Airway Trauma in a High Patient Volume Academic Cardiac Electrophysiology Laboratory Center

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BACKGROUND: Providing anesthesia and managing airways in the electrophysiology suite can be challenging because of its unique setting outside of the conventional operating room. We report our experience of several cases of reported airway trauma including tongue and pharyngeal hematoma and vocal cord paralysis in this setting.

METHODS: We analyzed all of the reported airway trauma cases between December 2009 and January 2011 in our cardiacl electrophysiology laboratories and compared these cases with those without airway trauma. Data from 87 cases, including 16 cases with reported airway trauma (trauma group) and 71 cases without reported airway trauma from the same patient population pool at the same period (control group), were collected via review of medical records.

RESULTS: Airway trauma was reported for 16 patients (0.7%) in 14 months among 2434 anesthetic cases. None of these patients had life-threatening airway obstruction. The avoidance of muscle relaxants during induction in patients with a body mass index less than 30 was found to be a significant risk factor for airway trauma ($P = 0.04$; odds ratio, 10; 95% confidence interval, 1.1–482). Tongue or soft tissue bite occurred in 2 cases where soft bite block was not used during cardioversion. No statistically significant difference was found between the trauma and the control groups for preprocedure anticoagulation, anticoagulation during the procedure, or reversal of heparin at the end of the procedure.

CONCLUSIONS: The overall incidence of reported airway trauma was 0.7% in our study population. Tongue injury was the most common airway trauma. The cause seems to have been multifactorial; however, airway management without muscle relaxant emerged as a potential risk factor. Intubation with muscle relaxant is recommended, as is placing a soft bite block and ensuring no soft tissue is between the teeth before cardioversion. (Anesth Analg 2013;116:112–7)

The use of catheter ablation therapy in patients with atrial fibrillation (AF) has become significantly more prevalent over the past decade. Increasingly, patients who are elderly with multiple comorbidities and those with more persistent AF are now considered candidates for ablation.1 Given the typically long duration and complexities of this procedure, adequate sedation is essential for patient comfort, safety, and optimal outcome. Ablations can be performed under general anesthesia or sedation. Although the use of general anesthesia for catheter ablation has been shown to have improved long-term outcome compared with conscious sedation,2 data regarding complications and outcomes related to anesthesia in this setting are too limited to make any recommendations or guidelines for providing anesthesia specifically in electrophysiology laboratories.

Providing anesthesia in a nonstandard operating room setting such as an electrophysiology laboratory can be challenging, and equipment (radiograph cameras, mapping systems, etc.) can limit the working space and make intubation awkward. Furthermore, muscle relaxants are often avoided for cardiac catheter ablations, to facilitate identification of the phrenic nerve and avoid its injury. Moreover, patients in electrophysiology laboratories are often under therapeutic anticoagulation; minor airway injury, which could otherwise be inconsequential, could potentially trigger severe complications. Retropharyngeal, lingual, and epiglottic hematomas have been reported as complications of anticoagulation therapy.3–6 In the Hospital of the University of Pennsylvania, there has been a shift from the use of conscious sedation to general anesthesia for electrophysiology procedures over the past few years. During this time, several cases of airway trauma have been reported and discussed as part of quality improvement. Many of the cases triggered otolaryngologist (ear, nose, and throat [ENT]) consultation for potential upper airway obstruction.
All of these cases underscore the need to investigate airway trauma in cardiac electrophysiology patients. This study was designed to investigate the type of airway trauma and to identify the risk factors in patients having electrophysiology procedures. We hypothesized that some patient-specific features (such as body mass index [BMI]), anesthesia-specific factors (such as avoidance of neuromuscular blocking drugs [NMBDs] and use of high-frequency jet ventilation), and procedure-specific factors (such as cardioversion and anticoagulation) may have contributed to airway trauma. We analyzed all of our reported cases of airway trauma and compared these with cases without reported airway trauma. The goal was to develop recommendations to avoid this potentially life-threatening complication.

METHODS

This investigation was approved by the IRB of the University of Pennsylvania. Written informed consent was waived by the IRB. Patients involved in this study underwent electrophysiology procedures (mostly catheter ablation for AF) between December 2009 and January 2011. All anesthesia care, including tracheal intubation, was provided by certified registered nurse anesthetists with years of practice experience who were supervised by experienced anesthesiologists; no residents nor any trainees were involved in any of the cases included. We analyzed 16 cases with reported airway trauma (trauma group) and compared them with 71 cases without reported airway trauma from the same patient population pool at the same period (control group) who underwent interventional cardiac electrophysiological procedures. All patients were under general anesthesia with endotracheal intubation, except 2 patients in the trauma group and 1 patient in the control group who had a laryngeal mask airway (LMA). The following data were collected via review of medical records by multiple experienced anesthesiologists: demographic data, preoperative airway assessment, type of airway trauma, anticoagulation management, use of muscle relaxant, temperature probe insertion, use of jet ventilation, bite block insertion, GlideScope use, and number and energy of cardioversions during the procedure. Anticoagulation at the time of intubation was defined as the presence of any anticoagulation therapy, generally IV heparin, started before intubation.

Categorical data are presented using percentage; quantitative data are expressed as mean ± SD. Fisher exact test was used for statistical analysis of categorical data for the 2 groups. Confidence interval and odds ratio were calculated via a web-based calculator (http://www.hutchon.net/ConfidOR.htm) and Stata (V11; StataCorp LP, College Station, TX). The confidence interval is for the odds ratio. The \( P \) values are for the Fisher exact test and are considered statistically significant when \( P < 0.05 \).

RESULTS

Demographic Data

Of the 2434 anesthetic cases during the stipulated 14 months, 16 patients had reported airway trauma. These cases were evenly distributed over this time frame, not clustered. The patient population consisted predominantly of older male, overweight patients (BMI > 30 kg/m²), with one third of the patients having obstructive sleep apnea (OSA). There was no significant difference in age, gender, weight, height, BMI, left ventricular ejection fraction, history of OSA, or duration of the procedure (Table 1) between the trauma and the control groups.

Types of Airway Injury and Outcome

Airway trauma could be classified into 3 types (Table 2): tongue injury, pharyngeal hematoma, and multiple traumas. Ten patients experienced tongue injury. Five patients sustained complex injuries, including hoarseness, sore throat, difficulty swallowing, bruised uvula, lacerated uvula, vocal cord paralysis, oral bleeding, and palate trauma; 2 of them were treated with steroids.

Ten patients required urgent otolaryngologist evaluation; 2 patients needed a swallow test, and 1 patient needed intensive care unit (ICU) admission for potential airway obstruction (Fig. 1). There were no life-threatening airway obstruction consequences reported in any of the 16 trauma patients. However, almost all of the patients required temporary withholding of the needed heparin infusion. Fortunately, none of the patients in the current study had apparent (symptomatic) thromboembolic complications as a result of withholding heparin temporarily. All patients recovered well without known adverse consequences.

Risk Factors

There was no distinct demographic characteristic identified as a significant risk factor (Table 1). No statistically

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<td><strong>Trauma group</strong></td>
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Data are presented as mean ± SD unless otherwise indicated.

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significant differences were found in anticoagulation management, use of a Glidescope, soft bite block, or jet ventilation between the 2 groups (Table 3). Avoidance of a muscle relaxant for airway management in patients with a BMI <30 kg/m\(^2\) was identified as a potential significant risk factor for airway trauma.

Thirty-eight percent of patients in the trauma group and 65% in the control group received an NMBD during induction (\(P=0.053\)). However, for the patients whose BMI was <30 kg/m\(^2\), there was a statistically significant difference in rate of NMBD use between these 2 groups. In the trauma group, there were 6 cases without NMBD (86% vs control group, 38%; \(P=0.035\)). The odds ratio was 10; however, the 95% confidence interval was wide (1.0–482.0), and the \(P\) value was not corrected for the effect of multiple comparisons. Although the difference for the predicted difficult intubation (Mallampati \(\geq III\)) did not reach statistical significance, the odds ratio was nearly 6.

In the present study, airway injury was reported in 2 patients who had an LMA. One patient reported hoarseness, sore throat, and difficulty swallowing, with a bruised and lacerated uvula; otolaryngology evaluation revealed left vocal cord paralysis, which resolved completely after a month. The other patient had a sore throat, but no ENT consultation was needed. In the control group, an LMA was only used in 1 case. Two patients bit their tongue or soft tissue during cardioversion without a bite block.

**DISCUSSION**

In this study, we found that the rate of reported severe airway trauma in patients undergoing cardiac electrophysiology procedures overall was approximately 0.7%. The avoidance of a muscle relaxant during induction in patients with BMI <30 kg/m\(^2\) was identified as a statistically significant risk factor. Airway trauma was also reported in patients using an LMA. The most common airway trauma is tongue injury. These injuries can be severe enough to need ENT consultation and close observation in the ICU for potential airway obstruction.
Incidence of Airway Injury and Significance

Endotracheal intubation can cause airway injury that could potentially lead to life-threatening complications including tracheal injury and rupture. The common airway injuries related to anesthesia are vocal cord paralysis, granuloma, arytenoid dislocation, hemotoma, perforation, lacerations, and dental injury. The most common claims against the anesthesiologist are from dental injury. Two recent large studies indicated that the rate of dental injury is approximately 0.13% under general anesthesia and 0.2% in emergent intubation situations. In contrast, the most common reported injury in the present study was to the tongue, without any reported dental injury. Most were severe enough to necessitate ENT consultation, and 1 patient needed additional ICU observation because of airway patency concerns. The overall incidence was 0.7%, 3 times that of dental injury reported in an emergent setting. It is worth noting that airway trauma including trauma to the tongue and larynx, as seen in this study, accounted for 30% of airway claims in an analysis of claims against the National Health Service in England from 1995 to 2007. It is vital to analyze the potential risks and find solutions to reduce airway-related complications in this new frontier of anesthesiology.

Risk Factor Analysis and Potential Solutions

Demographic Factors

Although obesity has been associated with difficult intubation, only BMI > 40 kg/m² was found to be a risk factor. OSA has been considered a risk factor for difficult airway, and the combination of obesity and OSA is always a challenge to anesthesiologists due to a potentially difficult airway. Although we initially thought that obesity and OSA could be significant risk factors for airway injury, no significant difference was revealed between the 2 groups. This finding may have been due to small sample size or anesthesiologist precautions when managing this subgroup of patients.

Muscle Relaxants

Monitoring the phrenic nerve is important during ablation of AF, so anesthesia without muscle relaxants is desired by cardiologists for these procedures. Intubation without a muscle relaxant is achievable with deep anesthesia or with the combination of propofol and remifentanil. However, difficult intubations and adverse hemodynamic events are more frequently related to intubation without muscle relaxants, and excellent intubation conditions are more frequent when muscle relaxation is used.

Airway management without muscle relaxants has been favored by some anesthesia providers, especially for patients who are not obese and not anticipated to be difficult to intubate. Unfortunately, this study indicated that airway trauma might be associated with absence of muscle relaxants during induction. It is interesting that the potential association is only seen in the subgroup of patients with BMI < 30 kg/m² with an odds ratio of 10. It is important to note that there is a discrepancy between the statistical analysis for P value for Fisher exact test for this potential risk factor and the wide confidence interval for the odds ratio as demonstrated and explained in Table 3. The wide 95% confidence interval may have been caused by the small number of patients in the trauma group. The loss of a statistically significant difference when the patients with BMI > 30 kg/m² were added into the data analysis was probably because the anesthesiology providers tended to use a muscle relaxant or other airway precautions for morbidly obese patients. On the basis of these findings, the use of a muscle relaxant for airway management in electrophysiology patients is recommended.

Anticoagulation and Airway Trauma

Hematoma in the upper airway has been reported to be a complication for patients who were anticoagulated, with severity varying from asymptomatic to obstruction requiring a surgical airway. Thus, anticoagulated patients are at risk of spontaneous hematoma, and even a minor injury caused by any event in the upper airway such as intubation and vigorous oral suctioning could lead to a hematoma. During ablation procedures for AF and any left-sided ablations, the activated clotting times are typically kept in the 350-second range. We did not find any difference between the 2 groups in terms of anticoagulation management; thus, we cannot conclude that anticoagulation is a significant risk factor. However, it is likely that anticoagulation at the time of intubation could be an important precipitating factor. Thus, it is recommended to intubate patients before heparinization to reduce potential airway hematoma associated with minor airway trauma.

Clinicians should be aware that an initially asymptomatic lingual bruise could worsen to a hematoma, completely obstructing the airway, although this did not apply to any of the patients in this study except for 1 patient who needed additional ICU observation. Withholding heparin infusion might have prevented life-threatening airway obstruction. However, withholding heparin could potentially put these postablation patients at risk of clot formation. Fortunately, this catastrophe did not occur in this small number of reported patients.

Laryngeal Mask Airway

The LMA was developed as an alternative method to manage the airway, especially in patients with a difficult airway. Although LMA insertion is technically easier than endotracheal intubation, it can be associated with airway injuries, including sore throat, hoarse voice, and epiglottic edema.

In a recent study comparing 2 different methods of LMA insertion, 16% to 32% of LMAs became blood-stained, indicating soft tissue abrasion. This high rate of blood staining is not generally a significant issue; however, it could be problematic in patients with high-intensity anticoagulation. The frequency of blood-stained LMAs in anticoagulated patients is unknown, but severe laryngeal hematoma after LMA insertion in a patient with bleeding diathesis has been reported. In the present study, airway injury was reported in 2 patients using an LMA in the trauma group. Although no conclusion can be made from this small number of cases, an LMA might not be a good choice for airway management in anticoagulated electrophysiology patients.
**Bite Block**

Two cases in this study involve bite-related injury during cardioversion. It is critical to place a soft bite block between patients’ teeth and to ensure there is no tongue or soft tissue between the teeth before cardioversion, to avoid this complication.

**Limitations**

The major limitation of this study is that it is retrospective, and only reported airway injuries were included. With the small sample size, it is not powered enough to reveal all contributing factors. There may have been occult cases of airway trauma, which may have been relatively minor and therefore not reported by patients and/or care providers.

In summary, the overall incidence of airway trauma was 0.7% of our study population. Tongue injury was the most common injury in the current study population. The cause seems to be multifactorial; however, airway management without a muscle relaxant emerged as a potential risk factor. A muscle relaxant is recommended for intubating these anticoagulated patients. Tongue biting can occur during cardioversion, without proper precautions, which include placing a soft bite block and ensuring that no soft tissue is between the teeth before cardioversion. Although no statistically significant difference was obtained between the groups for variables related to anticoagulation, the fact that these patients were typically anticoagulated at a high level probably contributed to the severity of airway trauma. Intubation before heparin administration is recommended.

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**DISCLOSURES**

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Attestation: Zhe Yan has seen the original study data, reviewed the analysis of the data, approved the final manuscript, and is the author responsible for archiving the study files.
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Contribution: This author helped design the study, conduct the study, analyze the data, and write the manuscript.
Attestation: Renyu Liu has seen the original study data, reviewed the analysis of the data, approved the final manuscript, and is the author responsible for archiving the study files.

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