AMERICAN ACADEMY OF OTOLARYNGOLOGY–HEAD AND NECK SURGERY FOUNDATION

OTO Open
2021, Vol. 5(4) 1–6

DOI: 10.1177/2473974X21065021
http://oto-open.org
SAGE

Comparison of Dental Injury Rates in Perioperative Intubation and Suspension Laryngoscopy for Otolaryngology Procedures

Caleb P. Wilson, BS[1], Erica Romano, MD[1], and Nilesh R. Vasan, MD[1]

Abstract

Objective. Direct laryngoscopy is an essential skill during perioperative intubation and otolaryngology procedures. Dental injury is a common complication of direct laryngoscopy. However, the technique and tools used by anesthesiologists, nurse anesthetists, and others during perioperative intubation and by ear, nose, and throat surgeons for their procedures are different. The purpose of this review is to explore the literature for all studies detailing rates of dental injury in each of these settings and to compare them to see if the approaches have a significant difference in rate of dental injury.

Data Sources. PubMed.

Review Methods. A comprehensive search of PubMed was performed through February 2021 with search terms "dental" and "intubation" or "laryngoscopy." PRISMA guidelines were followed. Studies documenting rates of dental injuries during intubation or during laryngologic procedures were included, and the 2 groups were compared.

Results. Twenty-three studies met inclusion criteria: 17 in the perioperative intubation group and 6 in the suspension laryngoscopy group. There was an increased incidence of dental injury in the perioperative intubation group (4.86%) as compared with the suspension laryngoscopy group (1.70%).

Conclusions. The difference in dental injury rate between the groups could be due to the differences in direct laryngoscopy technique or tools used, the presence vs absence of a dental guard, or a combination of these factors. More studies need to be performed to develop definitive and specific conclusions to recommend changes that prevent dental injury.

Keywords

direct laryngoscopy, dental injury, perioperative intubation, suspension laryngoscopy, review, systematic review

Received October 12, 2021; accepted November 13, 2021.

Direct laryngoscopy (DL) allows for visualization of the larynx and is an essential clinical skill used by medical providers during perioperative general anesthesia, surgical procedures in and around the larynx, and emergency airway scenarios. However, the preferred tools and techniques used for DL often vary among these providers. The type of DL is different between those who intubate and ear, nose, and throat (ENT) surgeons. For intubation, DL generally refers to a Macintosh or Miller laryngoscope, which is an open blade device that helps the user visualize the larynx to pass an endotracheal tube; for ENT surgeons, the DL is completely different. These ENT devices come in numerous sizes and are all constructed of metal. They are also completely enclosed barrels, which allow the ENT surgeon to directly perform procedures through the lumen of the laryngoscope after the scope has been suspended (**Figure 1**). For both groups, the devices described are true ''direct'' laryngoscopes, meaning that the users can see the larynx directly with their own eyes. This is in contrast to ''indirect'' laryngoscopy, which implies devices in which the user indirectly sees the larynx, usually by monitor (ie, video or fiberoptic laryngoscopy).[1]

One feared complication of either type of DL is dental injury. Besides the morbidity and cosmetic consequences for the patient, dental injury in perioperative tracheal intubation represents approximately one-third of all anesthesia-related legal claims.[2]

DL for intubation requires axial force on the laryngoscope handle to expose the glottis and perpendicular force to balance the torque on the laryngoscope.[3] Many laryngoscopes commonly used in perioperative intubation, such as the Macintosh and Miller blades, require the user to utilize muscle strength

[1]Department of Otolaryngology, University of Oklahoma Health Sciences Center, Oklahoma City, Oklahoma, USA

Corresponding Author:
Nilesh R. Vasan, MD, Department of Otolaryngology–Head and Neck Surgery, University of Oklahoma Medical Center, 800 Stanton L. Young Blvd, AAT 1400, Oklahoma City, OK 73104, USA.
Email: nilesh-vasan@ouhsc.edu

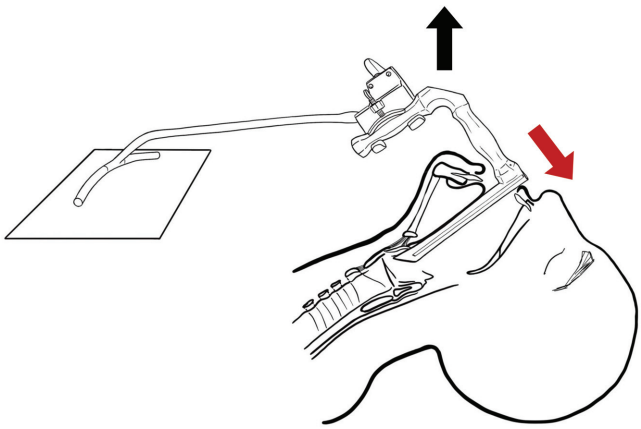

Figure 1. Suspension laryngoscopy with controlled downward force against the maxillary teeth (red arrow) with upward axial force being applied by suspension (black arrow).

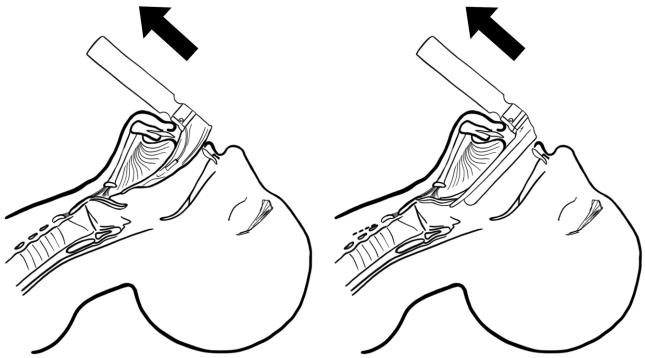

Figure 2. Direct laryngoscopy with the Macintosh (left) and Miller (right) laryngoscopes most used for intubation. Strength is needed to achieve upward axial force (black arrows) to visualize the airway by displacing tissue superiorly and anteriorly.

to achieve axial and perpendicular forces to visualize the airway by displacing tissue anteriorly and superiorly (**Figure 2**).[1,3] This type of DL force attempts to avoid contact with the teeth. Therefore, dental injury in these situations occurs due to accidental contact, possibly because of physical strain in a difficult intubation scenario with inadvertent movement of the laryngoscope against the teeth. In fact, some studies have found that it is quite common for laryngoscopes to encounter and put significant force on the maxillary incisors or gums, even for experienced intubators.[4,5] However, suspension laryngoscopy (SL), or microlaryngoscopy, is a common surgical approach used by ENT surgeons when operating on the vocal cords or other areas in and around the larynx. In SL, a rigid laryngoscope is used, which intentionally uses the teeth as a fulcrum during the procedure to raise the epiglottis for proper visualization of the larynx.[6] This results in a true laryngeal axis for the surgeon to view the glottic larynx (**Figure 1**). In these situations, rubber or soft plastic dental guards are always used to mitigate risk of dental injury. Using the maxillary teeth as a fulcrum reduces the force by the user and allows greater wrist abduction during visualization. While this form of DL intentionally places force on the teeth, it is uncommon to result in dental injury since a guard is always used and contact with teeth is controlled and not due to overstrained muscles or accidental loss of control.

Several large-scale retrospective studies and a few prospective studies have been published describing dental injury following perioperative intubation, dating back to Lockhart et al in 1986.[7] However, the existing literature describing dental injury following surgery utilizing SL is more limited. More recently, 3 such studies have been published, adding to the 3 that previously existed. Because head and neck surgeons and anesthesiologists employ different approaches to visualize the same area, it is worth comparing rates of dental injury to see if one approach avoids this complication more often. The goal of this study is to review the current literature and compare the resultant rates of dental injury between these methods of DL.

Methods

A comprehensive literature review via PubMed was performed through December 2020 following the PRISMA guidelines (Preferred Reporting Items for Systematic Reviews and Meta-analyses). Articles related to our topic were identified with the search terms ''dental'' and ''intubation'' or ''laryngoscopy.'' Upon removing duplicates, titles and abstracts were screened for relevant articles. English analytic studies documenting rates of dental injuries during intubation or laryngologic procedures were included. Non-English articles were included only when an English abstract was available and a dental injury rate was indicated. Review articles were excluded. Ultimately, 23 references meeting the selection criteria were included.[7-29] A flow diagram detailing this process is shown in **Figure 3**.

Results

Of the 23 studies reporting dental injury in association with visualization of the larynx, 6 followed SL and 17 followed perioperative intubation. Notably, each intubation study was prior to an elective operation rather than emergency intubation, which could predispose to higher rates of complications and dental injuries. The average rate of dental injury in the SL group was 1.70%, whereas that in the perioperative intubation group was 4.86%. Specific values extracted from each study are shown in **Tables 1** and **2**.

Discussion

Though not significant, there was an increased incidence of dental injury in the perioperative intubation group (4.86%) as compared with the SL group (1.70%). Interestingly, prospective studies tended to report much higher rates of dental injury than retrospective studies. In the perioperative intubation group, this was especially true: the rates of dental injury in the prospective studies for this group ranged from 2.23% to 38.6%,[14,21,22,28] as opposed to the retrospective studies, which all reported a <1% rate of dental injury. Analysis of the prospective studies alone demonstrated a larger difference in the dental injury rate between the groups: 16.2% in the perioperative intubation group vs 2.3% in the SL group. Due to the possible selection bias and underreported injuries in the

Table 1. Rates of Dental Injury During Suspension Laryngoscopy.

		Dental injury		
	No. of patients	No.	%	Study type
Klussmann (2002)[8]	339	22	6.5	Prospective
Dos Anjos Corvo (2007)[9]	37	1	2.7	Prospective
Rosen (2005)[10]	56	0	0	Prospective
Feng (2018)[11]	56	0	0	Prospective
Okui (2019)[12]	550	3	0.55	Retrospective
Larner (2019)[13]	213	1	0.47	Retrospective

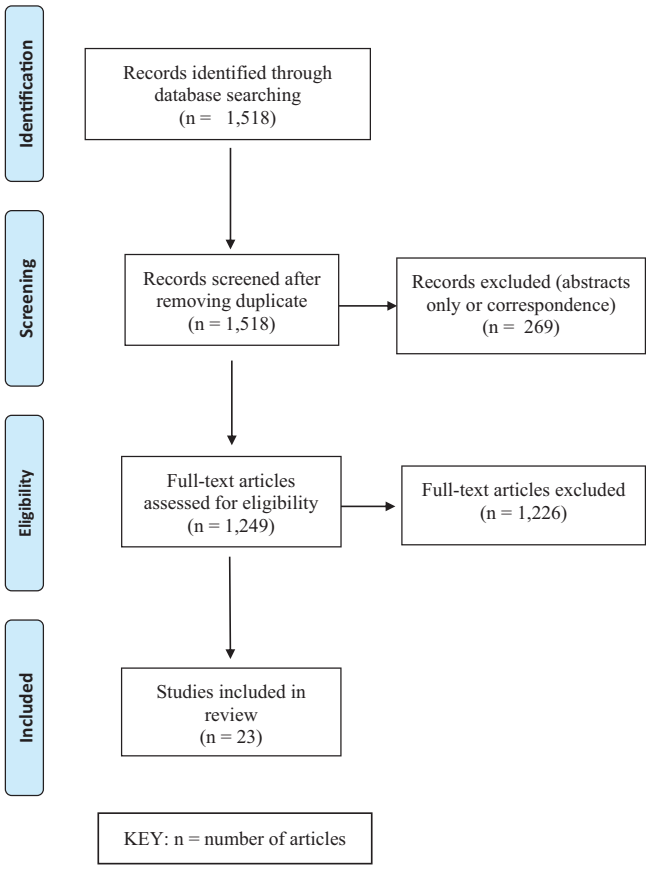

Figure 3. PRISMA flow diagram detailing the process of article selection for this review.

retrospective studies, it is likely that the actual average rates of dental injury are much higher than what we cite in this review. Therefore, more prospective studies need to be conducted to obtain accurate and complete data for comparison.

The SL studies had relatively small sample sizes, ranging from 37 to 550 patients. Thus, even just 1 patient with dental injury could result in a relatively large percentage, as demonstrated in the study by Dos Anjos Corvo et al.[9] It is interesting that 2 studies showed no dental injuries in the SL group. The perioperative intubation group, however, often included hundreds of thousands of patients. Future studies should analyze larger samples of patients to compare the 2 groups more accurately. A third, much larger group also exists in which otolaryngology–head and neck surgeons use nonsuspension laryngoscopes, traditionally with dental guards, for diagnostic evaluation of the larynx and pharynx. To our knowledge, there are no studies in the current literature that report dental injury in this specific group.

As previously described, SL is commonly performed by using the maxillary incisors as a fulcrum, with the teeth and/or gums protected by a tooth guard. This Brunings/Seiffert-type fulcrum stabilizer places significant force on the maxillary area. In contrast, holders rather than true suspension devices, such as a Killian or Zeitels gallows, can minimize or avoid laryngoscope contact with the maxillary area and may reduce the incidence of dental injury. Rosen et al and Feng et al specified the use of gallows suspension systems, and Larner et al described the use of Zeitels gallows for a minority of SL.[10,11,13] Interestingly, these 3 studies cited the lowest incidences of dental injury among the groups that assessed SL: 0%, 0%, and 0.47%, respectively. Prospective studies assessing different forms of SL and dental injury may reveal which suspension method causes less dental injury.

One other potential variable affecting the results is inconsistent definitions of ‘‘dental injury.’’ For instance, Warner et al did not include abrasions or other injuries that did not require intervention.[19] In contrast, Mourao et al included every dental injury regardless of intervention or whether the patient even noticed it.[28]

Several factors have been linked to increased rates of dental injury during intubation, such as not using a dental guard,[25] increasing number of intubation attempts,[28] preexisting poor dentition/dental disease,[14,15,18,19,21,23,24,26,29] and any risk factors that increase the risk for difficult intubation.[15,19] Ueda et al found that patients who had received dental guards during intubation had a significantly lower incidence of dental injury than those without guards.[25] While dental guards are not traditionally used during perioperative intubation in most places, Engoren et al recently demonstrated that even just the placement of a thin protective alcohol pad over the maxillary teeth reduces the strain placed on them by laryngoscopes in perioperative intubation and would likely lead to lower rates of dental injury.[30] Because plastic or

Table 2. Rates of Dental Injury During Perioperative Intubation.

		Dental injury		
	No. of patients	No.	%	Study type
Lockhart (1986)[7]	1,135,212	NA	0.1	Retrospective
Chen (1990)[14]	745	90	12.1	Prospective
Chopra (1990)[15]	113,074	39	0.04	Retrospective
Deppe (1998)[16]	NA	16	0.017	Retrospective
Magnin (1991)[17]	NA	126	0.025	Retrospective
Singleton (1993)[18]	2000	14	0.7	Retrospective
Warner (1999)[19]	598,904	132	0.022	Retrospective
Skeie (1999)[20]	120,086	75	0.06	Retrospective
Fung (2001)[21]	404	9	2.23	Prospective
Nakahashi (2003)[22]	5,946	185	3.1	Prospective
Newland (2007)[23]	161,687	78	0.045	Retrospective
Vogel (2009)[24]	115,551	130	0.11	Retrospective
Ueda (2010)[25]	30,845	110	0.36	Retrospective
Adolphs (2011)[26]	375,000	82	0.02	Retrospective
Mourao (2011)[27]	70	27	38.6	Prospective
Mourao (2013)[28]	536	134	25	Prospective
Tan (2018)[29]	55,158	51	0.092	Retrospective

Abbreviation: NA, not available.

Figure 4. The squared edges and ridges that face the maxillary teeth during perioperative intubation with a traditional Macintosh laryngoscope.

rubber dental guards are routinely placed on the maxillary teeth during SL, it is possible that one factor contributing to the lower frequency of dental injury in the SL group as compared with the intubation group is protection of the teeth by a dental guard. It should also be remembered that significant force is applied to the upper teeth when performing SL. This intentional pressure applied to the teeth via the dental guard is many times the inadvertent force that may be applied to the teeth when struggling to intubate a patient. Despite the forces utilized for SL, the dental injury rates are low.

Another factor that could contribute to the difference in dental injury rate is the type of laryngoscope used. The most common laryngoscope blades used for DL during perioperative intubation are the Macintosh and Miller blades.[1] These blades have edges and ridges that might increase the chances of injury upon contact with teeth (**Figure 4**). The laryngoscopes used for DL during SL are smooth cylindrical devices with rounded edges (**Figure 1**). For ENT procedures, the surgeon selects the appropriate laryngoscope for the procedure. In some cases, lower-profile devices may need to be used in situations such as prominent teeth or trismus. These scopes may be less likely to cause injury simply due to their design.

The types of dental injuries reported by the studies in both groups included enamel fracture, loosened or subluxated teeth, and tooth avulsion. However, it is interesting that the studies in the perioperative intubation group often reported enamel fractures as the most common injuries, whereas the studies in the SL group typically indicated loosened teeth as the main, if not only, dental injury.[8,13,28] Klussman et al conducted the only study that reported fractures and avulsions of teeth, but even in this, loosened teeth were the most common injury.[8] It is possible that this discrepancy in injury type is due to the previously described differences in DL technique. Fractures could be more common in perioperative intubation because injury occurs after unintentional and possibly uncontrolled contact with the teeth.

Dental injury is one of the most common injuries sustained by patients during DL, regardless of technique. Because these 2 groups utilize such different approaches to visualize the same area, it is important to look more closely at the rates and severity of dental injuries in each group so that steps can be taken to avoid these injuries in the future.

Author Contributions

Caleb P. Wilson, contributed to design, drafting the manuscript, and final editing; **Erica Romano**, contributed to drafting the

manuscript, creation of diagrams, and final editing; **Nilesh R. Vasan**, contributed to drafting the manuscript and final editing.

Disclosures

Competing interests: None.

Sponsorships: None.

Funding source: None.

ORCID iD

Nilesh R. Vasan https://orcid.org/0000-0002-9458-5286

References

1. Collins SR. Direct and indirect laryngoscopy: equipment and techniques. *Respir Care*. 2014;59(6):850-864. doi:10.4187/respcare.03033
2. Givol N, Gershtansky Y, Halamish-Shani T, Taicher S, Perel A, Segal E. Perianesthetic dental injuries: analysis of incident reports. *J Clin Anesth*. 2004;16(3):173-176. doi:10.1016/j.jclinane.2003.06.004
3. Hastings RH, Hon ED, Nghiem C, Wahrenbrock EA. Force and torque vary between laryngoscopists and laryngoscope blades. *Anesth Analg*. 1996;82(3):462-468. doi:10.1097/00000539-199603000-00005
4. Bucx MJL, Snijders CJ, Geel RTM, et al. Forces acting on the maxillary incisor teeth during laryngoscopy using the Macintosh laryngoscope. *Anaesthesia*. 1994;49(12):1064-1070. doi:10.1111/j.1365-2044.1994.tb04358.x
5. Lee J, Choi JH, Lee YK, Kim ES, Kwon OK, Hastings RH. The Callander laryngoscope blade modification is associated with a decreased risk of dental contact. *Can J Anaesth*. 2004;51(2):181-184. doi:10.1007/bf03018781
6. Orosco RK, Lin HW, Bhattacharyya N. Safety of adult ambulatory direct laryngoscopy. *JAMA Otolaryngol Head Neck Surg*. 2015;141(8):685. doi:10.1001/jamaoto.2015.1172
7. Lockhart PB, Feldbau EV, Gabel RA, Connolly SF, Silversin JB. Dental complications during and after tracheal intubation. *J Am Dent Assoc*. 1986;112(4):480-483. doi:10.14219/jada.archive.1986.0035
8. Klussmann JP, Knoedgen R, Damm M, Wittekindt C, Eckel HE. Complications of suspension laryngoscopy. *Ann Otol Rhinol Laryngol*. 2002;111(11):972-976. doi:10.1177/000348940211101104
9. Dos Anjos Corvo MA, Inacio A, de Campos Mello MB, Alessandra Eckley C, Campos Duprat A. Extra-laryngeal complications of suspension laryngoscopy. *Braz J Otorhinolaryngol*. 2007;73(6):727-732. doi:10.1016/S1808-8694(15)31167-8
10. Rosen CA, Andrade Filho PA, Scheffel L, Buckmire R. Oropharyngeal complications of suspension laryngoscopy: a prospective study. *Laryngoscope*. 2005;115(9):1681-1684. doi:10.1097/01.MLG.0000175538.89627.0D
11. Feng AL, Song PC. Laryngeal force sensor: quantifying extralaryngeal complications after suspension microlaryngoscopy. *Otolaryngol Head Neck Surg*. 2018;159(2):328-334. doi:10.1177/0194599818768482
12. Okui A, Konomi U, Watanabe Y. Complaints and complications of microlaryngoscopic surgery. *J Voice*. Published online May 31, 2019. doi:10.1016/j.jvoice.2019.05.006
13. Larner SP, Fornelli RA, Griffith SD. Consistent technique limits suspension laryngoscopy complications. *Int Arch Otorhinolaryngol*. 2019;23(3):e305-e310. doi:10.1055/s-0039-1684036
14. Chen JJ, Susetio L, Chao CC. Oral complications associated with endotracheal general anesthesia. *Ma Zui Xue Za Zhi*. 1990;28(2):163-169.
15. Chopra V, Bovill JG, Spierdijk J. Accidents, near accidents and complications during anaesthesia: a retrospective analysis of a 10-year period in a teaching hospital. *Anaesthesia*. 1990;45(1):3-6. doi:10.1111/j.1365-2044.1990.tb14492.x
16. Deppe H, Reeker W, Horch HH, Kochs E. Tooth injury during intubation—diagnostic and therapeutic aspects. Article in German. *Anasthesiol Intensivmed Notfallmed Schmerzther*. 1998;33(11):722-725. doi:10.1055/s-2007-994843
17. Magnin C, Bory EN, Motin J. Tooth injuries during intubation: a new preventive device. Article in French. *Ann Fr Anesth Reanim*. 1991;10(2):171-174. doi:10.1016/s0750-7658(05)80461-7
18. Singleton RJ, Ludbrook GL, Webb RK, Fox MAL. Physical injuries and environmental safety in anaesthesia: an analysis of 2000 incident reports. *Anaesth Intensive Care*. 1993;21(5):659-663. doi:10.1177/0310057x9302100530
19. Warner ME, Benenfeld SM, Warner MA, Schroeder DR, Maxson PM. Perianesthetic dental injuries: frequency, outcomes, and risk factors. *Anesthesiology*. 1999;90(5):1302-1305. doi:10.1097/00000542-199905000-00013
20. Skeie A, Schwartz O. Traumatic injuries of the teeth in connection with general anaesthesia and the effect of use of mouthguards. *Endod Dent Traumatol*. 1999;15(1):33-36. doi:10.1111/j.1600-9657.1999.tb00746.x
21. Fung BK, Chan MY. Incidence of oral tissue trauma after the administration of general anesthesia. *Acta Anaesthesiol Sin*. 2001;39(4):163-167.
22. Nakahashi K, Yamamoto K, Tsuzuki M, et al. Effect of teeth protector on dental injuries during general anesthesia. Article in Japanese. *Masui*. 2003;52(1):26-31.
23. Newland MC, Ellis SJ, Peters KR, et al. Dental injury associated with anesthesia: a report of 161,687 anesthetics given over 14 years. *J Clin Anesth*. 2007;19(5):339-345. doi:10.1016/j.jclinane.2007.02.007
24. Vogel J, Stübinger S, Kaufmann M, Krastl G, Filippi A. Dental injuries resulting from tracheal intubation—a retrospective study. *Dent Traumatol*. 2009;25(1):73-77. doi:10.1111/j.1600-9657.2008.00670.x
25. Ueda N, Kirita T, Imai Y, et al. Dental injury associated with general anesthesia and the preventive measures. Article in Japanese. *Masui*. 2010;59(5):597-603.
26. Adolphs N, Kessler B, von Heymann C, et al. Dentoalveolar injury related to general anaesthesia: a 14 years review and a statement from the surgical point of view based on a retrospective analysis of the documentation of a university hospital. *Dent Traumatol*. 2011;27(1):10-14. doi:10.1111/j.1600-9657.2010.00955.x
27. Mourao J, Neto J, Viana JS, Carvalho J, Azevedo L, Tavares J. A prospective non-randomised study to compare oral trauma from laryngoscope versus laryngeal mask insertion. *Dent*

Traumatol. 2011;27(2):127-130. doi:10.1111/j.1600-9657.2010.00947.x

28. Mourao J, Neto J, Luis C, et al. Dental injury after conventional direct laryngoscopy: a prospective observational study. *Anaesthesia*. 2013;68(10):1059-1065. doi:10.1111/anae.12342
29. Tan Y, Loganathan N, Thinn KK, Liu EHC, Loh N-HW. Dental injury in anaesthesia: a tertiary hospital's experience. *BMC Anesthesiol*. 2018;18(1):108. doi:10.1186/s12871-018-0569-6
30. Engoren M, Rochlen LR, Diehl MV, et al. Mechanical strain to maxillary incisors during direct laryngoscopy. *BMC Anesthesiol*. 2017;17(1):151. doi:10.1186/s12871-017-0442-z