Original Article

Perioperative Dental injury: A Review of 23,574 General Anesthesia Procedures

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Objective: This retrospective study aimed at assessing the incidence of dental injury (DI) after incorporation of video airway devices into clinical practice.

Methods: All incidents of anesthesia-related DI in operation theater in adult patients from the perioperative record database of a tertiary referral center between January 1, 2015 and December 31, 2015 were retrospectively reviewed. Patients whose DI was not related to anesthesia (e.g., surgical procedure-related) and those with age under 18 were excluded from the current study. To investigate the overall incidence of anesthesia-related DI, the PubMed database was searched to identify relevant articles in the last decade (i.e., from 2009 to 2019). Data on anesthesia-related DI at our institute were used for comparison.

Results: A total of 23,574 general anesthesia procedures were identified. Of the 11 incidents of DI, three were surgery-related and eight were anesthesia-related. The incidence of anesthesia-related DI was 0.03%. From the literature review, the highest incidence of DI was noted in patients undergoing tracheal intubation (0.11% to 25%), followed by those receiving anesthetic care (0.04% to 0.11%) and general anesthesia (0.02% to 0.09%). The incidence of anesthesia-related DI at our institute was lower than that (i.e., 0.04%) of a large-scale study involving over eight hundred thousand patients and was much lower than that reported in another Taiwanese study (i.e., 0.11%).

Conclusions: Our study demonstrated that incorporation of video airway devices into clinical practice seemed to have a positive impact on the incidence of overall anesthesia-related DI according to a literature-based comparison.

Key words: tracheal intubation, Macintosh laryngoscope, Trachway stylet, dental injury

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Introduction

Trauma to the patient's teeth is a common anesthetic event and responsible for the largest number of malpractice claims against anesthetists.[1-3] It is generally acknowledged that perioperative dental injuries (DI) occur mainly during laryngoscopy and are triggered by direct trauma of the laryngoscope to the teeth. The flange of the Macintosh blade appears responsible for such damage.[4] Other DI-associated risk factors also included the presence of difficult airway and pre-existing poor dentition.[5-7] Indeed, for patients with poor dentition, even a slight dental contact with an airway device (e.g., laryngoscope) may cause DI[4] that may be associated with severe complications such as ingestion and aspiration.[7,8]

In recent years, a large number of video intubation devices have been introduced in the market, and some are claimed to reduce the risk of dental trauma by reducing the forces applied to the maxillary incisors.[9-11] Although a recent meta-analysis showed that the incidence of oral, mucosal or dental injuries with videolaryngoscopy was lower than that with Macintosh laryngoscopy during tracheal intubation[12] another isolated retrospective study identified the use of McGrath videolaryngoscope as a risk factor for DI (i.e., odd ratio, 2.51).[6] The Trachway intubating stylet (Trachway®, Biotronic Instrument Enterprise Ltd., Taichung, Taiwan, R.O.C.) is a video-assisted system equipped with a rigid intubating stylet.[13] Because of the absence of a large blade, frequencies of airway trauma with this device during airway manipulation are reported to be low compared to those associated with Macintosh laryngoscope.[14] In addition, Trachway® has been reported to be effective in the management of difficult airway.[13,15] Three sets of Trachway® were available at our institute since 2013. Studies to re-examine the incidence of DI in recent years are still scarce. Taking into account the reported benefits of Trachway® compared to conventional laryngoscopy, we hypothesized that the incidence of DI at our institute may be low. Therefore, the aim of our study was to investigate the incidence rate of DI at our institute, and the overall incidence of anesthesia-related DI in the literature was also acquired for comparison.

Methods

Study populations, design, and setting

All incidents of anesthesia-related DI in operation theater in adult patients from the perioperative record database of a tertiary referral center between January 1, 2015 and December 31, 2015 were retrospectively reviewed. Patients whose DI was not related to anesthesia (e.g., surgical procedure-related) and those with age under 18 were excluded from the current study. Since some patients received more than one operation during the study period, the number of cases was defined as the events rather than the number of patients. The study was conducted in accordance with the Declaration of Helsinki and was approved by the Institutional Review Board (EMRP-106-020) of the institute. Informed written consent was waived because of the retrospective nature of the study.

Anesthesia and intubation procedures

Detailed oral/dental examination before anesthetic induction is a routine practice at our institute. Before airway manipulation, anesthesiologists routinely evaluated each patient's dental condition by confirming the removal of all false teeth and testing tooth mobility through applying a light force to the tooth with a tongue depressor. In the presence of poor dentition (defined as visible movement of tooth), the risk of DI was explained routinely to the patient's family and this information was documented in the anesthetic records. At our institute, there are still no established criteria or

standards guiding the use of airway devices for tracheal intubation in patients with poor dentition. Therefore, the choice of airway devices was at the discretion of the anesthesiologists. Three sets of Trachway® purchased before 2013, were available at the institute during the study period.

Definitions

Poor dentition was defined as any visible movement of tooth when a light force was applied on pre-intubation assessment. DI was defined as injury involved subluxation, luxation, avulsion, crown fracture, or damage to fixed partial denture, regardless of the dental status.[7]

Literature search strategy

To investigate the overall incidence of anesthesia-related DI regardless of the causes, the PubMed database was searched to identify relevant articles in the last decade (i.e., from 2009 to 2019) using the following keywords: "dental injury", "teeth injury", "airway complications", "dental trauma", "intraoperative", "anesthesia", or "tracheal intubation". The selection criteria included studies published in the English language, those in the operating room setting, and those with available formation on the overall incidence of DI. Articles published in non-English languages and those failed to provide reliable first-handed data on DI incidence including case-series studies, review articles, and letters were excluded from the present study. Data on anesthesia-related DI at our institute from January 1, 2015 to December 31, 2015 were used for comparison.

Results

From January 1, 2015 to December 31, 2015, a total of 23,574 general anesthesia procedures were identified (Table 1). Poor dentition was found in 2,045 patients (8.7%). During the study period, anesthesia was performed by 15 anesthesiologists. Of the 11 incidents of DI during the study period at our institute, three were surgery-related and eight were anesthesia-related (Table 2). The incidence of anesthesia-related DI was 0.03% (1 per 2,947 procedures). Of the eight incidences of anesthesia-related DI, five were intubation-related and all occurred following the use of a laryngoscope.

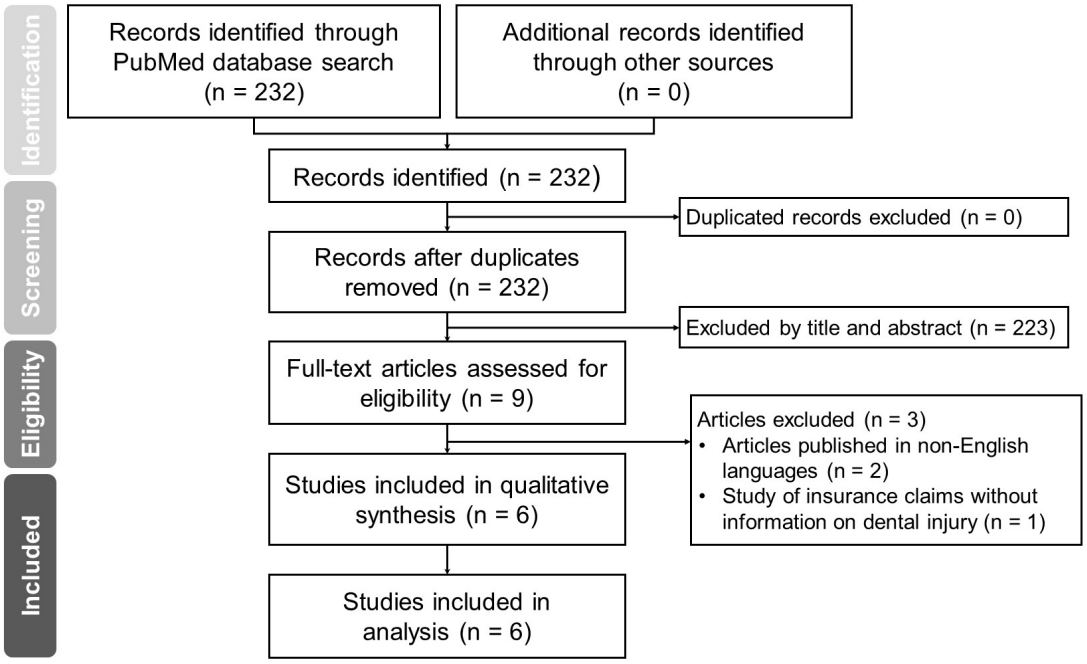

Fig. 1 Study flow diagram. Database searching was performed in last 10 years (2009 – 2019).

Table 1. Demographic and clinical characteristics of patients (n = 23,574).

Variables	N (%)
Gender (male)	14,357 (60.9%)
Age (year)	58.4 ± 12.7
Height (cm)	165.8 ± 8.1
Weight (kg)	64.4 ± 11.3
ASA status ≥ 3	7,190 (30.5%)
Mallampati score ≥ 3	1,603 (6.8%)
Emergency surgery	778 (3.3%)

ASA: American Society of Anesthesiologist; Values are number (proportion) or mean (SD).

Figure 1 represents the flow diagram and summarizes the reasons for exclusion of records. Of a total of 232 potentially eligible reports obtained from the database search, no record was removed for duplicated work. We then excluded 223 records after the initial review of the title and abstract. Overall,[9] studies were considered relevant and were read in full. After another 3 articles were excluded, a total of 6 reports were included in the final analysis (Fig. 1).

The incidences of DI in studies published from 2009 to 2019 are demonstrated in Table 3. The highest incidence of DI was noted in patients undergoing tracheal intubation (0.11% to 25%),[16,17] followed by those receiving anesthetic care (0.04% to 0.11%)[18,19] and general anesthesia (0.02% to 0.09%).[6,20] From January 1, 2015 to December 31, 2015, the incidence of anesthesia-related DI at our institute was 0.03% (8/23,574), which was lower than that (i.e., 0.04%) of a large-scale study involving over eight hundred thousand patients[18] and was much lower than that reported in another Taiwanese study (i.e., 0.11%).[19]

Discussion

Poor dentition and difficult intubation have been reported to be common risk factors for DI.[5] Although video intubation devices are known to be effective for the management of difficult airway as well as the avoidance of airway injury,[12] their clinical roles in preventing DI were poorly defined. Our study demonstrated that incorporation of video airway devices into clinical practice seemed to have a positive impact on the incidence of overall anesthesia-related DI according to a literature-based comparison.

In our patients, DI did not occur with the use of Trachway® for airway manipulation. There are several possible explanations. First, tracheal intubation with a laryngoscope is an identified contributor to DI.[5] However, tracheal intubation with Trachway® does not require mechanical elevation of the tongue base for direct visualization of the laryngeal inlet, thereby avoiding the risk of DI. In our clinical practice, a two-hand jaw thrust maneuver was often used

Table 2. Characteristics of patients with perioperative dental injury.

Case	Age (y) and sex	BMI (kg/m^2)	ASA	Poor dentition	Intubation attempt	MS	Discovery location	Injury type	Skill level[a]	Provoking factors for PDI
1	57M	25.9	3	Yes	1	1	OR	Avulsion	6	Mask ventilation
2	72F	28	3	Yes	1	1	OR	Avulsion	8	Mask ventilation
3	22F	28	3	Yes	1	2	OR	Avulsion	3	Laryngoscopy
4	60M	21.8	2	Yes	1	2	OR	Avulsion	7	Laryngoscopy
5	85F	17.9	3	Yes	1	1	OR	Avulsion	7	Laryngoscopy
6	57M	26.9	3	Yes	1	3	OR	Avulsion	8	Laryngoscopy
7	75M	30.5	2	Yes	1	2	OR	Avulsion	2	Laryngoscopy
8	49M	17.7	2	Yes	1	2	OR	Avulsion	2	Extubation[b]

F: female; M: male; BMI: body-mass index; ASA: American Society of Anesthesiologist; MS: Mallampati score; OR: operating room; PDI: perioperative dental injury; [a]Skill level defined as the number of years being attending anesthesiologists; [b]Dental injury inflicted during recovery from general anesthesia while patient biting on.

Table 3. Incidence of perioperative dental injury in literature (2009 – 2019).

Authors (year published)[Ref.]	Country	Study design	Study population	Study period	Number	Number of DI patients	DI Incidence
Adolphs et al. (2011)[20]	Germany	Retrospective	GA	1990 – 2004	375,000	82	0.02%
Vallejo et al. (2012)[18]	United States	Retrospective	Anesthesia	2001 – 2008	816,690	360	0.04%
Mourao et al. (2013)[16]	Portugal	Prospective	Intubation	2011	536	134	25%
Ham et al. (2016)[17]	Korea	Retrospective	Intubation	2006 – 2015	290,415	94	0.03%
Kuo et al. (2016)[19]	Taiwan	Retrospective	Anesthesia	2010 – 2013	24,137	26	0.11%
Tan et al. (2018)[6]	Singapore	Retrospective	GA	2011 – 2014	55,158	51	0.09%
Current study	Taiwan	Retrospective	Anesthesia	2015	23,574	8	0.03%

DI: dental injury; GA: generl anesthesia

to provide enough space for Trachway® introduction. Second, because difficult airway is another contributor to DI, the effectiveness of Trachway® in difficult airway management[13,14] may reduce the incidence of DI during the intubation process.

By using teeth mobility as a routine screening measure, the prevalence of poor dentition in our patients was about 8.7%, which was consistent with that of a previous Taiwanese study (i.e., 7.53% to 9.74%).[19] This finding should remind the anesthesiologists of performing routine oral/dental examination before anesthetic induction. At our institute, pre-anesthetic oral/dental examination primarily consisted of visual inspection and palpation of tooth mobility. Despite the possible lack of accuracy,[21] this approach provides a quick and convenient assessment of the dental status. As shown in our study, all incidents of DI occurred in patients with poor dentition defined by this measure, suggesting that this simple procedure may be a quick tool for pre-anesthetic dental screening.

Based on our literature review, the incidence of DI varied according to the study population, study design, and study period (Table 3). It seems that large-scaled studies with a long study period tend to report a low incidence of DI. At our institute, as DI remained uncommon in clinical practice (i.e., 0.03% at our institute), this event was not registered routinely in our database before 2015. We suggested that the incidence may also be underestimated in other large-scaled studies. Kuo et al, reported a baseline DI incidence of 0.11% before implementation of a quality improvement program to reduce the incidence of DI.[19] As our patient population had a similar prevalence of poor dentition and study period compared with those in that study,[19] we may assume our baseline incidence of DI to be 0.1%. In other words, after incorporation of Trachway® into our clinical practice, even though this airway device was not routinely used in high risk patients, the incidence of anesthesia-related DI plummeted by 70% from 0.1% to 0.03%. However, because this suspicion was made based on a literature-based comparison, further studies are required to confirm our findings.

Other methods that may prevent DI include the use of mouth guards,[22] modified laryngoscope blades with lower flange heights,[23] and wire fixation of loose teeth before tracheal intubation.[2] However, mouth guard is not routinely used in clinical practice as it may obstruct the view of the oral cavity[24] and some tooth protectors are not recommended for routine use because of cost consideration.[25] Although the blade-to-tooth distance is demonstrated to increase when a callander laryngoscope blade is used,[23] this modified blade is not widely available and may be limited in its ability to displace the tongue out of the line of sight. Despite the introduction of various intubation techniques, protection devices and

recommendations for the prevention of DI in the recent decade, it seems that the incidence of DI-related claims did not decrease significantly (1990 – 1995 vs. 2003 – 2010) from insurance analysis in France,[7,26] suggesting that prevention of DI remains a challenge for anesthesiologists. By implementing a quality improvement program through education, perioperative dental assessment, and pre-procedure dental protection, the incidence of anesthesia-related DI has reportedly decreased from 0.11% (26/24,137 patients) to 0.01% (2/20,870 patients) in a previous Taiwanese study.[19] These findings highlighted the effectiveness of comprehensive strategies for further prevention of DI.

Review of literature in the last decade demonstrated an incidence of anesthesia-associated DI ranging from 0.04% to 0.11% in patients receiving anesthetic care.[18,19] Although intubation procedure is often a cause of DI, this event can be caused by other provocative events such as tracheal extubation, insertion of oral airway, and airway manipulation with laryngeal mask airways.[2,6] In our report, DI occurred in two patients during mask ventilation, implying a possible association between the forces applied to the face and DI as noted in previous studies.[6,7] This finding also emphasized that DI prevention strategies should be initiated before intubation-related procedure. It is very important to routinely explain to the patient or family the risk of DI whenever anesthesia service is provided for high-risk individuals. In an eight-year database analysis of 592 claims, preoperative informed consents concerning possible DI were documented in only 34.8% of patients,[7] highlighting that preoperative informed consent should be a priority in the management of this patient population.

Tracheal intubation using conventional direct laryngoscopy remains a common practice

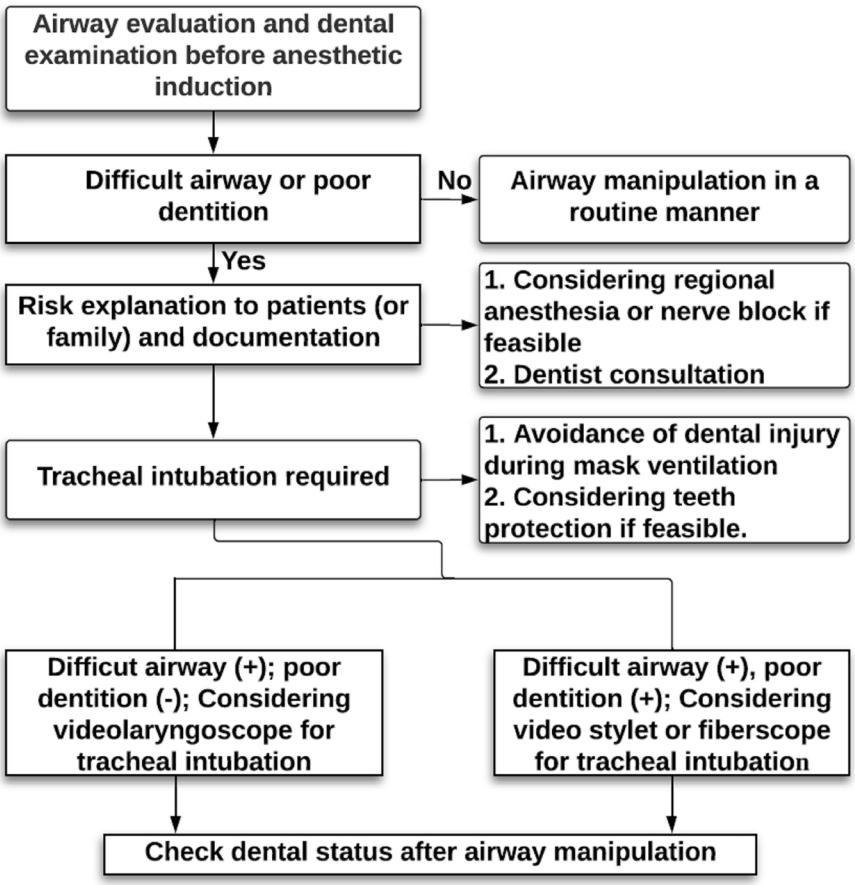

Fig. 2 Strategies to prevent dental injury in patients with difficult airway or poor dentition.

at our institute. Because the first three sets of Trachway® were purchased in 2013 when the learning curve began, we collected data for the current study in 2015 with the assumption that all anesthesiologists were proficient in the use of the device. However, the choice of airway devices for intubation was left to the discretion of each anesthesiologist, suggesting that a bias may exist in this study. A proposed flow chart of pre-anesthetic airway and dentition assessment based on the results of this study and those of previous investigations is shown in Figure 2.

There are several limitations in the current report. First, as the findings were based on a single institute, the data may not be extrapolated to other institutes at which other airway devices were available. Second, precise identification of the teeth injured and the outcomes of dental consultation were not documented. In addition, although anesthesia-related dental injuries include subluxation, luxation, avulsion, and crown fracture, the incidence of each type of injury varied greatly. For instance, the incidence of avulsion was 35% in one study,[19] whereas it was only 7.4% in another.[17] The finding of an incidence of a relatively low incidence of avulsion (i.e., 0.03%) in the present study with the absence of other types of injuries may be attributed to its relatively small sample size and short follow-up period (i.e., one year). Therefore, further large-scale studies are warranted to support our findings. Third, the predictors for DI were not statistically evaluated because of the limited number of patients. Finally, reliable information on the incidence of DI before the introduction of Tachway® at our institute was unavailable for comparison in the current study because our institute did not require detailed documentation of DI before 2015. Additionally, although we proposed that the use of Trachway® for intubation in the current study during the study period may reduce the incidence of dental injuries compared with that in previous studies, information about the use of Trachway® and other airway management devices was not available in their medical records. Therefore, the impact of the use of Trachway® on the incidence of DI remains unclear.

Conclusion

In conclusion, our study demonstrated that incorporation of video airway devices into clinical practice seemed to have a positive impact on the incidence of overall anesthesia-related DI according to a literature-based comparison. Additionally, intubation-related dental injury was not noted in patients receiving Tachway-assisted intubation, suggesting the merits of its use in patients with poor dentition.

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