Emergency Cricothyrotomy in Confined Space Airway Emergencies: A Comparison

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PGY = post-graduate year

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Abstract

Introduction: In confined-space airway emergencies, prehospital personnel may need to perform cricothyrotomy when conventional airway techniques cannot be utilized or have failed. This study is a prospective, cross-over, randomized controlled trial that compares two widely-known techniques using two commercially available kits.

Methods: Twenty residents at Palmetto Health Richland Department of Emergency Medicine participated in the study. Their performance was assessed using the time required to placement and correctness of placement for each device. The residents performed the procedures on an Air-Man™ manikin that had been situated in a confined space. The residents also indicated which kit they would prefer in a confined-space, emergency airway situation.

Results: All of the devices were placed in the airway. The mean time to placement for the Melker™ and Quicktrach™ kits was 108.5 seconds and 23.9 seconds, respectively. This yielded a mean difference of 84.5 seconds, which provided a t-statistic of 8.88 ($p < 0.0001$). There was no evidence of a carry-over effect ($p = 0.292$) or a period effect ($p = 0.973$). All residents preferred using the Quicktrach™ kit.

Conclusions: Use of the Quicktrach™ kit resulted in the fastest time to placement, was placed correctly in the airway, and was preferred by each of the residents. Its small, simple, and sturdy design, with few parts and easy manipulation, allow the Quicktrach™ to be a valuable option in prehospital situations involving confined spaces. The Melker™ kit, with its many parts, and need for greater manipulation, is not as easily utilized or preferred in a confined space scenario.

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Introduction

Emergency cricothyrotomy is a procedure performed when all other attempts to gain airway control have failed, such as when endotracheal intubation is impossible due to airway obstruction. In most instances, this procedure is performed in the emergency department by emergency physicians, surgeons, or anesthesiologists. However, there is an indication for use of this technique in the prehospital phase during disasters, especially those involving confined-space airway emergencies when conventional techniques might not be effective in a timely fashion. A review of the literature found no studies involving emergency cricothyrotomy under these circumstances, although prior studies have evaluated and compared various techniques in other settings.[1–3] In this study, a wire-guided, or Seldinger technique (Melker™) was compared to a catheter-over-needle technique (Quicktrach™). The time for placement, correctness of placement, and performer preference of the two kits mentioned above was assessed.

Methods

In this prospective, cross-over, randomized control trial, 20 residents of the Palmetto Health Richland Department of Emergency Medicine performed cricothyrotomies using the Melker™ and Quicktrach™ kits on a Air-Man™ manikin from Laerdal (Air-Man Model #1022661, Laerdal Corp., Stavanger, Norway). The manikin, which is used to teach the cricothyrotomy procedure, has a simulated airway including a neck skin over the cricothyroid membrane leading to a molded trachea. To simulate a disaster situation, the manikin was placed in a confined space. This confined space consisted of an approximately three-foot-wide (one meter) by 30-inch-tall (75 mm)

	Time	In	Seconds
Resident	Melker™	Quicktrach™	Difference(M-Q)
1	162.9	26	136.9
2	115.6	29.7	85.9
3	84.8	14.6	70.2
4	71.2	12.4	58.7
5	73.8	8.5	65.3
6	75.6	21.5	54.1
7	59.1	15.4	43.6
8	219.4	27.2	192.2
9	94.8	23.2	71.5
10	193.1	48.1	145.0
11	153.3	19.9	133.3
12	90.3	14.1	76.3
13	80.2	20.0	60.2
14	132.2	35.2	97.0
15	147.1	25.4	121.6
16	76.4	63.6	12.8
17	108.3	13.9	94.5
18	86.8	15.3	71.4
19	69.0	17.7	51.3
20	75.5	27.0	48.5

Table 1—Time (seconds) to placement for the Melker™ and Quicktrach™ kits for each resident.

by seven-foot-long (two meters) tunnel constructed of PVC pipe and plywood boarding. The manikin was situated at the far end of the tunnel and was positioned based on right versus left hand dominance of the resident performing the procedure. Current teaching of the emergency cricothyrotomy procedure recommends that the operator perform the procedure on the patient's right side if left-handed, and on the patient's left side if right handed.[4] In other words, the operator's dominant hand is positioned cephalad and the non-dominant hand is positioned caudad.

Prior to the residents performing the procedure, an in-service was provided to introduce the Melker™ and Quicktrach™ kits, provide familiarity with the devices, and to illustrate the correct way to perform each technique. This in-service training was provided by the lead investigator. Immediately following the instructional portion of the in-service, the residents were given the opportunity to experience performing each technique on the manikin in the Palmetto Health-University of South Carolina School of Medicine Simulation Center. During this time, the residents received further instruction from the lead investigator as needed. The goal of the in-service training was to attempt to standardize the resident's proficiency at performing the procedures prior to data collection. The confined space was not revealed to the residents until they were to undergo timed performance of the procedure, which constituted the data collection phase.

Kit	Mean Time to Placement (Sec)
Melker	108.5
Quicktrach	23.9

Table 2—Mean time (seconds) to placement for the Melker™ and Quicktrach™ kits.

Once the manikin had been positioned in the confined space, the kits were placed on the thorax of the manikin in random order and the resident entered the confined space. After the resident was positioned beside the manikin, the timing to completion of the procedure began when the resident began to open it. The timing phase ended when the resident said "stop", indicating that the procedure was completed. The procedures were observed directly by the lead investigator at all times. At the end of the procedure, the resident would exit the confined space and the manikin was inspected by the lead investigator. The manikin was examined for *correctness of placement*, defined as being in the airway or out of the airway. These results, as well as time to placement, were not revealed to the resident. Upon completion of the examination of the manikin, the resident again entered the confined space after the second kit had been placed on the thorax of the manikin, and the process was repeated. At the end of the trial session, the residents were asked which kit they would prefer in this situation, and the answers were recorded. This process was repeated for all 20 residents tested. There were no time limits set to complete the cricothyrotomy.

The residents who participated in this study all were current residents of the Department of Emergency Medicine at Palmetto Health Richland. The resident pool consisted of seven PGY-1, six PGY-2, and seven PGY-3 residents.

Results

All cricothyroid airways were placed correctly, i.e., there were no placements of either device outside of the manikin's airway. The times for placement for Melker™ and Quicktrach™ kits are listed in Table 1. For the Melker kit, the mean time to placement was 108.5 seconds (standard error = 10.09 seconds); for the Quicktrach kit, the mean was 23.9 seconds (standard error = 2.91 seconds), (Table 2). The mean value for the difference was 84.5 seconds (standard error = 9.5 seconds). A preliminary overall test for equality of means provided a t-statistic of 8.88 ($p<0.0001$), indicating a statistically significant difference between mean times to placement for the two kits.

This study was conducted as a cross-over design in which each subject used both kits. As such, there was no evidence of a carry-over effect ($p = 0.292$), nor of a period effect ($p = 0.973$). The test on treatments was significant ($p < 0.0001$), indicating a

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longer time to placement for the Melker™ kit compared to the Quicktrach™ kit.

All residents preferred the Quicktrach™ kit based on subjective questioning immediately following the use of both devices.

Discussion

All attempts at placement, regardless of kit type, were in the airway. All residents preferred the Quicktrach™. Most notably, this study produced results similar to findings of previous studies.[1] This study reproduces that finding when the kits were employed in a confined space situation. Several studies involving the comparison of the two kits have been done, but none in a confined-space setting.

In this study, an environment was created that would be uncomfortable to work in and would not provide optimal conditions for performing the cricothyrotomy procedure. The fact that the Melker™ kit has many parts, requires more steps, and greater manipulation including some assembly, and that the Quicktrach™ has only three parts and requires less manipulation, may have contributed to these results. These characteristics could affect the performance times, especially in a disaster situation.

There were no complications when the Quicktrach™ kit was used. It remained sturdy and performed well. The only performance issue was that the latex of the neck skin would not allow the catheter to seat fully against the manikin due to recoil effect and increased friction. This might be easy to remedy with a small vertical incision similar to that placed for insertion of the Melker™ and other kits using the Seldinger technique. The instructions for use of the Quicktrach™ currently do not include direction for this using incision. However, this may be a sound recommendation when using this kit on human subjects as well, and might only minimally increase the time to placement.

The Melker™ kit also performed well structurally. The only component requiring replacement was the guide wire. The guide wire sometimes kinked while sliding the catheter and introducer over it, an occurrence which happens when the procedure is performed on living subjects.

The residents who performed the procedures in this study were at different levels of education and training with an almost equal complement from each post-graduate year of this residency program. It is not believed that this affected the time to placement, and did not affect the correctness of placement, since all were correctly placed in the airway. It is not known if the residents had prior experience with performing cricothyrotomies as they are very rarely performed in this emergency department. Due to this fact, all residents were given in-service education and training to facilitate familiarity with the procedure and the two different techniques. Therefore, all residents had roughly the same experience with the procedures.

This study was limited by several factors. A true disaster situation cannot be recreated or constructed in the simulation laboratory at a hospital. Even to do so, the sights, sounds, and smells of a disaster setting would have to be accurately reproduced. Ideally, the authors hoped to evoke the emotional impact of having to crawl into a confined space and secure a patient's airway as a prehospital healthcare provider. However, it was not possible to accurately simulate certain aspects of the encounter. The Air-Man™ manikin was anatomically correct and very lifelike. Although fairly realistic, neither manikins nor cadaveric specimens can truly represent the feel of a living patient's skin and anatomy as it is a dynamic situation. Manikins by nature are static structures.

The Melker™ kit utilizing the Seldinger technique, is a ubiquitous kit in Emergency Departments, and serves its purpose well in that environment. In this study, the interest was in which kit may best suit those prehospital providers who respond to provide care to others during disasters. In this capacity, it is believed that the Quicktrach™ cricothyrotomy kit is the best. Its small size, few parts, and simple, sturdy design make the Quicktrach™ a valuable option in emergency airway management, especially from a disaster medicine standpoint.

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