Conversion of Emergent Cricothyrotomy to Tracheotomy in Trauma Patients

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Objectives: 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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The early establishment of a patent and secure airway, in either the field setting or the emergency department, is a basic tenet of trauma care. Endotracheal intubation remains the initial airway of choice for trauma patients with a decreased Glasgow Coma Scale score or airway or ventilatory compromise and can be achieved with a high degree of success in most cases. During recent years, the laryngeal mask airway and double-lumen tube (Combitube; Tyco-Kendall Healthcare Products, Mansfield, Massachusetts) have also gained popularity because of their simplicity and demonstrated effectiveness in both prehospital and in-hospital settings. The establishment of a surgical airway, however, remains indicated for those patients in whom these initial adjuncts fail to provide adequate airway access or for those patients with severe facial or neck injuries that preclude the insertion of an endotracheal tube. Cricothyrotomy, which can be rapidly and successfully performed in both field and hospital settings by a variety of trained professionals, has been widely advocated as the initial surgical airway of choice in these emergent situations.

Among patients who require a cricothyrotomy and survive their initial injuries, many may require the prolonged use of a surgically created airway. Traditional surgical teaching has dictated that a cricothyrotomy tube placed for emergency purposes should be converted to a tracheotomy tube within 72 hours in these patients primarily because the prolonged use of this airway access is thought to be associated with a prohibitive risk of subglottic stenosis. Although this practice continues to be advocated by contemporary authors, the literature on which this assumption is primarily based is now...
older than 80 years. A growing body of more contemporary literature has suggested that the risk associated with the prolonged use of a cricothyrotomy tube, particularly that of airway stenosis, may be much lower than previously believed.\textsuperscript{8,9,13-30} The risk of conversion, although less well examined, may also be associated with underappreciated risk.\textsuperscript{29,31} The aims of the present review 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 complications associated with conversion.

### METHODS

We conducted a search of the medical literature using the keyword cricothyrotomy in PubMed (http://www.pubmed.gov; accessed May 6, 2008), a service of the National Library of Medicine of the National Institutes of Health and OVID MEDLINE databases. A total of 153 publications that pertain to cricothyrotomy were identified. A consensus panel of 3 reviewers (P.T., J.D., and K.I.) reviewed each study and their references to extract all studies that addressed open cricothyrotomy in human patients. A total of 153 publications that pertain to cricothyrotomy were identified and analyzed to abstract the following data: patient population type, nature of cricothyrotomy tube placement, clinical outcomes, and follow-up. An additional subgroup of trauma patients was also identified for examination (Table 2).

### RESULTS

Twenty published series and studies were identified. Seventeen of these consisted of retrospective reports, and 3 were prospective, observational series. Considerable variance in methods and follow-up among these investigations was noted. In these reports, 1134 total cricothyrotomies were documented, with 511 survivors available for follow-up (Table 1). Follow-up periods ranged overall from 2 to 60 months, with a mean of 16 months. Chronic subglottic stenosis was documented in 11 of 511 overall survivors (2.2%). Surgical intervention to correct stenosis was required in 7 of the 511 survivors (1.4%).

Among trauma patients, 452 cricothyrotomies were performed. Adequate documentation that these procedures were performed for emergent airway access was available in 368. The overall rate of chronic subglottic stenosis in this setting was 0.9% (4/452) and 1.1% (4/368) when cricothyrotomy was used to establish emergent airway access. Only 1 of 368 trauma patients (0.27%) required surgical treatment for chronic subglottic stenosis after emergent cricothyrotomy for trauma (Table 2).

The examination of complications directly related to conversion to tracheotomy was limited to only 2 identified case series consisting of 15 total patients.\textsuperscript{29,31} The overall complication rate from these 2 reports was 53.3% (8/15), with a mortality rate of 28.6% in 1 series.\textsuperscript{31}
Despite the presumed higher risk of subglottic stenosis after cricothyrotomy, several subsequent examinations, however, have refuted the findings of Jackson. Brantigan and Grow23 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 al.15 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 antecedent 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, Francois and colleagues20 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 surgical32 and dilatational tracheotomy.22 In a prospective, observational examination of 58 cardiothoracic surgery survivors who underwent open tracheostomy, Walts et al.33 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.15 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.35 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>
<th>Level of Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>McGill et al16, 1982</td>
<td>26</td>
<td>26</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Miklus et al,1989</td>
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<tr>
<td>Boyle et al,18, 1993</td>
<td>69</td>
<td>69</td>
<td>0</td>
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<tr>
<td>Salvino et al,21 1993</td>
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<td>Hawnkins et al,24 1995</td>
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<td>66</td>
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<td>Jacobson et al,9 1996</td>
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<td>Gillespie and Eisele,26 1999</td>
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<tr>
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<td>Rehm et al,28 2002</td>
<td>36</td>
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<tr>
<td>Wright et al,29 2003</td>
<td>46</td>
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<tr>
<td>Francois et al,30 2003</td>
<td>9</td>
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<td>Not stated</td>
<td>Not stated</td>
<td>II</td>
</tr>
<tr>
<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>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: See Table 1.
phagia. It has been hypothesized that injury to the cri-
ocothryoid muscle may contribute to alterations in vocal
tenor and phonation. Although human data are lacking,
animal studies have failed to demonstrate electromyo-
elographic or muscle morphologic changes after pro-
longed use of a cricothyrotomy tube. In addition, this se-
quela may not be unique to this particular form of surgical
airway. Walts and colleagues, in a report on the fol-
low-up of 58 survivors of tracheotomy for respiratory fail-
ure after cardiovascular surgery, noted that 24% of pa-
tients 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 alter-
dations of deglutination, the particular risk of crico-
thorotomy for this morbidity, compared with that of trache-
otomy or orotracheal intubation, has not been defined.

The risk of conversion itself has not been well estab-
lished but is most certainly a concerning entity. In an ex-
amination by Wright et al, investigators found that,
among 8 patients who underwent conversion, compli-
cations occurred in 5 (62.5%). They also noted that pa-
tients who underwent conversion required a signifi-
cantly greater subsequent length of hospital stay compared
with their counterparts who had continued use of their
cricothyrotomy tube for airway access. In another re-
port by Altman and colleagues, of 7 patients (43%) who
underwent conversion at a mean of 6.1 days experi-
enced 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
forementioned figures are interesting, they are based
largely on retrospective studies and class III studies that
used mixed methods and uncontrolled patient selec-
tion. The type and size of endotracheal cannula used
are also poorly documented or highly variable among exist-
ing investigations. Given that the diameter and materi-
als 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 docu-
mented. The methods and indications for evaluation of
stenosis are unclear. Follow-up procedures are highly
variable and poorly documented, with no standardiza-
tion. 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 manda-
tory conversion of emergently established cricothy-
rotomy to a subsequent surgical or percutaneous trache-
otomy, a prospective, randomized validation of this practice is warranted. The primary end point of such trial
should be designed to evaluate clinically significant sub-
glottic stenosis that requires treatment as evaluated by
endoscopic examination of the larynx, vocal cords, and
trachea before intensive care unit discharge and decan-
nulation and during the postdecanulation follow-up.
Secondary end points would include complications asso-
ociated with the second procedure, such as tracheoin-
nominate fistula, incidence of aspiration and pneu-
monia, acute respiratory failure owing to inadvertent
decannulation, tracheoesophageal and tracheocutane-
ous fistula, chronic dysfunction of the vocal cords, de-
glutination 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 hos-
pital, time to decannulation, and cost analysis. Given the
small number of emergently established cricothyrotom-
ies at a single institutional level, a multi-institutional trial is necessary to validate the practice.

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

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