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Evaluation of dental injury following endotracheal intubation using the Periotest® technique

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Abstract – The hazards of damage to teeth and their periodontal attachment during tracheal intubation are well known. Dental trauma represents the commonest single reason for complaints against anesthesiologists. In order to predict the possible risk of perianesthetic iatrogenic tooth luxation we evaluated the use of a measuring method (Periotest® technique), being well established for the diagnosis of periodontal disease. In 120 patients undergoing elective surgery, we compared the amount of tooth mobility before and after general anesthesia to different scores assessing the difficulty of tracheal intubation. Furthermore, the level of work experience of the intubating anesthetist was compared with the degree of postoperative tooth mobility. Changes of periodontal attachment could not be detected by the Periotest® technique. The Periotest® technique does not seem to have the ability to detect early periodontal changes associated with endotracheal intubation.

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Key words: general anesthesia; endotracheal intubation; dental trauma; Periotest® device

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In general anesthesia, trauma to the patient's teeth is a rare event but a considerable worry to the anesthetist as teeth are especially vulnerable to damage by laryngoscopy in preparation for endotracheal intubation (1). Following direct damage to the laryngoscope, about 20% of anesthesia-related dental injuries occur during recovery when the patient may bite vigorously upon the *in situ* plastic airway tube or may grind the teeth while emerging from anesthesia (2). Dental trauma is the commonest single reason for lawsuits against anesthetists (1). In literature, the incidence of occurrence of dental trauma, notably damage to the maxillary incisors associated with anesthesia range widely from 1:1000 to 1:10 (3–7). An increased risk is seen in cases exhibiting factors predisposing to dental trauma. Those are emergencies, patients with a situation where laryngoscopy is difficult (for example restricted mouth opening, decreased mandibular mobility, large tongue, poor visualization of the hypopharynx, shortened thyromental distance, limited neck extension (8) and patients presenting increased vulnerability of their teeth caused by caries, periodontal disease or sophisticated dental reconstructions, such as porcelain-capped teeth and crowns, or fixed partial dentures (9).

Most dental traumas are caused by direct pressure during laryngoscopy and intubation. The maxillary incisors (in particular the upper left central incisor) are most frequently involved (3). Fracture of crowns and roots of natural teeth (44.8%), followed by partial luxation (20.8%) and avulsion (20.8%) are known to be the most common traumas (5).

Dental treatment of minor injuries, such as chippings or uncomplicated fractures of dental cutting edges is relatively easy. The management of tooth luxation injuries appears more difficult. During tooth luxation the gingival attachment is often torn and presumably pulpal vascular supply is severed with consequently increased risk of pulp necrosis and root resorption. Periodontal ligament and pulp may regenerate or show repair with scar or bone tissue after wounding. Yet there is evidence that tooth luxation resulting in increased tooth mobility at the time of injury causes significantly worsened prognosis (10). Intrusion is the severest form of displacement injury and can occur when the tooth has been forced axially through the socket wall, resulting in damage to alveolar bone, periodontal ligament and the cementum layer of the root (11). In lateral luxation, crown displacement is typically orally, with the root apex being forced facially, often with resulting fractures of the labial bone plate. Intrusion and lateral luxation presumably not only sever the pulp's blood supply, but also result in a crushing injury to the root surface and alveolar process immediately surrounding the apex, leading to further injury to the pulp and possibly limiting the potential for repair. Treatment of tooth luxation injuries may be extensive with consequently significant personal and financial burden to the patient.

As most teeth avulsed in adults during general anesthesia exhibit advanced periodontal disease, information of the patient's periodontal status is of interest for the anesthetist not only to implement action for prevention of traumatic impact but also for forensic reasons when it comes to documentation of periodontal status with regard to liability claims. Furthermore, early diagnosis of structural changes of periodontal tissue following traumatic impact is essential in periodontal therapy (12). Yet anesthesiologists have limited methods to detect dental diseases. Preanesthetic evaluation of the oral cavity primarily consists of visual inspection and palpation of tooth mobility and may result in a misinterpretation of the dental status as patients with moderate or even severe periodontitis may present with normal looking gingiva. Porcelain-capped teeth may not be recognized as unnatural teeth. Further rather dental methods used for diagnosis of periodontal diseases, like clinical assessment of gingival inflammation, measurement of periodontal pocket depths and estimation of alveolar bone resorption in radiographs are essentially subjective and do not fit in the daily routine of anesthesiologists.

The Periotest® technique (Figs 1 & 2) provides a non-invasive, dynamic and objective measure of periodontal function (13, 14). Invented for the diagnosis of periodontal diseases, the Periotest® device measures the reaction to an electronically controlled and reproducible impact applied to the tooth crown. The 'Periotest® value' (PTV) depends to some extent on tooth mobility, but mainly on the damping characteristics of the periodontal tissue, including bone. The PTV can be recorded quantitatively with great accuracy even if there is no radiologic evidence of disease (14).

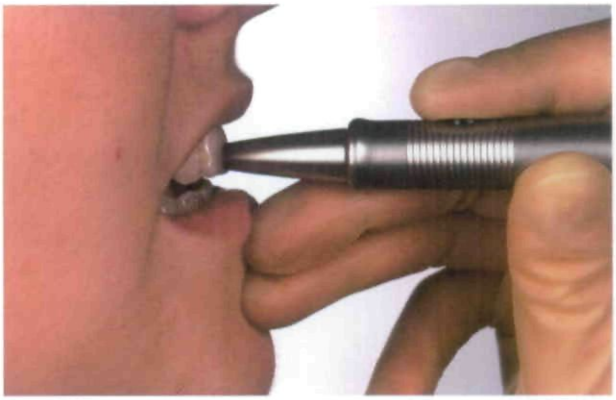

Fig. 1. Periotest® measurement. The handpiece has to be held horizontal and right-angled to the tooth surface under test.

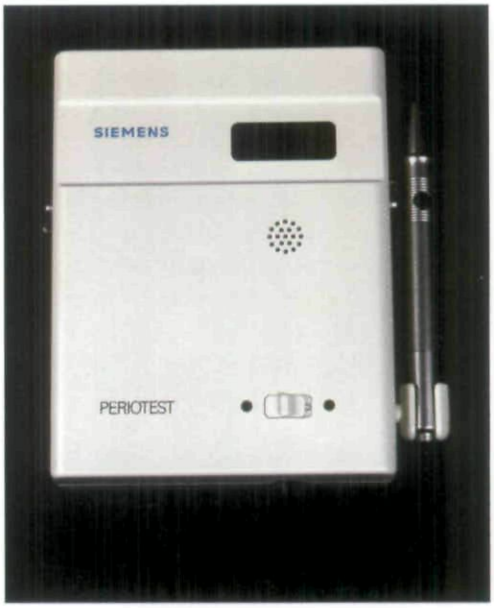

Fig. 2. Periotest® device.

This study was performed to evaluate the feasibility using the Periotest® technique as a biophysical parameter for assessing dental damping characteristics and tooth mobility in patients undergoing general anesthesia in order to provide an objective parameter displaying the patient's periodontal status.

Method

One hundred and twenty patients, 66 females and 54 males, ages ranging from 15 to 75 (mean average 35.9) undergoing elective surgery were included in this study. Apart from requiring surgery patients were otherwise unremarkable. Patients were divided into four groups following the bedside test classification described by Mallampati et al., modified by Samsoon and Young (15–17) suggesting that difficulty of intubation is unlikely if the anesthetist is able to see uvula and soft palate in a patient with fully opened mouth and protruded tongue (Table 1). Patients were furthermore classified by the Wilson risk score (Table 2) (18), while noting that both tests – despite showing high specifity – have poor sensitivity. The five risk factors contributing to the Wilson score are weight, head and neck mobility, jaw movement, mandibular retrusion and the presence or absence of buck teeth. Each factor is graded from 0 to 2 based on set criteria; total risk score ranges from 0 to 10. A score >2 predicts 75% of difficult intubations.

After given informed consent the pre-anesthetic dental status was assessed and recorded the day prior to operation. Upper and lower incisors, canines and bicuspids were examined by just one dentist to avoid inter observer variance.

The Periotest® device (Siemens AG, Bensheim, Germany) was used in this study to examine dental damping characteristics. This device produces a reproducible percussive force. A rod with a tapping head is held in low friction bearings contained by a dental handpiece. On command the tapping head is accelerated by a propulsion coil. The velocity remains constant even if the distance between the handpiece and the tooth under percussion varies up to a certain range. The deceleration of the tapping head on impact with the tooth is detected by an accelerometer installed in the tapping head. This operation is repeated for each tooth 16 times in 4 s. The clinical degree of tooth mobility related to damping loss is correlated with the percussion signal. Deceleration is increased in the presence of stronger periodontal damping capabilities. The PTV represents the degree of mobility. The PTV depends on the extension of the root surface. Dental restorations like fillings or crowns have no influence on the PTV. Increased tooth mobility is represented by an increase of the PTV.

All intubations were performed using the Macintosh laryngoscope. The level of practical experience of the intubating anesthetist was documented. The intubating anesthetist was not aware of the intentions of the ongoing study. No added precautions to avoid dental trauma have been taken. As soon as possible after surgery and not later than first postoperative day patients were reexamined by using the Periotest® technique. Statistical analyses were performed using the JMP® version 3.1.4 software (SAS Institute Inc., NC, USA).

Table 1. Mallampati classification modified by Samsoon and Young

Class 1	Faucial pillars, uvula, soft palate and tonsils visible
Class 2	Faucial pillars, uvula and soft palate visible
Class 3	Only base of uvula and soft palate visible
Class 4	Soft palate not visible

Table 2. The Wilson risk score

Risk factor	Level
Weight	
<90 kg	0
90–110 kg	1
>110 kg	2
Head and neck movement	
Above 90°	0
About 90° (i.e. ±10°)	1
Below 90°	2
Jaw movement	
IG* ≥5 cm or SLux** >0	0
IG* <5 cm and SLux** =0	1
IG* <5 cm and SLux** <0	2
Receding mandible	
Normal	0
Moderate	1
Severe	2
Buck teeth	
Normal	0
Moderate	1
Severe	2

*Inter incisor gap.

**Subluxation, i.e. maximal forward protrusion of the lower beyond the upper incisors.

Results

With regard to the classification described by Mallampati et al., modified by Samsoon and Young (15–17). Twenty patients met criteria for class 1, 55 patients were represented in class 2, 26 patients were classified as class 3 and 19 patients as class 4. As to the Wilson score, 89 of the patients were expected not to cause any trouble with intubation procedure. Thirty-one patients had a score >2. They were supposed not to be easily laryngoscopied.

Those in class 1 and 2 ($n = 75$) posed no difficulty at intubation. Those in class 3 and 4 ($n = 45$) caused difficulty at laryngoscopy and intubation, such that the epiglottis was not visible to the anesthetist at laryngoscopy despite adequate relaxation and correct positioning of the patient. Although we observed minor discrepancies between the sort of classification and difficulty at intubation in few patients there were no significant differences.

Prior to operation no tooth was assessed at 'high risk' in terms of periodontal status. Clinical examination of the teeth after surgery showed no clinical signs of tooth damage. No patient had a gingival bleeding following intubation.

The Periotest® equipment was found easy to use. To detect changes in tooth mobility following endotracheal intubation the difference of pre- and postoperative Periotest® values was compared, taking sex into consideration data relating to the upper incisors is shown in Figs 3 and 4.

Furthermore, preoperatively assessed PTVs were compared with postoperative values by *t*-test with regard to the difficult group ($n = 45$) and the straightforward group ($n = 75$) based on the Mallampati and the Wilson score (data shown in Figs 5 and 6). Results showed a wide variation of Periotest® readings. There were no statistically significant differences between the groups nor between the PTVs within one group (data not shown).

Anesthetists with internship or residency work experience (inexperienced anesthetists) intubated 32 of the patients. Eighty-five of the intubations were performed by those having worked in anesthesia for more than 5 years (attendings, experienced anesthetists). Although there were indices suggesting increased tooth mobility after general anesthesia performed by inexperienced anesthetists that could not be seen in the group of experienced anesthetists

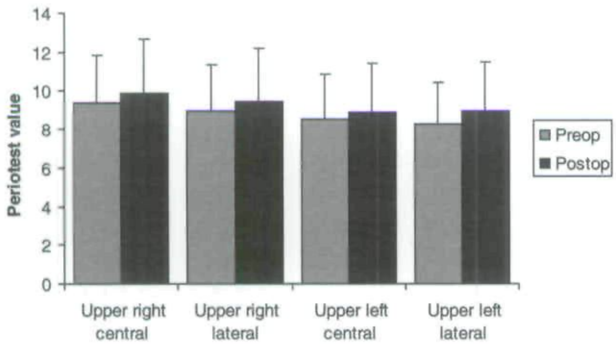

Fig. 3. Difference of pre- and postoperative PTVs of the upper incisors following endotracheal intubation in females. The tendency of slightly increased postoperative values shows no statistical significance.

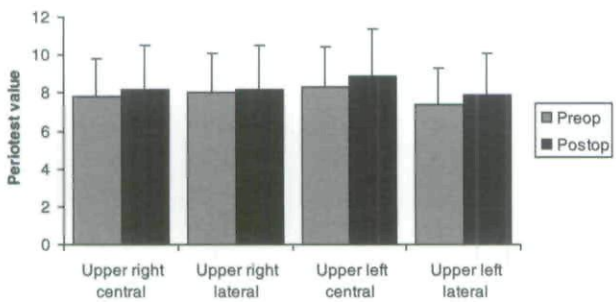

Fig. 4. Difference of pre- and postoperative PTVs of the upper incisors following endotracheal intubation in males. The tendency of slightly increased postoperative values shows no statistical significance.

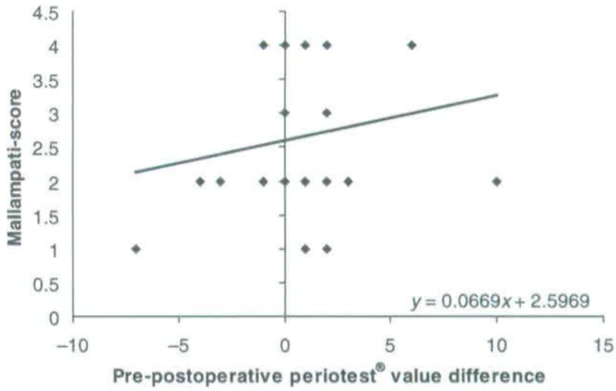

Fig. 5. Relationship between pre- and postoperative PTV and the Mallampati Score.

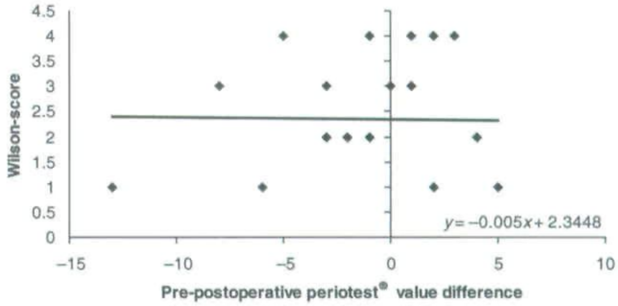

Fig. 6. Relationship between pre- and postoperative PTV and the Wilson Score.

this difference was without statistical significance (data not shown).

Discussion

The Periotest® technique enables the physician to detect apparent periodontal changes in an early state. For example, periodontal bone resorption affects the dental damping characteristics in up to 74% (12). This study suggests that the Periotest® device does not seem to be capable of detecting periodontal changes associated with general anesthesia. This is in accordance with other authors who could not detect early periodontal changes in experimental studies (19). These findings could be attributed to the fact that during general anesthesia only minor changes occur within the periodontium. This in turn is in conflict with studies clearly indicating that during routine laryngoscopy performed by experienced anesthetists the maxillary incisors are exposed to considerable forces as the majority of anesthetists use those teeth as a fulcrum point of leverage as the most efficient way to bring the glottis into view (1). Although the Macintosh laryngoscope blade can negotiate most tight oropharyngeal corners because of it's total curve of almost 30 degrees (20) during laryngoscopy the vertical component often contacts the upper frontal teeth. In patients with limited motion of the mandible this results in limited rotation of the distal end of the blade. In clinical practice, there is agreement that during difficult intubations some levering on the maxillary incisors is inevitable (1). Experienced anesthetists apparently do not differ from beginners in terms of the forces applied to the maxillary incisors (21). There is suggestion to use alternative techniques such as fiberoscopy or a laryngeal mask airway (LMA) in difficult intubation situations. To scent out difficult situations, preoperative examination of every patient includes assessment of the range of extension of the cervical spine, the functional integrity of the temporomandibular joint, maximum mouth opening, and characteristics of dentition and tongue size.

Preoperative assessment of the functional condition of the dental periodontium of every patient should be combined with clinical parameters and remains the most important factor in preventing dental injury during anesthesia. All patients should undergo a thorough visual examination by the anesthetist prior to operation. Where there is a difficult situation for intubation, the anesthetist must attach much more weight to the possibility of dental damage, especially in patients presenting increased tooth mobility. Dental restorations that may be affected by airway management should be noted on the patient's chart. Patients must be informed about the possibility of dental damage and sign consent.

There are several publications on taking preventive steps by the use of devices protecting the teeth during laryngoscopy (22). Others suggest modifying the laryngoscope blade in order to avoid dental damage (23). The use of different types of prefabricated or custom-made gumshields or mouthguards – generally known as tooth protectors in prevention of sports injuries – during endotracheal intubation does not guarantee avoidance of anesthesia-related dental trauma (7). It may preserve dental enamel from chipping but it would not prevent avulsion of mobile teeth (24). The main disadvantage of those rather thick tooth protectors evolves from a lack of space within the oral cavity leading to poor visibility and consequently difficulty in guiding the endotracheal tube into the larynx (7). Poor visibility might be the reason for widespread refusal in daily routine.

Better results could be obtained by careful preanesthetic dental examination. Assessment of the patient's dental status and identification of vulnerable teeth are of primary importance in the prevention of dental damage. A pre-anesthetic dental evaluation by a dentist could be advantageous, and a protector designed for the patient personally could have a better preventive effect and reduce the number of litigations against the anesthesiologist or the affiliated health care institution.

The results of this study suggest that preoperative assessment is the most important factor in preventing dental injury during anesthesia. All patients should undergo a thorough visual examination by the anesthesiologist prior to operation. In case of an increased risk of perianesthetic trauma to the teeth (periodontal disease, limited mouth opening, malocclusion) further evaluation of the dental status is mandatory.

References

1. Bucx MJ, Snijders CJ, van Geel RT, Robers C, van de Giessen H, Erdmann W et al. Forces acting on the maxillary incisor teeth during laryngoscopy using the Macintosh laryngoscope. Anaesthesia 1994;49:1064–70.
2. Vogel C. [Zahnverletzungen während der Allgemeinnarkose und ihre Haftpflichtfolgen (author's transl)]. Anaesthesist 1979;28:347–9.
3. 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.
4. Burton JF, Baker AB. Dental damage during anaesthesia and surgery. Anaesth Intensive Care 1987;15:262–8.
5. Folwaczny M, Hickel R. [Oro-dentale Verletzungen während der Intubationsnarkose (author's transl)]. Anaesthesist 1998;47:707–31.
6. Chen JJ, Susetio L, Chao CC. Oral complications associated with endotracheal general anesthesia. Ma Zui Xue Za Zhi 1990;28:163–9.
7. Aromaa U, Pesonen P, Linko K, Tammisto T. Difficulties with tooth protectors in endotracheal intubation. Acta Anaesthesiol Scand 1988;32:304–7.
8. White A, Kander PL. Anatomical factors in difficult direct laryngoscopy. Br J Anaesth 1975;47:468–74.
9. Chadwick RG, Lindsay SM. Dental injuries during general anaesthesia. Br Dent J 1996;180:255–8.
10. Eklund G, Stalhane I, Hedegard B. A study of traumatized permanent teeth in children aged 7–15 years. Part III. A multivariate analysis of post-traumatic complications of subluxated and luxated teeth. Sven Tandlak Tidskr 1976;69:179–89.
11. Camp JH. Diagnosis and management of sports-related injuries to the teeth. Dent Clin North Am 1991;35:733–56.
12. Buchmann R, Ham AJ, Lange DE. [Der Einsatz des Periotestverfahrens in der Parodontaldiagnostik-Klinische Studien in Kritischer Sicht (author's transl)]. Quintessenz 1991;42:785–91.
13. Lukas D, Schulte W. Periotest–a dynamic procedure for the diagnosis of the human periodontium. Clin Phys Physiol Meas 1990;11:65–75.
14. Schulte W, Lukas D, Ernst E. [Periotest values and mobility of periodontally diseased teeth–comparative study]. Quintessenz 1991;42:1255–63.
15. Mallampati SR. Clinical sign to predict difficult tracheal intubation (hypothesis). Can Anaesth Soc J 1983;30:316–7.
16. Mallampati SR, Gatt SP, Gugino LD, Desai SP, Waraksa B, Freiberger D et al. A clinical sign to predict difficult tracheal intubation: a prospective study. Can Anaesth Soc J 1985;32:429–34.
17. Samsoon GL, Young JR. Difficult tracheal intubation: a retrospective study. Anaesthesia 1987;42:487–90.
18. Wilson ME, Spiegelhalter D, Robertson JA, Lesser P. Predicting difficult intubation. Br J Anaesth 1988;61:211–6.
19. Kocher T, Plagmann HC, Hein R, Brennicke C. [Über den Einsatz des Periotestgerätes zur Früherfassung experimen-

tell erzengter parodontaler Veränderungen (author's transl)]. Dtsch Zahnarztl Z 1989;44:493–5.
20. Bellhouse CP, Dore C. Predicting difficult intubation. Br J Anaesth 1989;62:469.
21. Bishop MJ, Harrington RM, Tencer AF. Force applied during tracheal intubation. Anesth Analg 1992;74:411–4.
22. Salisbury 3rd PL, Curtis Jr JW, Kohut RI. Appliance to protect maxillary teeth and palate during endoscopy. Arch Otolaryngol 1984;110:106–7.
23. Bizzarri DV, Giuffrida JG. Improved laryngoscope blade designed for ease of manipulation and reduction of trauma. Anesth Analg 1958;37:231–2.
24. Hoffmann J, Alfter G, Rudolph NK, Göz G. Experimental comparative study of various mouthguards. Endod Dent Traumatol 1999;15:157–63.