority, as we all know. Consider that patients who need surgical airways have a high mortality regardless of the airway access method you choose. Each situation must be individualized and, ultimately, if you are successful at obtaining an airway and the patient survives, you chose the right option for that patient. Second, if the patient is already endotracheally intubated and has been so for any significant length of time, a tracheotomy is probably the better choice. Third, cricothyroidotomy may be an acceptable long-term means of airway access *if* done correctly and if the patient is properly selected. Along the same lines, and perhaps the most useful point for an otolaryngologist, conversion of a cricothyroidotomy to a tracheotomy may not be necessary if the history is favorable. Fourth, cricothyroidotomy is a good

means of emergency airway access for a wide variety of providers.

## CONCLUSION

In conclusion, I would have to say that the "right" decision lies somewhere in between Dr. Jackson's statement that "there should be taught only one tracheotomy and that should be low"<sup>1</sup> and Drs. Brantigan and Grow's statement that "cricothyroidotomy [is] the method of choice for elective and emergency use in problems requiring tracheotomy."<sup>15</sup>

## DISCUSSION

*Question from the floor:* What would you have done for the patient you mentioned at the beginning?

*Response:* At my level of training, I would have done a cricothyroidotomy as well. I would expect, however, that as I get further along in my residency, I will be able to do a tracheotomy just as quickly and will use that as my preferred means of surgical airway access as most of you do.

*Question from the floor:* What would you tell that general surgeon now?

*Response:* In that particular patient, I would now probably be more willing to not convert his cricothyroidotomy to a tracheotomy immediately. He had no evidence of laryngeal pathology as the etiology for his ARDS, had not been intubated prior, and was not a professional voice user. I certainly do not think it is wrong to convert to a tracheotomy, but I think an argument can be made for not doing so.

*Question from the floor:* The cricothyroid membrane is very small. I think one great disadvantage of a cricothyroidotomy is that you can not use a big tube for ventilation and for suctioning. Isn't that true?

*Response:* Several of the papers mentioned this issue briefly.<sup>8,23</sup> Anatomic studies reveal that the cricothyroid membrane is, on average, 9 × 30 mm. The outer diameter of a no. 4 Shiley tube (Mallinkrodt Inc, St Louis, MO) is 8.5mm, and a no. 6 is 10mm. A no. 7 endotracheal tube has an outer diameter of 9 mm. Therefore, I am concerned about whether we can effectively ventilate a patient, particularly one who needs high airway pressures as in ARDS through a small tube like that, because I

would probably use a no. 4 Shiley in order to reduce the risk of pressure necrosis of the laryngeal cartilages. I did not find any human studies addressing this matter.

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## REFERENCES

1. Jackson C: Tracheotomy. *Laryngoscope* 19:285, 1909
2. Brantigan CO, Grow JB: Cricothyroidotomy revisited again. *Ear Nose Throat J* 59:26-38, 1980
3. Jackson C: High tracheotomy and other errors: The chief causes of chronic laryngeal stenosis. *Surg Gynecol Obstet* 32:392-395, 1921
4. Sise MJ, Shackford SR, Cruickshank JC, et al: Cricothyroidotomy for long-term tracheal access. *Ann Surg* 200:13-17, 1984
5. Boyd AD, Romita MC, Conlan AA, et al: A clinical evaluation of cricothyroidotomy. *Surg Gynecol Obstet* 149:365-368, 1979
6. Brantigan CO, Grow JB: Cricothyroidotomy: Elective use in respiratory problems requiring tracheotomy. *J Thorac Cardiovasc Surg* 71:72-81, 1976
7. Esses BA, Jafek BW: Cricothyroidotomy: A decade of experience in Denver. *Ann Otol Rhinol Laryngol* 96:519-524, 1987
8. Kuriloff DB, Setzen M, Portnoy W, et al: Laryngotracheal injury following cricothyroidotomy. *Laryngoscope* 99:125-130, 1989
9. Morain WD: Cricothyroidostomy in head and neck surgery. *Plast Reconstr Surg* 65:424-428, 1980
10. Nugent WL, Rhee KJ, Wisner DH: Can nurses perform surgical cricothyrotomy with acceptable success and complication rates? *Ann Emerg Med* 20:367-370, 1991
11. McGill J, Clinton JE, Ruiz: Cricothyrotomy in the emergency department. *Ann Emerg Med* 11:361-364, 1982
12. Cole RR, Aguilar EA: Cricothyroidotomy versus tracheotomy: An otolaryngologist's perspective. *Laryngoscope* 98:131-135, 1988
13. Greisz H, Qvarnstrom O, Willen R: Elective cricothyroidotomy: A clinical and histopathological study. *Crit Care Med* 10:387-389, 1982
14. Weymuller EA, Cummings CW: Cricothyroidotomy: The impact of antecedent endotracheal intubation. *Ann Otol Rhinol Laryngol* 91:437-439, 1982
15. Brantigan CO, Grow JB: Subglottic stenosis after cricothyroidotomy. *Surgery* 91:217-221, 1982
16. Gleeson MJ, Pearson RC, Armistead S, et al: Voice changes following cricothyroidotomy. *J Laryngol Otol* 98:1015-1019, 1984
17. O'Connor JV, Reddy K, Ergin A, et al: Cricothyroidotomy for prolonged ventilatory support after cardiac operations. *Ann Thor Surg* 39:353-354, 1985
18. Miklus RM, Elliot C, Snow N: Surgical cricothyroidotomy in the field: Experience of a helicopter transport team. *J Trauma* 29:1506-1508, 1989
19. DeLaurier GA, Hawkins ML, Treat RC, et al: Acute airway management: Role of cricothyroidotomy. *Am Surg* 71:12-15, 1990
20. Holst M, Hertegard S, Persson A: Vocal dysfunction following cricothyroidotomy: A prospective study. *Laryngoscope* 100:749-755, 1990

21. Spaitte DS, Joseph M: Prehospital cricothyrotomy: An investigation of indications, technique, complications, and patient outcome. *Ann Emerg Med* 19:279-285, 1990
22. Salvino CK, Dries D, Gamelli R: Emergency cricothyroidotomy in trauma victims. *J Trauma* 34:503-505, 1993
23. Isaacs JH, Pedersen AD: Emergency cricothyroidotomy. *Am Surg* 63:346-349, 1997
24. McGovern FH, Fitz-Hugh GS, Edgemon LJ: The hazards of endotracheal intubation. *Ann Otol Rhinol Laryngol* 80:387-389, 1971