Ivy Loop Wiring: A Useful Form of Endotracheal Tube Stabilization in Burn Patients

La ligature d'Ivy, utile pour stabiliser la sonde trachéale chez les patients brûlés

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Abstract

The stabilization of endotracheal tubes in the burn population presents many problems. Access to the face for dressings, debridements, and the use of topical antimicrobials prevent adequate stabilization of the endotracheal tube with commonly used methods. Conventional methods have an increased risk of shifting, which can lead to injury to the friable burned tissue or unplanned extubation. To prevent these complications, alternative methods using the dentition to stabilize the endotracheal tube have been described. Here, we present our technique of using Ivy loops to secure the endotracheal tube. It is a simple method with low complications that provides a strong stabilization of the tube while giving access to the face.

Résumé

La stabilisation de la sonde trachéale au sein de la population des grands brûlés s'associe à de nombreux problèmes. Il est impossible d'utiliser les méthodes habituelles pour la stabiliser, afin de conserver l'accès au visage pour les pansements, les débridements et l'application d'antimicrobiens topiques. La méthode classique accroît le risque de délogement, qui peut susciter des blessures aux tissus brûlés friables et une extubation non planifiée. Afin de prévenir ces complications, il existe une autre méthode de stabilisation de la sonde trachéale, qui fait appel à la dentition. Dans la présente étude, les chercheurs exposent leur technique d'utilisation des ligatures d'Ivy pour sécuriser la sonde trachéale. C'est une méthode simple, au faible taux de complications, qui assure une stabilisation élevée de la sonde tout en maintenant l'accès au visage.

Keywords

endotracheal tube, Ivy loops, burn, inhalational injury, unplanned extubation

Introduction

The use of endotracheal tubes (ETTs) and mechanical ventilation are mainstays of intensive care units (ICUs). These methods are commonly used in the burn patient population particularly when inhalational injuries are present. Up to one-third of burn patients will have an inhalational injury.^{1,2} These patients will often have sustained facial burns.³ These injuries carry a significant mortality and morbidity increase.⁴ Many of these patients will be intubated in order to protect the airway and potentially mechanical ventilation.

In all intubated patients, stabilization of the ETT is crucial. Stabilization prevents migration and unexpected endotracheal extubation (UEE), a potentially serious airway complication. To prevent this risk, various methods of securing the ETT have

been developed ranging from tape to commercially available devices. Most of these methods require the use of an adhesive attached to the face to secure the ETT. However, in the burn population, this can be difficult to achieve. Facial burns will lead to the fluid losses and require application of antimicrobial ointments and dressings affecting the adhesive. If the patient requires prolonged intubation, the adhesives can cause damage

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to the friable skin. In addition, these patients will require dressings and potential operations on their faces which the stabilization can interfere with.

To leave the face free in burn patients from ETT stabilizing devices would be ideal. There are multiple descriptions of techniques that attempt this, including the use of commonly used craniofacial techniques—orthodontic splints,⁵ enamel anchors,⁶ intermaxillary fixation (IMF) screws,⁷ circumdental wiring,⁸ and arch bars.⁹ Ivy loops are a commonly used technique to establish IMF in patients with facial fractures. In a commentary, it has been stated that a group has successfully used Ivy loops in pediatric patients.¹⁰ Here, we present our method of ETT stabilization using the Ivy loop technique in adult and pediatric patients.

Indications

All adult patients requiring ETT are potential candidates. Most commonly this technique is applied to patients with facial burns requiring intubation and possible ventilation. It is particularly useful in burn patients undergoing facial surgery or patients requiring a stable ETT fixation when in the prone position. The Ivy loop will be completed at the time of initial intubation or during the initial operation when the previous stabilization method will be exchanged. Suitable dentition, defined as 2 adjacent pre-molars or molars, are required to apply the technique. The technique is ideally applied to the maxillary dentition due to the relative immobility; however, in the case of absent maxillary dentition, the mandibular dentition can be used. If no dentition is available, the technique can still be used if combined with IMF screws. An IMF screw is placed in the maxilla to act as the point of fixation for the Ivy loop. The Ivy loop can then be placed through the IMF screw and fixated to the ETT as described later.

Contraindications

Patients with complete absence of usable dentition on both the maxilla and mandible are unable to undergo this technique, unless modified with IMF screws. Also loose dentition is unsuitable for this technique as the tooth can avulse destabilizing the ETT. The requirement for intubation and ventilation should always be reviewed prior to applying the Ivy loop. If patient is a candidate for extubation, the technique should not be used.

Technique

Ivy loops are made from 24-gauge wire cut into halves. The wire is folded upon itself to form a U. Using a mosquito or fine needle driver, clamp the bend in the wire. Rotate the wire clockwise around the clamp to form the eyelet. This should leave an eyelet and 2 limbs similar to the depiction in Figure 1A. Ensure the eyelet has a diameter of sufficient size to pass one of the limbs.

With the patient in the supine position, an assistant stabilizes the ETT. Previous stabilization methods are removed if present.

Figure 1. Fabricating an Ivy loop begins with a 26-gauge wire cut in half. This is then folded on itself. Using a fine needle driver or a mosquito clamp, the wire is twisted into the pictured Ivy loop. Images of 26-gauge wire, wire bent and twisted into an Ivy loop (A). The wire is then based through the interdental space, then around the proximal and distal teeth. This acts as a support while providing 2 free limbs used to secure the endotracheal tube (ETT; B). The wire is then wrapped around the ETT tube twice. Ivy loop secured ETT using maxillary dentition (C).

The ideal teeth for securement are identified. We favour the space between the 2 pre-molars if available. If unavailable, our preference is to utilize maxillary dentition that have more than 1 tooth root for stability before considering mandibular dentition that provide less immobilization due to jaw movements. When 2 suitable teeth are identified, the pre-fabricated Ivy-loop is passed through the interdental space, buccal to lingual, with a needle driver. This will place the loop on the outer portion of the gingiva. One of the limbs is then passed around the distal tooth from lingual to buccal and brought through the Ivy loop eyelet. The remaining limb is brought lingually to buccally around the proximal tooth. Both are completed with a heavy needle driver or wire twister (Figure 1B). The ETT is then stabilized by placing the tube in between the 2 limbs and twisting the wire down to the point that it will indent but not occlude the ETT, avoiding the pilot tubing for the balloon on the ETT. This is repeated a second time (Figure 1C). Excess wire can be trimmed with a wire cutter. Ensure before completing the procedure that the tube has not shifted if previously placed and the tube is patent, allowing a suction catheter to be passed for endotracheal suctioning.

Post-Procedure

Immediately after the procedure, a standard chest X-ray should be completed to confirm ETT position. Wiring should be inspected as per respiratory therapists' assessment. Wire cutters should be kept at patients' bedside in case of emergency such as ETT blockage. Wire can be removed in situ with the ETT tubing upon extubation.

Pearls and Pitfalls

This technique can be performed at the bedside or in the OR. In the OR, there is often suitable lighting and the benefit of paralysis. Wearing a headlight greatly improves the lighting both in the OR and more importantly at the bedside. The patient will rarely be paralyzed at the bedside, which will affect jaw opening. The technique can be completed without paralysis but with more difficulty than the OR setting. Having a retractor such as a sweetheart or farabeuf retractors to retract the tongue aids wire placement.

A major downfall of the technique is the removal of the Ivy loop for extubation. This requires someone with the knowledge and skill to remove the wire, which is often beyond the training of the respiratory therapist prior to extubation of the patient. In our institution, the burn unit has ample support, so a staff physician or resident is available to remove the wire, but this could be a complicating factor in some centres.

Complications

Complications are rare and usually minor from Ivy loop insertion. Bleeding can occur from the gingiva, which is usually self-limited. In non-sedated or minimally sedated patients, there may be some irritation from the wire. The most potentially severe complication would be wire fracture. Due to this, respiratory therapists should be instructed to check the wires during routine assessments. If fractured, the wire should be immediately replaced to prevent UEE.

Discussion

The requirement for airway management is common in burn patients. Inhalational injuries can occur in up to one-third of burn patients varying with total body surface area.^{1,3} Often patients are intubated, even with minimal signs as damage to the airway is progressive resulting in difficult airways. These patients will frequently have facial burns associated as 55% of burn patients have facial burns.³

Endotracheal tube stabilization presents multiple challenges in the burn population. Currently used methodologies can prevent adequate burn care by obstructing debridements, topical antimicrobials, and dressings. The application of topical antimicrobials and exudate from the burn can affect the adhesive from commonly used ETT stabilization methods. Inadequate burn care may increase the risk of infection and scarring, while inadequate stabilization can lead to unplanned extubation. An early review examined 5 protocols for securing ETT in patients with facial burns at different burn centres.^{5,11} With the exception of one, all required adhesive being applied to the face, with the exception of a one protocol using a safety pin through the ETT. Most of the described methods obscure the face from burn care and one identified slippage of the stabilization device as a risk. This can greatly increase the risk of unplanned extubation.

Unplanned extubation can be a catastrophic complication in the ICU. Incidences range from 0.7% to 15.9% and can lead to bronchospasm, pneumonia, hypoxia, cardiac arrest, and death.¹² Many devices have been tried to prevent this dreaded complication. However, none have proven to be superior. Force simulators have shown that certain commercial stabilizers require a higher force for extubation, though this may not translate clinically to less extubations.¹³

Since the protocol review, techniques have focused on stabilization that avoids adhesives on the burnt face. Most use wire or suture to stabilize the ETT to either the nasal septum or the patients' dentition. While all methods avoid having the stabilizing device, Ivy loops offer a few advantages. It only requires insertion of 1 wire into the dentition but still offers the strength of having wire over suture. This also allows for easier removal than arch bars that require multiple interdental wires.

Conclusion

Stabilization of ETTs can remain a challenge in burn patients. Currently used techniques can obscure burn care and have diminished effectiveness of tube stabilization. Here, we present a technique of ETT stabilization that allows for optimal burn care with adequate stabilization.

Authors' Note

Edward E. Tredget was responsible for the development of the technique. All authors contributed to the manuscript preparation and critical review. All authors have agreed upon the final version.

Declaration of Conflicting Interests

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