Conversion of Emergent Cricothyrotomy to Tracheotomy in Trauma Patients

Peep Talving, MD, PhD; Joseph DuBose, MD; Kenji Inaba, MD; Demetrios Demetriades, MD, PhD

Objective: To review the literature to determine the rates of airway stenosis after cricothyrotomy, particularly as they compare with previously documented rates of this complication after tracheotomy, and to examine the complications associated with conversion.

Data Sources: We conducted a review of the medical literature by the use of PubMed and OVID MEDLINE databases.

Study Selection: We identified all published series that describe the use of cricothyrotomy, with the inclusion of the subset of patients who require an emergency airway after trauma, from January 1, 1978, to January 1, 2008.

Data Extraction: Only 20 published series of cricothyrotomy were identified: 17 retrospective reports and 3 prospective, observational series.

Data Synthesis: Considerable variance in methods and follow-up periods were noted between examinations. Published experiences documented the results of 1134 total patients for whom cricothyrotomy was performed, including 368 trauma patients who underwent emergent cricothyrotomy. The rate of chronic subglottic stenosis among survivors after cricothyrotomy was 2.2% (11/511) overall and 1.1% (4/368) among trauma patients for follow-up periods with a range from 2 to 60 months. Only 1 (0.27%) of the 368 trauma patients in whom an emergent cricothyrotomy was performed required surgical treatment for chronic subglottic stenosis. Although the literature that documents complications of surgical airway conversion is scarce, rates of severe complications of up to 43% were reported.

Conclusions: Cricothyrotomy after trauma is safe for initial airway access among patients who require the establishment of an emergent airway. The prolonged use of a cricothyrotomy tube, however, remains controversial. Although no study to date has demonstrated any benefit of routine conversion to tracheostomy, considerable deficiencies in existing studies highlight the need for further investigations of this practice.

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older than 80 years. A growing body of more contemporar
y literature has suggested that the risk associated with
the prolonged use of a cricothyrotomy tube, par

cularly that of airway stenosis, may be much lower than
previously believed.5,9,13-30 The risk of conversion, al
though less well examined, may also be associated with
underappreciated risk.29,31 The aims of the present re
view are to review the literature to determine the rates
of airway stenosis after cricothyrotomy, particularly as
they compare with previously documented rates of this
complication after tracheotomy, and to examine the com
plications associated with conversion.

METHODS

We conducted a search of the medical literature using the
keyword cricothyrotomy in PubMed (http://www.pubmed.gov; ac
cessed May 6, 2008), a service of the National Library of Medi
cine of the National Institutes of Health and OVID MEDLINE
databases. A total of 153 publications that pertain to cricothy-
rotomy were identified. Twenty studies were performed for emer
gent airway access (Table 1). Twenty studies were iden
ified and analyzed to abstract the following data: pa
tient population type, nature of cricothyrotomy tube place
ment, clinical outcomes, and follow-up. An additional sub

test was also identified for examination (Table 2).

RESULTS

In the late 19th century, Chevalier Jackson began to es

lish surgical airway operative techniques as standard-
ized procedures. During his investigations, he con
ducted extensive examinations of the complications
associated with the performance of these interventions.
In a 1921 publication,10 he reported on a series of 200
cases of subglottic stenosis after the surgical creation of

<table>
<thead>
<tr>
<th>Source</th>
<th>Study Design</th>
<th>No. of Cricothyrotomies</th>
<th>No. of Survivors</th>
<th>Follow-up Time, mo</th>
<th>No. With Chronic SGS</th>
<th>No. Operated On</th>
<th>Level of Evidence</th>
</tr>
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<td>18</td>
<td>11</td>
<td>12.0-24.0</td>
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<td>Wright et al30 2003</td>
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<tr>
<td>François et al31 2003</td>
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<td>32</td>
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**Table 1. Studies Included in the Review**

Abbreviation: II indicates prospective clinical study or retrospective analysis of reliable data, including observational, cohort, prevalence, or case-control studies; III, retrospective study, including database or registry reviews, a large series of case reports, and expert opinion; SGS, subglottic stenosis.
airways. Among these cases, Jackson determined that 30 of the lesions were secondary to laryngeal inflammation and cartilage necrosis owing to diphtheria or other causes of inflammation. Of the remaining 170 patients with subglottic stenosis, 158 (92.9%) had undergone cricothyrotomy. After noting that the preponderance of patients with subglottic stenosis had a history of cricothyrotomy, he concluded that the use of this type of surgical airway was associated with a prohibitive risk of stenosis compared with tracheotomy. Largely on the basis of the report by Jackson, surgical dogma that advises against elective cricothyrotomy and supports the practice of early conversion to tracheotomy after emergent cases gained widespread acceptance. Even today, authors continue to recommend adherence to these principles to avoid the risk of subglottic stenosis after cricothyrotomy.11

Several subsequent examinations, however, have refuted the findings of Jackson. Brantigan and Grow32 were among the first to challenge the dogma against cricothyrotomy in 1976. These investigators reported their experience with the use of elective cricothyrotomy in 655 cardiovascular patients, without a single subglottic stenosis in their series. In our review of reports that followed, we identified 20 series with similar findings. From 20 studies we noted a chronic subglottic stenosis rate of 2.2% among survivors of hospitalization for follow-up periods that ranged from 2 to 60 months. In the largest of the prospective series of cricothyrotomy, Sise et al20 documented only 2 cases of subglottic stenosis after the use of this airway approach among 76 critically ill patients. Both of the patients with stenosis in this report were adolescent trauma patients. Each underwent cricothyrotomy only after complications associated with anecedent endotracheal intubation. As Weymuller and Cummings14 have previously shown, the performance of cricothyrotomy after previous endotracheal intubation is known to be associated with stenosis rates in excess of 30%.

In a prospective, observational study, François and colleagues30 compared outcomes of critically ill patients who underwent cricothyrotomy with a cohort undergoing tracheotomy. The investigators found that both the incidence and severity of complications between the 2 groups were similar. Overall, our finding of a 2.2% rate of chronic subglottic stenosis, the most commonly voiced concern that pertains to cricothyrotomy tube use, compares favorably with a recently reported series of survivors of open surgical33 and dilatational tracheotomy.34 In a prospective, observational examination of 58 cardiothoracic surgery survivors who underwent open tracheostomy, Waits et al33 found that 9.2% of patients had tracheal stenosis as verified by direct fiberoptic endoscopy visualization during a mean follow-up period of 2.1 years. In another prospective, observational study of 146 patients who underwent either open or dilatational tracheotomy, Koitschev and colleagues34 found that the severe suprastomal stenosis (grade II, >50% of the lumen) was present in 19.2% of patients via endoscopy at a mean follow-up of 75 days.

In addition to the risk of chronic subglottic stenosis, several other concerns that pertain to the prolonged use of a cricothyrotomy tube have also been proposed. Even among advocates of the technique, concerns that pertain to the use of this form of surgical airway for children and adolescents have been voiced. In the aforementioned prospective series by Sise et al,20 the only 2 patients found to develop stenosis were adolescents, although both of these individuals had been previously intubated via an endotracheal route. On the basis of these findings, the authors of this report recommended the avoidance of cricothyrotomy in younger patients. In a recent report by Parrilla et al,23 however, total complication rates of 42% were noted after tracheotomy in a large population of pediatric patients, which suggests that any surgical manipulation of the pediatric airway may be likely to predispose patients to stenosis and other airway complications. The explanation for this, as Parrilla and colleagues point out, is likely multifactorial. Currently, the role of cricothyrotomy in children and adolescents remains ill-defined.

Less morbid complications of cricothyrotomy have also been raised as a concern, including voice change and dys-

### Table 2. Studies With Available Data That Pertain to Trauma Patients

<table>
<thead>
<tr>
<th>Source</th>
<th>No. of Cricothyrotomies</th>
<th>No. With Emergent Airway Established</th>
<th>No. With Chronic SGS</th>
<th>No. Operated On</th>
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<td>François et al,20 2003</td>
<td>9</td>
<td>Not stated</td>
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<td><strong>Total No. (%)</strong></td>
<td><strong>452 (100.0)</strong></td>
<td><strong>368/452 (81.4)</strong></td>
<td><strong>4/452 (0.9)</strong></td>
<td><strong>1/4 (25.0)</strong></td>
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</table>

Abbreviations: See Table 1.
phagia. It has been hypothesized that injury to the cricothyroid muscle may contribute to alterations in vocal tenor and phonation. Although human data are lacking, animal studies have failed to demonstrate electromyelographic or muscle morphologic changes after prolonged use of a cricothyrotomy tube. In addition, this sequela may not be unique to this particular form of surgical airway. Wahts and colleagues, in a report on the follow-up of 38 survivors of tracheotomy for respiratory failure after cardiovascular surgery, noted that 24% of patients reported voice changes. The true incidence of alterations in voice after cricothyrotomy is unknown. The incidence of dysphagia after cricothyrotomy, likewise, has not been defined. It has previously been appreciated that prolonged ventilation is associated with higher rates of swallowing abnormalities, particularly at extremes of age. Although the prolonged use of an emergently placed airway tube may predispose patients to alterations of deglutination, the particular risk of cricothyrotomy for this morbidity, compared with that of tracheotomy or orotracheal intubation, has not been defined.

The risk of conversion itself has not been well established but is most certainly a concerning entity. In an examination by Wright et al., investigators found that, among 8 patients who underwent conversion, complications occurred in 5 (62.5%). They also noted that patients who underwent conversion required a significantly greater subsequent length of hospital stay compared with their counterparts who had continued use of their cricothyrotomy tube for airway access. In another report by Altman and colleagues, of 7 patients (43%) who underwent conversion at a mean of 6.1 days experienced severe complications, which resulted in 2 deaths and 1 patient with permanent neurologic impairment.

Unfortunately, the existing literature that pertains to routine conversion of cricothyrotomy to tracheotomy may raise more questions than it answers. Although the aforementioned figures are interesting, they are based largely on retrospective studies and class III studies that used mixed methods and uncontrolled patient selection. The type and size of endotracheal cannula used are also poorly documented or highly variable among existing investigations. Given that the diameter and materials of cannula involved may affect the type and rate of subglottic stenosis, the absence of this information is significant.

The diagnosis of subglottic stenosis among these studies is, unfortunately, also not universally well documented. The methods and indications for evaluation of stenosis are unclear. Follow-up procedures are highly variable and poorly documented, with no standardization. Once diagnosed, the optimal modality and timing for treatment are, likewise, not defined. The percentage of patients who require surgical correction of stenosis is also questionable because confounding comorbidities may preclude consideration for such procedures in many patients.

Because of the lack of evidence that supports mandatory conversion of emergently established cricothyrotomy to a subsequent surgical or percutaneous tracheotomy, a prospective, randomized validation of this practice is warranted. The primary end point of such trial should be designed to evaluate clinically significant subglottic stenosis that requires treatment as evaluated by endoscopic examination of the larynx, vocal cords, and trachea before intensive care unit discharge and decannulation and during the postdecannulation follow-up. Secondary end points would include complications associated with the second procedure, such as tracheoinnominate fistula, incidence of aspiration and pneumonia, acute respiratory failure owing to inadvertent decannulation, tracheoesophageal and tracheocutaneous fistula, chronic dysfunction of the vocal cords, deglutination abnormalities, and voice alterations. Other important end points would be markers of efficacy, such as length of stay in the intensive care unit and the hospital, time to decannulation, and cost analysis. Given the small number of emergently established cricothyrotomies at a single institutional level, a multi-institutional trial is necessary to validate the practice.

In conclusion, several class III studies have suggested that there is no benefit associated with conversion of cricothyrotomy to tracheotomy. Conversely, no existing literature supports the routine use of this practice. In the absence of adequate evidence on which to base practice, however, the role of routine conversion of emergent cricothyrotomy to tracheotomy remains a matter of contention. Prospective investigation designed to settle this debate is warranted.

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