Dental Traumatology

Dental Traumatology 2010; **26**: 459–465; doi: 10.1111/j.1600-9657.2010.00935.x

Traumatic dental injuries during anaesthesia: part I: clinical evaluation

Gaudio Rosa Maria[1], Feltracco Paolo[2], Barbieri Stefania[1,2], Tiano Letizia[1], Alberti Martina[2], Delantone Massimiliano[3], Ori Carlo[2], Avato Francesco Maria[1]

[1]Department of Legal Medicine, University of Ferrara, Ferrara; [2]Department of Anaesthesia and Intensive Care, University of Padova, Padova; [3]Department Emergency Unit, Hospital Venezia-Mestre, Italy

Correspondence to: Barbieri Stefania, Department of Anaesthesia and Intensive Care, University of Padova, Via Giustiniani 2, 35128 Padova, Italy
Tel.: 3943410225
Fax: 39498218289
e-mail: stefibarbieri@libero.it

Accepted 12 August, 2010

Abstract – Dental injuries represent the most common claims against the anaesthesiologist. Dental lesions are frequent complications of oro-tracheal intubation and major causal factors are (i) poor dentition, (ii) aggressive laryngoscopy, (iii) insufficient anaesthesia and curarization, (iv) emergency interventions and (v) lack of experience by the anaesthesiologist. *Materials and methods:* We conducted a retrospective analysis of 83 cases of dental lesions occurring during elective, emergent and urgent surgery requiring general anaesthesia with tracheal tube placement in the years between 2000 and 2008. Preoperative evaluation of dental status was obtained from the anaesthesiology chart, filled by an experienced anaesthesiologist during the preoperative visit. Anaesthesiological records were inspected by physicians of Legal Medicine Department with the aim to attribute responsibility for the damage and manage potential reimbursements. Costs related to the required dental repair were also noted. *Results:* Eighty-three patients of a total of 60.000 surgical procedures (no day surgery) under general anaesthesia were affected by dental lesions (0.13%). Seventy-five per cent of lesions occurred during intubation manoeuvres for elective major surgery, 15% occurred at tracheal intubation for minor surgery and 10% were related to emergency surgery. Teeth avulsions accounted for 50% of lesions, followed by damage to crowns and bridges (14%), luxations and fractures (>15%). *Discussion*: The overall incidence of dental injury in our retrospective study was 1.38 per 1000 anaesthetics, which is slightly higher than those reported by some and lower with respect to others. Avulsion of a permanent tooth occurred in patients who were affected by severe mobility of native teeth while undergoing surgery. Even though the majority of anaesthesiologists were trained enough in the use of airway devices and aware of the potential damage while using excessive forces, some unexpected difficulties may have led to lesions. It is known that damage to teeth can occur even in the absence of negligence.

In a retrospective study of 598 904 consecutive patients requiring anaesthesia over an 11-year period, McGovern et al. found the dental injury rate to be as high as 1 in four patients (1, 2).

Dental injuries are not only cosmetic in effect but constitute a serious personal injury. Inadequate dentition, oral disease, tissue damage, and irregular and severe dental caries can represent a functional limitation causing chewing, eating and/or speaking difficulty. Dental trauma during anaesthesia may increase the risk of aspiration particularly when complications are represented by cusp or incisor edge fractures in the presence of root fragments or in patients with severe tooth mobility. Several Authors have suggested that repeated laryngoscopy can cause trauma and oedema to the airway making a bad situation (cannot intubate) worse (cannot intubate and cannot ventilate) leading to hypoxia, regurgitation, aspiration and possibly dental injury (3–5).

The incidence reported in literature of 'troublesome' or 'awkward' intubation requiring 'less than or equal to two laryngoscopy attempts' ranges between 1% and 18% (6); in particular, the incidence of 'difficult' intubation requiring 'more than two laryngoscopy attempts' is 1–4% and that of failed intubation is 0.05–0.35% (4). Several factors are associated with such difficulty: reduced mouth opening, large tongue, reduced neck movement, prominent upper teeth and specific medical conditions such as ankylosing spondylitis, rheumatoid arthritis and cervical spine trauma.

The incidence of dental damage during orotracheal intubation depends on several factors, the most important being poor dental conditions and important impingement against dental arch.

Many occurrences are caused by the application of pressure by the hard metallic blade of the laryngoscope. Difficult intubations require more force applied to the laryngoscope blade; indeed, in case of difficult airway management, the anaesthesiologist may use the upper teeth as a fulcrum if a satisfactory view of the glottis cannot otherwise be obtained.

The ASA Task Force on management of the 'difficult airway' has defined difficult laryngoscopy as being unable

'to visualize any portion of the vocal cords with conventional laryngoscopy' and defined difficult intubation as 'an airway that requires more than three attempts or more than 10 min to secure by direct laryngoscopy' (4, 7, 8).

Trauma because of excessive force or incorrect use of the laryngoscope can cause oedema, bleeding, dental and soft tissue damage even when performed by skilled professionals.

In literature, the incidence of dental trauma, notably damage to the maxillary incisors associated with anaesthesia, ranges widely from 1:1000 to 1:10 anaesthetics (9, 10). Hoffmann and co-workers reported (11) a 44.8% incidence of fractures of the crowns and roots of natural teeth, followed by partial luxations (20.8%) and avulsions (20.8%). Patient conditions may also have an impact on practicing correct laryngoscopy with associated a different risk of lesions.

During the preanaesthesia visit, a complete evaluation of the patient's dentition is recommended; preoperative dental examination should be conducted by an experienced anaesthesiologist, as unrecognized defects may have a significant impact on both risk of injury and postoperative patient's claims. Patient with unstable teeth must be informed about the possibility of avulsion, dental crowns and bridges ruptures, loosening and need for postoperative restoration. A detailed description of teeth abnormalities should be reported in the Anesthesiological Chart (AC).

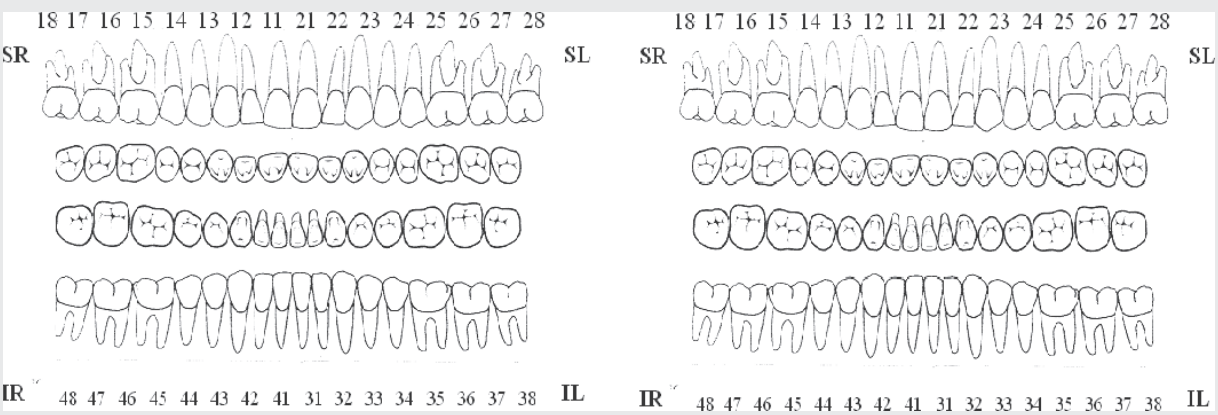
In this study, we investigated the main characteristics of the dental injuries identified by the anaesthesiology incident reporting and constituting a body of malpractice claims received by the Department of Legal Medicine of the University of Ferrara over an 8-year period.

Materials and methods

We conducted a retrospective analysis of 83 cases of dental lesions occurring during elective, emergent and urgent surgery requiring general anaesthesia with tracheal tube placement in the years between 2000 and 2008. The case series is a part of the malpractice claims concerning anaesthesiological procedures received over the same period. Data on preoperative evaluation of dental status were obtained from a specific section of the anaesthesiological chart (Table 1), filled by an experienced anaesthesiologist during the preoperative visit. In this chart, the number of natural anterior and posterior teeth, carious surfaces and root fragments, periodontal disease, the presence of caps, crowns, cups edge fractures and other defects were recorded on a physiological dental map. Patients with expected difficult laryngoscopy or intubation, and/or increased vulnerability of the teeth before surgery were informed on the possibility of perioperative dental damage. Oral inspection was performed in all patients even after surgery to discover any previously missed damage or a new one (which may

Table 1. Dental map and perioperative description sheet of dental lesion

Dental Evaluation



Pre-operative

Mobile Prosthesis.....

Fixed Prosthesis.....

Implants.....

Periodontal disease....

Max Mouth opening.....

Mallampati.....

Post-operative

Notes After Surgery.....

.....

.....

.....

have) occurred at the time of tracheal extubation. The data recorded were also confronted with Mallampati Scores, airway management method, (the number of) laryngoscopy attempts, experience of the anaesthesiologist, pre-existing dental lesions and status of dentition. In case of dental trauma or avulsion, every patient was visited by a dentist with the purpose to describe the lesion and when possible repair. This study was conducted in the Departments of Anesthesia of the University Hospital of Padova, Ferrara and Mestre, and records with the reported damage sent to the Department of Legal Medicine of Ferrara University.

Anaesthesiology records were inspected by physicians of the Legal Medicine Department with the aim to attribute responsibility for the damage and manage potential reimbursement. Costs related to the required dental repair were also noted.

Results

Eighty-three patients of a total of 60.000 surgical procedures (no day surgery) under general anaesthesia suffered dental lesions (0.13%). The study population consisted of 44 women (mean age 49.5, mean body mass index (BMI) 27.46, and 39 men (mean age 47.5 mean BMI 25.58).

The type of dental lesions and the incidence are reported in (Table 2). Almost 60% of damage occurred in patients between 45 and 60 years of age. Seventy-five per cent of lesions occurred during intubation manoeuvres for elective major surgery, 15% occurred at tracheal intubation for minor surgery and 10% were related to emergency surgery. Nine individuals at the time of surgery suffered from severe parodontal disease and 14 from minor dental deficits. Up to 20% of anaesthesiological records, however, lacked a detailed description of preoperative dental condition.

Tracheal intubation was performed by experienced anaesthesiologists in 78% of cases. In six cases, a difficult intubation had been predicted, while it was unexpectedly arduous in 8. Avulsions of mobile teeth most frequently occurred in easy (35 cases) rather than in difficult intubations (six cases). Almost 90% of dental lesions were determined by the laryngoscope blade, the rest were likely caused by excessive biting against the Guedel cannula or a rush extubation. Upper incisors were injured in 75 patients (90.3%). No protection devices (tooth guards) were ever used during intubation. Up to 70% of dental lesions could not be 'acutely' repaired by the dentist. All patients were reimbursed for repair of dental injuries, with the amounts ranging from 200 to 3500 euro per incident. The comprehensive cost of all injuries was 85.000€. We report here also three clinical cases which can be of particular interest to the anaesthesiologist practicing intubation: (i) advanced periodontal disease, (ii) skeletal class II hyperdivergent and (iii) anterior open bite with marked upper incisor inclination.

Table 2. Tooth trauma during and after anaesthesia

Iatrogenic dental trauma (2000–2007)	Adult patients (%)
Avulsion of permanent teeth in patients with severely mobile teeth	50
Damage to crowns and bridgeworks	14
Luxation	3.8
Teeth fractures	12
Number of fractured teeth: 1	10
2 or more	2
Bulk fractures	1

Fig. 1. A 55-year-old man with vulnerable teeth.

Case 1

The preanaesthetic evaluation of a 55-year-old male (ASA III) with vulnerable teeth, especially considering the force to be applied during laryngoscopy. Fig 1).

Preoperative assessment of the airway and teeth condition identified limited mouth opening, pre-existing dental damage, angled teeth with an inflammation within the supporting tissues.

Reduced root support was evident with large exposure of cementum as a result of a widespread periodontal disease. Teeth showed a marked inclination because of dental migration that often accompanies the progress of the disease. A typical symptom of advanced disease is severe tooth mobility. A patient with these features has an increased risk of dental injury during tracheal intubation and sedation because of tube grinding. Break force and resistance to avulsion are reduced compared to a tooth with undamaged periodontal ligament because of the unfavourable ratio between the dental portions in and out of the bone. In case of periodontal disease, the strength applied against the teeth during intubation can lead to avulsion if no proper protection is applied. A complex dental procedure is then needed to rehabilitate an avulsed tooth and financial implications are significant. Restoration of each avulsed tooth costs approximately €2800.

Case 2

A 19-year-old girl is affected by Angle's classification II antero-posterior jaw relationship with a hypoplastic and retruded mandible (Fig. 2a,b). Such patient is difficult to intubate because of the reduced airway space. Moreover, assessment of dental status shows important inclination and overjet (large distance between upper and lower incisors) that make teeth more vulnerable. Difficult intubation and increased inclination of the teeth can lead to dental injury. If dental fracture occurs in both

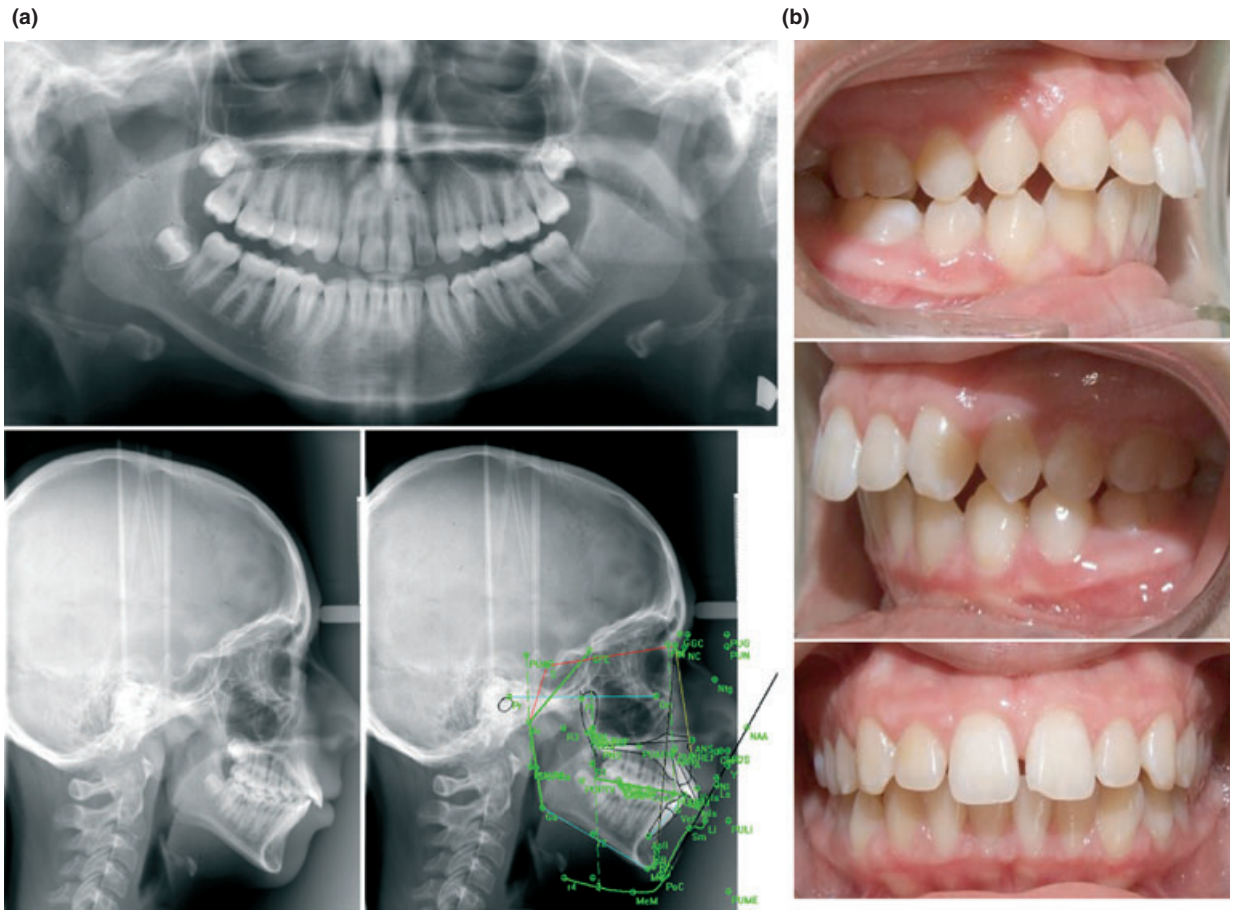


Fig. 2. (a) A 19-year-old girl with ipoplasic retrured mandible Rx and (b) dental inclination and large distance between upper and lower incisor.

Fig. 3. Mixed dentition and marked inclination.

upper incisors (without involving the pulp), it requires a restoration with porcelain veneers (for aesthetic reasons in a young patient). The cost of this procedure for two teeth is about €2000.

Case 3

In case 3, assessment of dental status of the patients showed mixed dentition and a marked inclination of upper incisor because of a mandible retrusion (Fig. 3). Tooth fracture in such a patient is highly problematic because of incomplete root formation. Once the injury has occurred, an early dental consult may reduce the damage. In case of immature apex with pulp vitality, a pulp capping, partial pulpotomy or cervical pulpotomy should be performed to preserve vitality of pulpal tissues at root level. If pulp necrosis occurs, endodontic treatment is needed. Survival of any tooth with immature apex after trauma is reduced because of the decreased cervical dentin thickness and the shorter physiological root length, making such tooth susceptible to fractures during function. A long-run follow-up is needed. If the tooth survives, a ceramic crown will often be needed after the growth ends. Charge for this procedure may be more than €1500 for each tooth and the outcome is not always favourable.

Discussion

Dental trauma is still a common complication of general anaesthesia with tracheal intubation. A brief description of types of damage along with suggestions for a clinical check-up and prognosis is reported in (Table 3).

Preoperative assessment of dental disease responsible for tooth weakness and demineralization is essential to

Table 3. Clinical evaluation and prognosis

Concussion, subluxation, dislocation, intrusion
Concussion and subluxation: both involve a little injury of PLD (periodontal ligament)
Concussion: a damage to tooth without displacement or increased mobility
Subluxation: tooth is mobile but not displaced
Clinical check-up: pulp sensibility test and RX every 1,3 and 6 months
Prognosis: pulp necrosis in 3–6% of cases
Lateral and estrusive dislocation: tooth can be dislocated in any direction
Prognosis: hinge on displacement degree and root development, excellent healing in immature tooth. Pulp necrosis occurs in 15–85% of cases and is more prevalent in tooth with apex closed
Intrusion: the apex is forced against alveolus bone, with strong compression of vascular and neural bundle; the intruded tooth must be immediately repositioned in the immediate post-trauma period
Prognosis: in 96% of cases, intruded teeth with closed root apices lost their vitality
Fractures
Incomplete enamel fractures: without dental substance loss
Uncomplicated fracture involving enamel and dentin : immediate protection of the dentinal wound is important for the preservation of tooth vitality; pulp necrosis after wide fracture: 54% without dentin covering
Complicated enamel–dentine fracture with pulp esposition: timing affects treatment; if the tooth is treated within few hours a conservative approach is indicated
Root fractures: involving or not involving pulp; pulp necrosis occurs in 25% of cases and is related to fragment displacement.
Crown-root fractures: deep crown-root fractures can only be restored when the fracture line is localized not deeper than at 1/3 of the length of the root; in case of a superficial localization of the fracture line, restoration with composite material or with the fractured tooth segment is indicated; healing of a root fracture is only possible when the tooth is immobilized for a sufficiently long period
Complicated crown-root fractures (with pulp esposition): prognosis for this tooth is unfavourable
Avulsion
Avulsion of permanent teeth: the management and immediate treatment of an avulsed permanent tooth will determine the long-term survival of the tooth. Timing is essential, the avulsed tooth must be replanted IMMEDIATELY (<5 min is decisive for PDL regeneration). If this procedure is not possible, tooth must be put in an isotonic liquid as milk. Cool milk can maintain cell function for almost twice as long as room temperature milk. Ice around the milk container can be used. A saline solution, as liquid for contact lens, is suitable. Water causes ipotonic lysis of PDL cells. Inflammatory root resorption in avulsed teeth can occur, and the tooth is substituted by bone. This resorption and the ankylosis that follows cannot be treated and must be prevented
Prognosis: if dry, in 15 min progenitor cells of PDL cannot differentiate into fibroblasts; in 30 min, most PDL cells are dead

estimate the risk of trauma: an adequate information on the patient's periodontal status should be of interest to the anaesthetist not only to increase awareness of potential traumatic impact but for forensic reasons as well. A preanaesthetic evaluation of the airway and dentition status (Table 1) is useful to choose, the appropriate laryngoscope (type and number of blade) and a possible dental protection device so as to ensure the success of the procedure and limit dental damage. A combination of tests may improve accuracy in predicting difficult intubation (8, 12). The Mallampati Score may estimate the size of the tongue relative to the oral cavity and may indicate whether the mouth can be opened adequately to permit intubation. Thyromental distance is considered to be an indicator of mandibular space (12). In patients with limited mandibular range of motion, the rotation of the distal end of the blade is limited making levering on the maxillary incisors inevitable during difficult intubations (8). Quinn and co-workers (13) found the force used during laryngoscopy to be the usual cause of injury. Warner et al. (3) reported that dental injury is more common in patients who are difficult to intubate. Rose and Cohen reported higher rates of oxygen desaturation and hypertension, as well as an increased incidence of dental injury and ICU admission, in patients who were difficult to intubate (4).

The maxillary incisors are frequently injured, and pre-existing poor dentition with large decays or restorations, advanced periodontitis, presence of dental prosthesis, shedding deciduous teeth, jaw misalignment and anterior crowding are well-recognized risk factors.

The overall incidence of dental injury in our retrospective study (1.38 per 1000 anaesthetics) was slightly higher than those reported by others, who observed frequencies ranging from one per 1.000 to one per 2.800 anaesthetics (1, 14, 15). On the other hand, it is consistently lower in comparison with the data reported by Nakahashi et al. and Chen et al. (2.1% and 12.1%, respectively) (16, 17).

In contrast to the report by Vogel et al. (14), avulsions of a permanent tooth occurred in 50% of study population; this apparently very high incidence can be explained by the large number of patients who were affected by severe mobility of native teeth while undergoing surgery. Damage of crowns, bridgeworks, subluxations and dislocations occurred less often than reported by previous authors (overall incidence of 18% with respect to 21–29%) (14, 16). Overall incidence of crown, enamel, bulk and root fractures (around 15%) resulted lower than that observed by Givol et al. (around 40%) (18), Vogel et al. (>32%) (14) and Newland et al. (>40%) (15).

Fractures of teeth accounted for only 12% of all lesions with only one tooth involved in 10% of cases and two teeth in 2% of injured patients. As commonly reported, upper incisors were very frequently injured; in our series, maxillary central incisors were involved with a greater incidence (>90% of cases) than that described in various studies (18, 19). The high degree of preoperative motility and weak roots could have contributed to significant damage even under moderate forces.

Residents and young anaesthesiologists were not frequently involved in dental damages; in almost 80% of trauma, laryngoscopy and tracheal intubation was performed by 'experienced hands'.

Even though the majority of anaesthesiologists were trained enough in the use of airway devices and aware of

the potential damage while using excessive forces, some unexpected difficulties may have led to lesions. It is known that damage to teeth can occur even in the absence of negligence.

Standard Macintosh laryngoscope (no. 3 blade), whose prominent flange may easily touch the maxillary central incisors, was used in >90% of cases of dental lesion. Methods proposed to decrease dental injury in at-risk patients include angulated blades, modified blades with soft heels or with no heel at all, teeth protectors or alternative devices (LMA, LMA Proseal, Flexible fiber-optic intubation), (9, 14, 20). A large number of laryngoscope blade designs are proposed with the aim of facilitating tracheal intubation with a good laryngoscopic view and a decreased risk of dental injury. According to the dental fracture models studied by Itoman et al. (2), plastic laryngoscope blades have a lower potential for dental fracture compared with metal blades. Plastic laryngoscope blades would be best suited for trainees performing routine intubations under direct supervision. Metal blades would be more advantageous in difficult intubations preferably performed by experienced intubators (2). Lee and co-workers (20) reported the use of a modified Macintosh blade that reduced dental contact especially in cases of periodontal disease or extensive tooth mobility. The ability of the anaesthesiologist, appropriate dentition assessment and the use of metal modified laryngoscope blades can reduce dental contact and prevent iatrogenic dental trauma. In our investigation, the number of laryngoscopic attempts at intubation was not properly described in anaesthesiology charts; therefore, we could not exactly determine whether a greater incidence of trauma was related to a higher number of unsuccessful attempts. Emergency surgeries were not related to a higher risk of dental trauma with respect to elective surgery; this implies that caution at intubation was not lower when the oro-dental conditions of patients were unknown. More than 10% of individuals were preoperatively affected by severe parodontal disease and <20% from minor deficits; as previously reported, a precarious dentition predisposes to injuries even when maximal attention has been paid. Some patients are aware of their dental mobility but may not disclose it either because of embarrassment or because of underestimation of potential risk for anaesthesia procedures. Almost two-thirds of lesions occurred in patients between 45 and 65 years of age. A greater proportion of these subjects require surgery in comparison with younger people. Furthermore, periodontal diseases and reconstructive works tend to increase with age. Unlike the observations by Newland and co-workers (15), neither major nor minor lesions were strictly linked to anticipated or unexpected difficult intubation; avulsions, fractures, luxations, etc. most frequently occurred during laryngoscopic manoeuvres which have been reported as 'smooth' procedures. Vogel et al. (14) reported a similar distribution of easy and difficult intubation circumstances related to teeth damage. Important anaesthesiological implications of the 3 clinical cases presented consist of recognition of both root and gingival vulnerability and anatomical abnormalities of arches form and arch alignment. The overbiting (overjet) of maxillary incisors that extend far beyond the lower incisors and the 'V' shape of the arch make laryngoscopy complicated and can interfere with tracheal tube placement. Unfortunately, even though the anaesthesiology charts were provided with a dental map, not all records were completely filled with precise descriptions of preoperative dental status. An extensive evaluation of intraoral condition would have been valuable for the anaesthesiologist in charge. Some damages could have been prevented if pre-existing dental pathology had been better described and understood. In this regard, close cooperation with dentists has been advocated. The high costs associated with repairing injuries greatly increase the likelihood the patient will pursue a claim. Partial or total payment was provided to all 83 patients regardless of evident preoperative pathology. If all charts contained appropriate documentation and patients were adequately informed on the existence of a high risk of dental trauma, when present, the amount of reimbursement might have been lower. This study has several weaknesses because of its retrospective nature: the quality of clinical information obtained from the anaesthesiology charts was not homogeneous. Some characteristics of preoperative dental status and intraoperative airway instrumentation were quite difficult to detect. It is also possible that the real incidence of lesions, in particular of minor lesions, has been underestimated, as some patients who suffered 'not very relevant' damages may not have pursued claims.

Conclusions

Correct intubation manoeuvres, adequate technical skills and the use of proper airway devices may reduce the incidence and severity of adverse events. Even when particular attention is paid to poor dentition, especially during elective surgery or in case of anticipated difficult intubation, the risk of dental lesion cannot be completely eliminated. Injuries to teeth or dental prosthesis may occur unexpectedly to inexperienced physicians as well as to very experienced staff, both in easy and in difficult intubation procedures. Dental treatment prior to surgery, whenever possible, may help prevent or reduce the occurrence of incidents. Casual dental injury during general anaesthesia still represents the main base for malpractice claims against the anaesthesiologist. However, legal responsibility only exists in case of evident malpractice resulting in an avoidable damage to the patient. Familiarity with and application of protective tooth guards before intubation has been recommended to reduce the incidence of casual dental trauma; their routinary application has, however, led to controversial results (21, 22). For instance, a restrictive mouth opening, which limits the amount of space for laryngoscopy, can be further reduced by protective tooth guards. Based on claims pursued by our patients, we recognize the need for more rigorous evaluation and documentation of the preoperative status of dentition. A detailed preoperative information about the potential risks and a clear documentation along with regular reporting of incidental lesions to the Legal Service may reduce postoperative litigations and costs.

Acknowledgements

We acknowledge the invaluable assistance of Mariaelena Molinari, Laura Sguotti, Maria Consuma, and Carla Brighenti in performing this study.

References

1. Warner ME, Benenfeld SM, Wamer MA, Schroeder DR, Maxson PM. Perianesthetic dental injuries: frequency, outcomes, and risk factors. Anesthesiology 1999;90:1302–5.
2. Itoman EM, Kajioka EH, Yamamoto LG. Dental fracture risk of metal vs plastic laryngoscope blades in dental models. Am J Emerg Med 2005;23:186–9.
3. Warner MA, Shields SE, Chute CG. Major morbidity and mortality within 1 month of ambulatory surgery and anesthesia. JAMA 1993;270:1437–41.
4. Rose DK, Cohen MM. The airway: problems and predictions in 18,500 patients. Can J Anaesth 1994;41:372–83.
5. Bucx MJL, Snijders CJ, Geel RTM, Robers C, Giessen H, Erdmann W et al. Forces acting on the maxillary incisor teeth during laryngoscopy using the Macintosh laryngoscope. Anaesthesia 1994;49:1064–70.
6. Rudolph C, Henn-Beilharz A, Gottschall R, Wallenborn J, Schaffranietz L. The unanticipated difficult intubation. Rigid or flexible endoscope? Minerva Anestesiol 2007;73:567–74.
7. Cattano D, Panucucci E, Paolicchi A, Forfori F, Giunta F, Hagberg C. Risk factors assessment of the difficult airway: an Italian survey of 1956 patients. Anesth Analg 2004;99:1774–9.
8. Burkle CM, Walsh MT, Harrison BA, Curry TB, Rose SH. Airway management after failure to intubate by direct laryngoscopy: outcomes in a large teaching hospital. Can J Anaesth, 2005;52:634–40.
9. Lockhart PB, Feldbau EV, Gabel RA, Connolly SF, Silversin JB. Dental complications during and after tracheal intubation. J Am Dent Assoc 1986;112:480–3.
10. Aromaa U, Personen P, Linko K, Tammisto T. Difficulties with tooth protections in endotracheal intubation. Acta Anaesthesiol Scand 1988;32:304–7.
11. Hoffmann J, Westendorff C, Reinert S. Evaluation of dental injury following endotracheal intubation using periotest® technique. Dent Traumatol 2005;21:263:268.
12. Toshiya S, Zeinchiro W, Tetsuo I, Atsuhiro S. Predicting difficult intubation in apparently normal patients: a meta-analysis of bedside screening test performance. Anesthesiology 2005;103:429–37.
13. Quinn JB, Schultheis LW, Schumacher GE. A tooth broken after laryngoscopy: unlikely to be caused by the force applied by the anesthesiologist. Anesth Analg 2005;100:594–6.
14. Vogel J, Stubinger S, Kaufmann M, Krastl G, Filippi A. Dental injuries resulting from tracheal intubation- a retrospective study. Dent Traumatol 2009;25:73–7.
15. Newland MC, Ellis SJ, Peters KR, Simonson JA, Durham TM, Ullrich FA et al. Dental injury associated with anaesthesia: A report of 161,687 anesthetics given over 14 years. J Clin Anesth 2007;19:339–45.
16. Nakahashi K, Yamamoto K, Tsuzuki M, Tatebayashi S, Morimoto Y, Hirai K et al. Effect of teeth protector on dental injuries during general anesthesia. Masui 2003;52:26–31.
17. Chen JJ, Susetio L, Chao CC. Oral complications associatd with endotracheal general anesthesia. Ma Zui Xue Za Zhi 1990;28:163–9.
18. Givol N, Gershtansky Y, Halamish-Shani T, Taicher S, Perel A, Segal E. Perianesthetic dental injuries: analysis of incident reports. J Clin Anesth 2004;16:173–6.
19. Chadwick RG, Linsday SM. Dental injuries during general anaesthesia: can the dentist help the anesthesist? Dent Update 1998;25:76–8.
20. Lee J, Choi J, Lee Y, Kim E, Kwon O, Hastings R. The Callander laryngoscope blade modification is associated with a decreased risk of dental contact. Can J Anaesth 2004;51:181–4.
21. 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;15:33–6.
22. Brosnan C, Radford P. The effect of toothguard on the difficult intubation. Anaesthesia 1997;52:1011–4.