Tracheal Ring Fracture Secondary to Percutaneous Tracheostomy: Is Tracheal Flaccidity a Risk Factor?

Fausto Ferraro, MD,* Raffaele Marfella, MD, PhD,† Marianna Esposito, MD,* Jole Petruzzi, MD,* Annarita Torino, MD,* Anna d'Elia, MD,* Mario Santini, MD,‡ and Alfonso Fiorelli, MD, PhD‡

Objective: **To evaluate the risk factors of tracheal ring fracture and whether previous tracheal ring flaccidity predisposes to it in consecutive, mechanically ventilated, intensive care unit patients undergoing different percutaneous dilatational tracheostomy procedures (Ciaglia Blue Rhino, PercuTwist, and Ciaglia BlueDolphin).**

Design: **Single-center retrospective study performed between November 2006 and July 2013.**

Setting: **Single-center university hospital.**

Participants: **Two hundred nineteen consecutive intensive care unit patients.**

Interventions: **Video bronchoscopic percutaneous dilatational tracheostomies using different techniques, including Ciaglia Blue Rhino, PercuTwist, and Ciaglia BlueDolphin, were performed consecutively. During the procedure, the tracheal wall response to the routine external palpation was evaluated endoscopically to find the interanular space. An abnormal change in the tracheal ring shape (fingerprint) with anterior airway wall collapse was diagnosed as tracheal flaccidity.**

Measurements and Main Results: **Tracheal ring fracture occurred in 21 patients (9.6%). The proportion of tracheal ruptures was 16 (76.2%) after PercuTwist, 3 (14.3%) after Ciaglia Blue Dolphin, and 2 (9.5%) after the Blue Rhino technique. Significant risk factors for tracheal rupture were PercuTwist procedure ($p = 0.02$), tracheal flaccidity ($p = 0.0001$), and a period of intubation before a percutaneous dilatational tracheostomy procedure >14 days ($p = 0.01$).**

Conclusions: **In addition to the PercuTwist technique and intubation >14 days before tracheostomy, tracheal flaccidity was a significant risk factor for tracheal ring fracture. In the presence of this finding, a less traumatic tracheostomy procedure should be applied.**

KEY WORDS: ***bronchoscopic surgical procedures, intensive care, mechanical ventilation, tracheal rupture, tracheomalacia, tracheostomy, percutaneous, tracheostomy***

PERCUTANEOUS DILATATIONAL tracheostomy (PDT) has become increasingly popular for patients who need prolonged ventilator support, nearly replacing traditional surgical tracheostomy because it reduces time, cost, and complications.[1,2] The PDT perioperative complication rate, from complications such as bleeding, subcutaneous emphysema, posterior tracheal wall puncture, and tracheal lesions, is reported to be from 1% to 3%.[2] Several studies have suggested that the complication rate changes with different techniques used.[3] The tracheal ring rupture is a severe complication of PDT, occurring in 2% to 8.9% of cases[4,5] that can lead to tracheal stenosis, formation of tissue granulation, and/or scarring.[6–8] However, the pathophysiologic mechanisms and predictive risk factors of tracheal ring fracture still are unknown. This retrospective study aimed to evaluate the predictive risk factors of tracheal ring fractures in a consecutive series of mechanically ventilated patients treated with different standard PDT techniques (PercuTwist, Ciaglia Blue Rhino, and Ciaglia Blue Dolphin). In addition, the study focused on a particular anatomic condition not reported before in the literature—tracheal flaccidity—and how the standard PDT procedure should be modified in light of this finding.

*From the *Department of Anesthesiological, Surgical and Emergency Sciences, Second University of Naples, Naples, Italy, †Department of Geriatrics and Metabolic Diseases, Second University of Naples, Naples, Italy; and ‡Thoracic Surgery Unit, Second University of Naples, Naples, Italy.*

Address reprint requests to Alfonso Fiorelli MD, PhD, Thoracic Surgery Unit, Second University of Naples, Piazza Miraglia 3, Naples, Italy 80100. E-mail: alfonso.fiorelli@unina2.it

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METHODS

The clinical records of all consecutive mechanically ventilated patients undergoing an elective PDT from November 2006 to July 2013 at the intensive care unit and emergency unit of the Second University of Naples were reviewed retrospectively. Three different methods of PDT (PercuTwist, Ciaglia Blue-Rhino, and Ciaglia Blue Dolphin) were used consecutively. The choice of one approach over another was made on the availability of the kits and not for a specific indication. Exclusion criteria were (1) PDT performed for emergency, (2) the lack of endoscopic view during the PDT, (3) the lack of endoscopic check after the procedure, and (4) anatomic or pathophysiologic conditions (eg, short neck, coagulation abnormalities). The study design was approved by the institutional ethics committee of Second University of Naples. Informed written consent about the invasive procedure was obtained from the patients or their close relatives.

All PDTs were performed at bedside under bronchoscope guidance with a video system (Pentax EB 1570K, Ø 5.5 mm, Tokyo, Japan). All patients underwent total intravenous anesthesia; electrocardiography, pulse oximeter oxygen saturation, invasive blood pressure, end-tidal carbon dioxide, tidal volume, and airway pressure were monitored continuously. Before and after the procedure, a blood gas analysis was obtained. Ventilation and continuous video bronchoscopy were carried out according to the authors' technique, previously described.[9] The tracheostomy techniques used were Ciaglia Blue Rhino (William Cook Europe, Bjaeverskov, Denmark); a single-step screw-type dilatator technique (PercuTwist, Rush, Kernen, Germany); and Ciaglia Blue Dolphin (Ciaglia Balloon-Assisted Tracheostomy Introducer Set, William Cook Europe, Bjaeverskov, Denmark); all were performed with the conventional method as elsewhere described.[10–12] Because all tracheostomies were elective and programmable, they were performed by a dedicated team that was similar for all patients, composed

of a nurse and 2 intensive care physicians (one performing the bronchoscopy and the other performing the PDT). One of the intensivists was always the same (F.F.), a senior with more than 20 years of experience in tracheostomies. Routinely, before PDT, the first operator performed the neck palpation to examine tracheal anatomy and to identify the precise inter-tracheal ring space. The palpation was performed with the index finger of the hand, blocking the windpipe with the thumb and middle finger; at the same time, the second operator performed the video naso-tracheobronchial endoscopy. The space between either the second and third ring or the third and fourth ring was selected. During the procedure, the tracheal wall response to the external palpation was evaluated endoscopically to find the interanular space. Generally, the whole trachea collapsed, but the shape of the tracheal rings did not change (Fig 1A-1C); instead, when the tracheal ring changed its shape after the same palpation, an anterior airway wall collapse was observed, which appeared as an imprint of the finger that palpated it (fingerprint). This peculiar pattern was registered routinely as tracheal ring flaccidity (Fig 1B-1D). The flaccidity observation was not validated by blinded observers, but the entire staff agreed with the diagnosis on the monitor view. The video bronchoscope surveillance was performed during the whole procedure and allowed for the detection of potential tracheal ring fractures

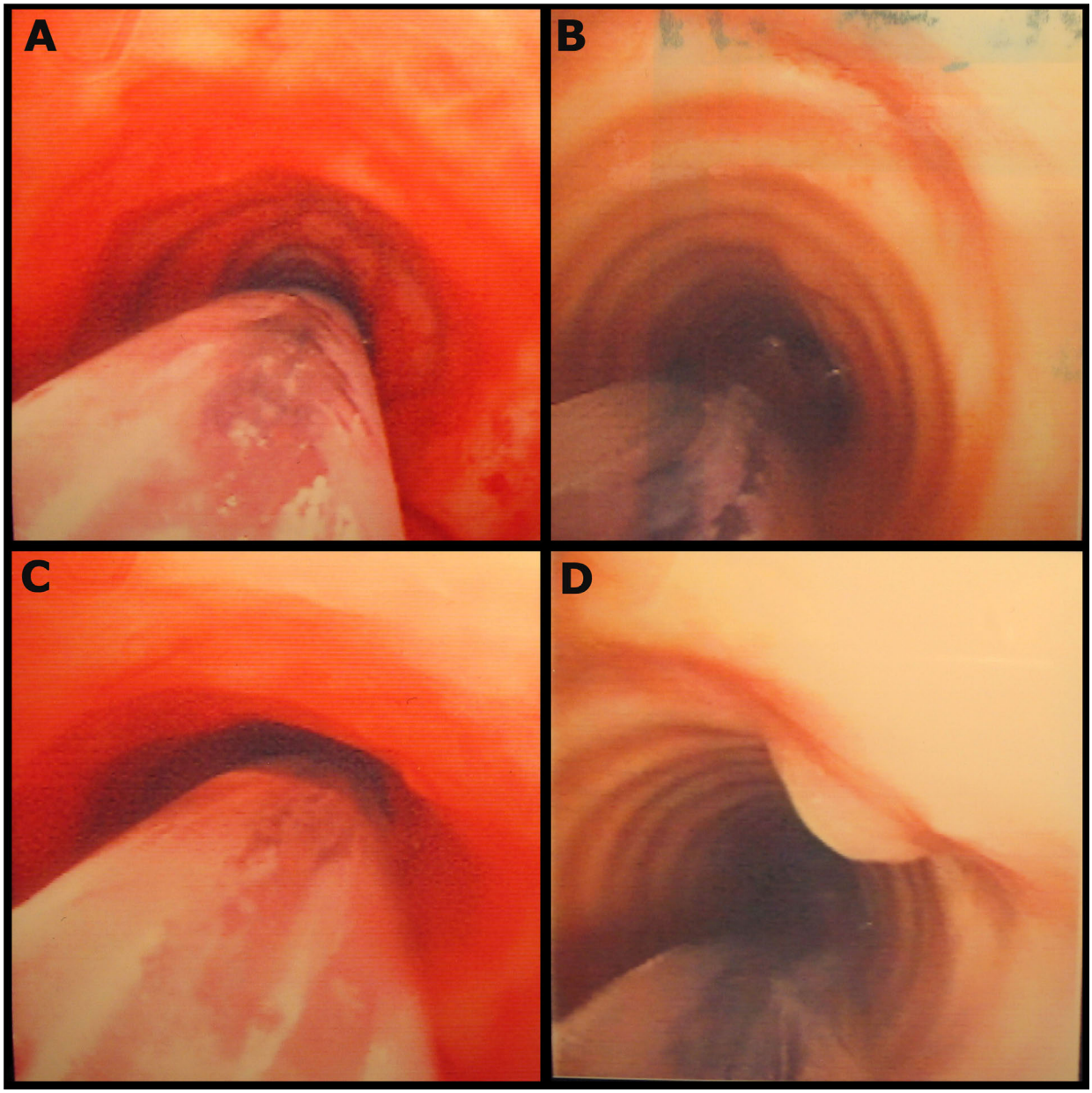

Fig 1. Patient with no tracheal rings flaccidity: During palpation, the whole windpipe collapses (A), but the shape of the tracheal rings does not change (B). Patient with tracheal rings flaccidity: During palpation (C), the flaccid tracheal rings collapse (D). At endoscopic view, it shows the mirror image of fingerprint.