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Traumatic dental injuries during anaesthesia. Part II: Medico-legal evaluation and liability

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Abstract – *Introduction*: Claims for tooth damage following intubation are increasing. An anaesthetic chart (AC) has been proposed to describe patient's pre-existent dental diseases and any possible lesions caused during intubation and extubation. *Materials and methods*: We conducted a retrospective study of 235 cases of dental lesions reported in litigation files from January 2000 to June 2009. Based on preoperative oral inspection the anaesthetist decided whether or not to use a protective aid. Two different tooth protectors were applied: (i) a standard mouthguard and (ii) silicone impression putty. *Results*: The study population consisted of 110 female (age 6–88 years) and 125 male patients (11–90 years) patients. In 66% of cases greater risk of perianesthetic dental injury was reported in the AC due to pre-existing poor dentition. In intubation procedures without protective devices dental subluxation/luxation occurred in 55% of patients, dental avulsion in 43%, exfoliation in 2%, and soft tissue damage in five patients. One patient suffered from transient facial nerve paralysis. The costs of treatments and of impression materials, as well as the total value of compensation for injuries are reported. *Discussion*: Definition and demonstrability of damages on the AC is important in order to separate the cases worthy of compensation from the non-compensable ones, as to evaluate the possibility of solving the litigation by extrajudicial channels. There are cases in which, based on AC reporting and device adoption the damage resulted to be compensable, but the costs were defined on different estimates of lesions. The use of a protective device makes it possible to down-modulate the damage compensation. *Conclusion*: The analysis of litigation records and 'incident reports' has suggested that the choice of accurate proceeding and the use of protection aids could reduce the number of claims, insurance premiums and the costs of litigation process, thus improving physician-patient relationship.

The number of legal proceedings in regards to professional liability is constantly increasing in Italy with a subsequent increase in insurance premiums. Introduction of very high-franchise clauses with unsettled insurance coverage leads hospitals to recede from contracts, and insurers to abandon the market, and all the while medical facilities, hospitals, and the medical staff spend more to insure themselves. ANIA (the National Association of Insurance Companies) shows that damage claims for malpractice or medical mistakes have increased by 66%: from 17 000 cases in 1996 to 28 000 in 2006.

Dental lesions are a frequent complication of orotracheal intubation and a wide range of factors are responsible for these: (i) poor dentition, (ii) impetuous or aggressive laryngoscopy for restricted visual field and/or limited mouth opening, (iii) incomplete anaesthesia and curarization during the induction period, (iv) emergent procedures, (v) lack of experience by the anaesthesiologist and/or inadequate or lack of supervision of trainees, (vi) lack of alternative intubation devices, (vii) lack of correct prophylactic measures.

A preoperative oro-pharyngeal evaluation should always be accurately performed by the anaesthetist as it helps choose the most appropriate airway strategies and reduce clinical risks and possible legal cases.

For this purpose an anaesthetic chart (AC) has been proposed in clinical practice to describe the patient's clinical condition, his/her pre-existent dental disease, and any possible lesions caused during intubation and/or extubation.

Careful handling of anaesthesia charts helps clarify the stomatological-prosthetic and the non-odontological risk factors, as well as assists in taking preventive measures to reduce the lesions.

In this paper we evaluated the ACs, litigation records and all closed anaesthesia claims received in our Department of Legal Medicine by Legal Unit Affairs of the University Hospital of Ferrara (Italy).

Materials and methods

We conducted a retrospective study of 235 cases of dental lesions reported in litigation files and medical

records we received by Legal Unit Affairs in the period from January 2000 to June 2009. This case series is part of 62 898 surgical procedures under general anaesthesia with tracheal intubation for major, minor, and emergency surgery (no day surgery). The ACs we evaluated consisted of two parts (Tables 1 and 2).

In part 1 (Table 1) basic patient data is reported such as demographic information, anamnestic and clinical condition, type of scheduled surgery, physical examination, head and neck mobility evaluation, risk factors for a difficult intubation, and the presence of any poor or mobile dentition, fixed or mobile dental prosthesis, pre-existing dentist consultation.

Part 2 (Table 2) reports on any post operative dental damage and possible adverse incidents that have occurred.

Based on preoperative oral inspection the anaesthetist decided whether to use a protection aid (mouthguard or toothpaste). The use of mouthguards to avoid dental trauma associated with anaesthesia has been frequently reported in literature (1–5).

Two different tooth protectors have been applied in our case series: (i) a standard dental protection device mouth guard: a plastic dental shield, (Fig. 1) and (ii) a silicone impression putty, a protection device recently introduced in our hospital (Fig. 2).

The dental silicone impression putties (i.e. Elite HD-Putty Soft, Fast Setting Zhermack, Aquasil Dentsply, Silagnum Putty, Virtual Ivoclar Putty Fast, Express™ Penta™ Putty Material 3M, etc.) are mixed and placed around the anterior maxillary teeth. We chose the Elite HD, which is the most economical and least rigid, and is easy to remove. This material is readily available and there is no special technique required to use it. Identical proportions of the base and catalyst are mixed until obtaining a homogeneous mix with no streaks (about 30 s).

This protection device reduces the risk of enamel fracture or chipping by directly shielding the teeth, and prevents avulsion by splinting them together thereby providing increased anchorage. A sausage-shaped mass is created and then moulded around the front teeth. It sets in approximately 5 min. The putty can be kept in the operative theatre and mixed just before the intubation procedure.

Results

The study population consisted of 110 females (46.8%) (age 6–88 years) and 125 males (53.1%) (age ranging from 11 to 90). Table 2 reports patients' demographic data, ASA class, preoperative oral evaluation, recog-

Table 1. AC: perioperative medical record

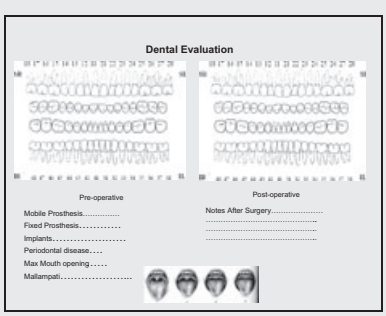
	Anaesthetist DR Patients	Date Dental evaluation	Department Procedures
PART 1	Medical record number Diagnosis Name-Surname F ☐ M ☐ Heigh (cm) Age Weight (kg) BMI ASA 1 ☐ 2 ☐ 3 ☐ 4 ☐ Anamnesthic/Clinical situation	Pre-operative Normal Dentition ☐ Poor Dentition ☐ Periodontal Disease ☐ Mobile Teeth N… Multiple Mobile Teeth ☐ Edentulate ☐ Carious ☐ Caps ☐ Crowns ☐ Reconstructive Work ☐ Dental Prosthesis ☐ Sup ☐ inf ☐ Dentistry consultation ☐ Perioral photography Yes ☐ No ☐	General Anesth ☐ Sedation ☐ Direct Laryngoscophy ☐ IOT ☐ IRT ☐ Laryngoscopic Blade N: LMA ☐ Supreme ☐ Pro-Seal ☐ Mask N Airtraq ☐ Glidescope ☐ Fibroscopic ☐ Laryngoscopy Easy☐ Difficult ☐ Previous Noted Difficulties ☐ Oral Opening < 3 Cm ☐ >3 Cm ☐ Mallampati Score 1 ☐ 2 ☐ 3 ☐ 4 ☐ Thyromental Distance >6 Cm ☐ < 6 Cm ☐ Cormack 1 ☐ 2 ☐ 3 ☐ 4 ☐ Head/Neck Surgery Cancer ☐ Limitated Neck Motion ☐
PART 2		Postoperative Subluxation/Luxation ☐ Exfoliation of teeth ☐ Tooth Avulsion ☐ Fracture ☐ Enamel Fracture ☐ Crowns dislocation ☐ Bridge dislocation ☐ Oral soft tissue trauma ☐	Mouthguards ☐ Toothpaste ☐ Notes Adverse incident Yes ☐ No ☐

Table 2. Demographic, incident report, injured teeth

Characteristic	Cases, *n* = 235
Age (years)	
6–10	4 (1.7%)
11–70	206 (87.6%)
81–90	15 (6.35)
BMI (kg m^{-2})	27.7 ± 6.4
Female/male	110 (46.8%)/125 (53.1%)
ASA	
I	52 (22%)
II	79 (33.6%)
III	98 (41.7%)
IV	6 (2.5%)
Cormack 3–4	12 (5.1%)
Emergency surgery	36 (15.3%)
Elective	199 (84.6)
No protection device	83 (35.3%)
Mouthguard	74 (48.6%)
Silicon impression putty	78 (51.3%)
Oral intubation	230 (97.8)
Nasal intubation	4 (1.7%)
LMA	1 (0.4%)
Previous difficult intubation	11 (4.6%)
Limited mouth opening	22 (9.3%)
Alternative intubation device	26 (11.0%)
Poor dentition	189 (80.4%)
Perioperative extremely mobile teeth	39 (16.5%)
Previous dental work of prostheses	111 (47.2%)
Reconstructive work	20 (0.85%)
Multiple mobile teeth	45 (19.1%)
Partial edentulism	89 (37.8%)
Carious teeth	52 (22.15)
Preoperative dental consultation(dentistry)	3 (1.2%)
Dental abscess/endodontic infection	2 (0.85%)
Head/neck surgery/cancer	6 (2.5%)
Limited neck motion	12 (5.1%)
Subluxation/luxation	99 (42.1%)
Tooth avulsion	22 (0.93%)
Teeth fracture	20 (0.85%)
Crown and root fracture	1 (0.4%)
Bridge dislocation	3 (1.2%)
Exfoliation of teeth	21 (8.9%)
Enamel fracture	5 (2.1%)
Oral soft tissues trauma	17 (7.2%)
Other injury	2 (0.85%)

Fig. 1. Dental protection device: Mouthguards.

Fig. 2. Dental protection device: Silicone Impression Putty.

nized risk factors, as well as the type of airway devices, and some adverse events on patients' teeth.

In all cases, the ACs were included within the patient's filing claims and litigation files (Insurance Company files). In 66% of cases greater risk of perianesthetic dental injury was identified and reported in the ACs, as a consequence of pre-existing poor dentition, manifest dental disease, the presence of prostheses, already damaged teeth, oral diseases and/or functional limitations. Other risk factors were also reported such as history of difficult intubation, previous neck surgery, oral chemo-or-radiotherapy, neoplasms of the tongue, oral trauma. A comprehensive view of the most common factors involved in dental damage in the period 2000–2009 is shown in Table 3.

Patient's information on the identification of vulnerable dentition and therefore of a higher risk of dental lesion was reported in the preoperative 'informed consent for anaesthesia'. Patients were classified as at high or low 'risk' for possible dental damage during anaesthesia.

Poor dentition such as the presence of mobile teeth, reconstructive work, carious teeth, abscess, etc. was reported in 189/235 of cases (80.4%); 179 out of 189 were at high risk of perianesthetic dental damage due to serious periodontal disease. In 152 subjects (64.6%) a protective device was used before intubation; patients were randomized so that 74 individuals out of 152 (48.6%) were assigned a mouthguard, whereas 78 (51.3%) received our new customized mouthguard (a dental silicone impression putty). Thirty-six out of 83 patients (43.3%) did not benefit from a protective device, since the intubation procedure was carried out in emergency conditions; 47 subjects (56.6%) who underwent elective intubation did not receive any kind of dental protection based on the anaesthesiologist's choice (35% of patients with normal dentition and 65% with poor dentition) (Table 2). In 9% of individuals no dental protection device was used because of the limited mouth opening, a previous difficult intubation, or high mobility of one or more teeth (the removal of the paste itself at the end of the procedure could have caused the tooth avulsion). A 'difficult intubation' was reported in 15% of cases, and required the use of alternative intubation aids (Glidescope®, Airtrach®, LMA Proseal®, Frova

Table 3. Factors involved in dental damage between 2000 and 2009

Poor dentition
Emergency circumstances and urgency procedures
Check equipment failure /failure of planning
Operator error
Improper technique
Failure to recognize difficult predicted intubation
Problems related on airway management
Impetuos or aggressive laryngoscopy
Inadequate or lack of supervision of trainees
Fatigue and decreased vigilance / time of day /excessive workload
Lack of alternative intubation devices (Glidescope, Airtraq..)
Incomplete anaesthesia, sedation and curarization
Lack of experience by the anaesthesiologist
Restricted visual field and or limited mouth opening (large tongue, macroglossia, retrognathism, short neck, prominent incisors, thyromental distance, limited neck extension)

introducer®, etc.). A protection device was always used in individuals with limited head movement and prior neck surgery. In intubation procedures without protection devices dental subluxation/luxation occurred in 55% of patients, dental avulsion or dental injury in 43%, exfoliation in 2%, and soft tissue damage was reported in five patients. One patient suffered from transient facial nerve paralysis, likely due to overpressure on the mandibular branch of the facial nerve. There were also two cases of dental injuries provoked by the Guedel oral airways. The costs of treatment are of dental lesions is reported in Table 4, and the costs of impression materials in Table 5. The total value of recompensation for injuries added up to 37 650 Euros.

By analyzing dental injuries reported in the ACs and the legal files, we found four different clinical situations for which we could identify various refundable hypotheses (Fig. 3).

Situation no. 1: A tooth fracture in a child with mixed dentition, marginal fracture of the central incisor involving dentin. In the preoperative evaluation no pre-existing disease (normal dentition) was reported on the AC. No protection device was used. The damage should be followed during child growth since dental elements are particularly delicate due to non-fully developed roots.

Situation no. 2: A dental injury in a patient with full permanent healthy dentition; the AC was filled in with a proper evaluation of the dental state, a device was placed, nevertheless dental luxation (element 22) did occur. The application of dental protection device could have reduced the extent of injury.

Table 4. Costs of procedures

	Obtained fares (euro)	
Type of procedure	Minimum	Maximum
Crown on implant in integral ceramic	700.00	1000.00
Osteonitegrated implant	700.00	1250.00
Crown on bridge in integral ceramic (four anterior teeth)	500.00	700.00
Middle structure on implant	200.00	500.00
Provisional crown on implant	80.00	150.00
Aesthetic ceramic veneers	500.00	1000.00
Pulpectomy (child)	50.00	130.00
Simple filling (child)	150.00	250.00
Endodontic treatment (child)	100.00	180.00
Hestetic ceramic veneers (child)	500.00	1000.00

Table 5. Dental silicone impression putty costs

Impression materials	Costs: Euro (€)
Detail precision ™	57
Affinis putty soft™	113.99
Elite H-D+™ putty soft Zhermack spa	37.45
Aquasil Dentsply ™	83.60
Provil fast set™	52.47
Silagnum Putty™	156.90
President Plus™ Coltene	59.64

Situation no. 3: A dental fracture involving the pulp (left central incisor 21) in a 76-year-old man with already compromised elements. In the preoperatory evaluation a pre-existing periodontal disease, multiple mobile teeth, and partial edentulism was evidenced. A protective device was used during intubation. Patients with similar dental conditions are particularly vulnerable to avulsion and to the risk of breaking up the teeth into small pieces. Because of large cavities already present involuntary damage can happen even with only a light contact with laryngoscope. For this reason the use of the paste is highly recommended.

Situation no. 4a: A 65-year-old man with only a few teeth which were badly damaged was affected by a tooth avulsion (inferior left canine 33). The use of the paste in this case is recommended because it splints the teeth together. This reduces the risk of tooth avulsion and consequent ingurgitation of fragments. Even though the use of paste in similar cases reduces the risk of tooth damage, it does not cancel it out. In addition, the removal of paste can be difficult and can carry a further risk of injury itself, because of the tooth shape, the fragility of the elements, and their mobility. The patient must be informed of all these risks.

Situation no. 4b: Teeth avulsions (central incisors 21 and 22) in a 77-year-old man with very few residual elements in compromised situation. On seriously compromised teeth the application of dental protection devices is not possible, and in spite of a correct intubation there could be dental injuries. The AC should be filled in with a precise pre-operatory evaluation of the patient's dental state. It is also essential to inform the patient about the high risk of damage to residual teeth/or elements even after appropriate manoeuvres.

Discussion

A dental lesion is considered by the Italian legal system from both a criminal and a civil point of view. The civil profile identifies the damage quantification in terms of 'biologic damage', which is treated with the highest 'personalization' by the civil code (CC). Damages can be compensated from the civil point of view only if its preventability can be demonstrated (art. 1225 CC) and the liability evidence is fulfilled (art. 1218 and 1225 CC). The civil activity related to a trial only takes place at the injured person's request. Such a mechanism lets us say

Fig. 3. Different clinical situations with various refundable hypotheses.

that, in the case of personal damage caused by medical-surgical activities, people often should prefer a monetary transaction between the parties, thus limiting the negative effects of a criminal suit (when established) or preventing the proceedings themselves (both penal and civil). In this respect, the physician must demonstrate that during the anaesthesiological procedures he/she took the proper precautions and adopted protector systems in order to ensure the maximum protection and avoid predictable damage.

AC forms have been proposed in order to document the patient's dentition before induction of anaesthesia. Perioperative charts are essential for the legal medicine team to collect information on preoperative dental situations, to establish the chronology and the way in which any possible injury had occurred, as well as to keep a record of the diagnostic and therapeutic procedures performed in cases of jatrogenic dental lesion (litigation files). When a poor dentition was reported in the preoperative examination, we randomly introduced the use of another protector device (Fig. 2), in alternative to the 'regular' standard devices. Some authors described teeth protectors reducing the direct contact of the upper teeth with the blade during laryngoscopy (6). It should be recognized, however, that the use of mouthguards, which are aimed at avoiding dental trauma associated with anesthesia, has been considered in many ways, ranging from helpful to totally ineffective (6–8). Dunnet and colleagues reported that The Medical Defence Union (USA) has suggested the routine use of dental shields during intubation, and it may be expected that courts could rate this use in the future as a standard of good clinical practice (9). Ghabash and colleagues advocated the use of surgical adhesive tape (3M Microfoam Surgical Tape®) on the metallic blade of the laryngoscope (10). Various prefabricated mouthguards or those used preventively in sports do not guarantee an endotracheal intubation free from dental traumas. Numerous studies have shown that the upper incisors are at greatest risk for damage (they are frequently used as a fulcrum). In particular, teeth restored with poor technique are extremely vulnerable (6). Buck and colleagues reported that the forces applied on the maxillary incisors during laryngoscopy in adult patients was 49 Newton on average (11). Improved 'laryngoscope designs' e.g. 'Callender Laryngoscope Blade', 'Dental protector Blade' and 'Improved Laryngoscope Blade' have been proposed to reduce dental lesions (6, 12). A recognized disadvantage of teeth protectors consists of the reduction of the mouth opening which limits the visualization of the larynx, and increases the difficulty of tracheal intubation. Furthermore, the instability of some protectors during the intubation procedures may cause distraction, poor visualization, and a reduced space for blade introduction. There are no data in literature on which model of preformed dental shields is clearly superior in reducing the risk of tooth damage during endotracheal intubation. Some Authors demonstrated that the incidence of dental damage during laryngoscopy for intubation may be reduced by adopting the video laryngoscopes, such as Glidescope®, McGRATH®, etc. (13).

The four clinical situations previously described represent a good explanatory model of modulating the extent of compensation in case of possible damage. Table 6 reports the different modalities of evaluation that lead a complete compensation or variable modulation of refund in accordance with the Italian Legal

Table 6. Claims/litigation/compensation/situations

Pre-operative dental evaluation	Preexisting disease	Device	Situation	Refund/no refund
Yes	NO	NO	1	Refund
Yes	NO	YES	2	Refund/ modulation
Yes	YES	YES	3	No refund
Yes	YES	NO	4a	Refund/ modulation
Yes	YES	NO	4b	No refund
No	NO	NO		Refund
No	YES	NO		Refund
No	YES	YES		Refund/modulation
No	NO	YES		Refund/modultion
Emergency/urgency	NO/YES?	NO /YES		No refund

System, depending on whether any dental disease was present at preoperative inspection and AC reporting, or whether a teeth protector was used. The AC is mandatory for damage compensation from a civil point of view; the definition and the demonstrability of the damage is important in separating the cases worthy to be compensated from the non-compensable ones, and in evaluating the possibility of solving the litigation by extrajudicial channels. As shown in Table 6 there are cases in which, based on AC reporting and device adoption the proved damage turned out to be compensable, but the costs were to be defined on different estimates of damage.

In making a comparison between protector's costs and the actual costs of compensable damages, the use of a device makes it possible to down-modulate the damage compensation (Table 6). For example applying a protection device even in the cases where no pre-existing diseases are reported in the ACs (Table 6; situation 2) allows for the potential compensation to be modulated, by demonstrating that all precautions were taken to avoid trauma (concept of modulation). In the cases of evident pre-existing pathologies on AC reporting (cracks, fragmentation, moving prosthesis, presence of broken ceramic or porcelain or instable teeth, extensively bad dental work, loose or fragile teeth), the use of a device is mandatory; with this precaution the means obligation is satisfied but the damage will not be compensable (Table 6; situation 3). In situation 4a of Table 6 the demonstration of a pre-existing poor dentition, even when a protector is not used, makes the cost of lesion to be compensated modulated. In patients with pre-existing very poor dentition it is not always possible to apply a device, nevertheless it is important to appropriately document the state of dentition (Table 6; situation 4b) in order to modulate the extent of refund.

Conclusion

Accurate perioperative evaluation of dentition, appropriate prophylactic measures during airway instrumentation and the proper use of mouthguards, when indicated, may result in a reduced incidence of dental injury. Even though a thorough preanaesthesia inspection associated with a skilful intubation procedure are not always sufficient to avoid damages, exercising cautionary measures during provocative events, such as difficult attempts at laryngoscopy and rush tracheal extubation, can aid in the prevention of major lesions. The potential health care implication of adverse events such as aspiration or ingestion of dental foreign objects or teeth must be considered by anaesthetists not only for the high financial costs but also for professional claims. A focused education at using dental protectors may help control care costs after anaesthesia. It is likely that an early use of alternative devices in case of difficult intubations, such as modified blades or laryngoscopes, or video laryngoscopes, positively contributes to a reduction of claims and suits, with all their related expenses and court costs. A reasonable reimbursement by the health care system should only include the repair costs of the dental trauma that was sustained in the perioperative period. Our initial findings confirm that the AC detailed reporting on preoperative dental conditions associated with either standard dental protection or a silicone impression putty (Elite HD) resulted in greater patient satisfaction and an appropriate modulation of possible compensation. Further studies are required to determine the real impact of using mouthguards in reducing dental injuries and their potential for down-modulating the amount of reimbursement in cases of accidental damage.

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