Assessment of the Efficacy of Submental Intubation in the Management of Midfacial and Panfacial Trauma Patients

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Abstract

Introduction Securing an airway in maxillofacial injuries remains a challenge and is an important objective on the part of a maxillofacial surgeon to thoroughly understand its management.

Purpose The aim of this study was to evaluate the efficacy and complications of submental intubation in the management of midfacial/panfacial trauma patients where oro-endotracheal or naso-endotracheal intubation is contraindicated and tracheostomy can be avoided.

Patients and Methods Twenty patients with maxillofacial injuries were selected for submental intubation who were admitted in Kamineni Hospital, Narketpally, Nalgonda during a 2 year period (2010–2012). The parameters used to assess the efficacy were; restoration of the occlusion, duration of the surgery, presence of scar, presence of infection, damage to vital structures or any post-operative salivary fistula.

Results Submental intubation allowed reduction and fixation of all fractures without the interference of the tube during surgical procedure in all of the patients. There were no intra-operative complications and none of the patients required post-operative ventilation. There were no significant post-operative complications. However, in one of the cases (case 4) infection of submental wound was seen and in another case (case 11) salivary fistula was formed. Both the cases were appropriately managed without any

difficulty. The submental scar was well accepted by all the patients.

Conclusion Submental intubation is a safe and extremely useful procedure in severe maxillofacial injuries. It presents a low incidence of operative and post operative complications. It allows both the surgeon and the anaesthetist to deliver a better quality of patient care.

Keywords Maxillofacial trauma · Submental intubation · Panfacial trauma · Midfacial fractures

Introduction

Securing an airway during the management of faciomaxillary injuries remains a challenge and is an important part of treatment. Modern techniques for surgical treatment of midfacial and panfacial fractures in maxillofacial trauma lead to special problems for airway management. The surgeon needs access to an unobstructed field and in most instances, maxillomandibular fixation is required intraoperatively for adequate reconstruction of facial fractures [1, 2]. Delivery of anesthesia for maxillofacial surgeries is a challenge because the anesthesiologist has to share the upper airway field with the surgeon [3].

Nasal endotracheal intubation is often contraindicated in the presence of fracture of the base of the skull. Comminuted midfacial fractures cause physical obstruction to the passage of naso-tracheal tube. Further, the presence of naso-endotracheal tube can interfere with surgical reconstruction of fractures of the naso-orbital ethmoid (NOE) complex [4, 5]. Among the complications are cranial intubation, epistaxis, trauma to the pharynx, pressure necrosis of the external nares, otitis media, sinusitis, sepsis, and inability to pass a tube through the nasal passages.

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These potential complications have been raised as relative contraindications to naso-endotracheal intubation for acute airway management in this patient group [6].

Surgical reconstruction often involves maxillo-mandibular fixation in the intraoperative period to restore the patient's dental occlusion. This precludes the use of oral endotracheal intubation in such cases [4].

Tracheostomy remains an excellent procedure for establishing a formal surgical airway. This procedure may involve a significant risk of iatrogenic complications, such as tracheal stenosis, internal emphysema, and damage to the laryngeal nerves, tracheoesophageal fistula and scarring [7].

A useful alternative method of managing the airway intraoperatively is by submental endotracheal intubation, which allows tracheal intubation by passing the tube through the floor of the mouth [8].

Submental intubation was first reported by Francisco Hernandez Altemir in 1986 as a procedure that could avoid tracheostomy and allow for the concomitant restoration of occlusion and reduction of facial fractures in patients ineligible for nasoendotracheal intubation. This procedure consists of exteriorizing an oral endotracheal tube through the floor of the mouth and submental triangle [9–11]. It allows free intra-operative access to the dental occlusion and to the nasal pyramid without endangering patients with nasofrontoethmoidal fractures. The Altemir method gained wide acceptance and with some modifications, is considered to be an attractive alternative to tracheostomy in the surgical management of selected cases of the operative field in the region of the face, the oral cavity, and the nose, providing the possibility of intra-operative control of the occlusion and the facial contour symmetry [12].

The method of intubation can be classified into two types. The first method 'Altemir sequence' involves a single endotracheal tube that is exteriorized through the submental dissection plane. The second method, referred to 'Green and Moore sequence' involves two endotracheal tubes whereby the first oral tube is replaced by a second tube introduced through the submental tunnel [13]. Another procedure consists of passing the reinforced tube of a laryngeal mask from intraorally to the submental region after creating a paramandibular, subperiosteal, and sublingual track thus taking advantage of the submental route for endotracheal intubation [14]. In our study we used a single flexometallic tube based on Altemir's general principle as it minimized the possibility of extubation during submental intubation procedure. Basically there are two standard approaches to submental intubation; they are paramedian and median approach. We have practised the paramedian approach in our study as it avoids vital structures in the floor of the mouth. Complications of submental intubation could include damage to the cuff balloon, infection of

Fig. 1 Submental incision marked

submental wound, abscess formation in the floor of the mouth, salivary fistula, development of mucocele, and hypertrophic scarring. All these complications are relatively rare and avoidable with meticulous technique [15].

The aim and objective of our study was to assess the efficacy and complications of the submental intubation in the management of midfacial/panfacial trauma patients where orotracheal or nasoendotracheal intubation is contraindicated and tracheostomy can be avoided.

Materials and Methods

A total Twenty patients were selected with panfacial trauma, of which 18 were males and 2 were females. The age range was 16–66 years with a mean age of 35 years. The type of fractures included was Le Fort I, Le Fort II, zygomaticomaxillary fractures, nasal bone fractures with or without mandibular fractures.

Preoperatively a thorough clinical and radiological examination was done, including 3-D CT scans to evaluate and assess the panfacial and midfacial fractures. Interdental tie wires were placed to temporarily immobilize the fracture fragments, wherever necessary upper and lower arch bar were placed. Preoperatively a standard regimen of antibiotics and analgesics was started. Flexometallic endotracheal tubes were selected in all cases, for the purpose of submental intubation, with a diameter of 7.5 in 11 cases, 7 in 8 cases and 6.5 in 1 case.

The technique used for submental intubation was an adaptation of the general principles published by Hernandez Altemir [9] in 1986. After the standard orotracheal intubation, a temporary draping of the mouth and chin was carried out. Subsequently, a 2 cm skin incision was marked and made in the paramedian region of the submental area, directly adjacent to the lower border of mandible (Figs. 1,

Fig. 2 Paramedian submental incision

Fig. 4 Pilot balloon held and taken out through submental incision

Fig. 3 Pilot balloon passed from intraoral floor incision

Fig. 5 Suture placed to fix tube in position

2). The muscular layers were traversed by blunt dissection using a curved artery forceps that was always in contact with the lingual cortex of the mandible. The mucosal layer on the floor of the mouth was incised over the distal end of the forceps, located in front of the sublingual caruncle and the forceps were then opened, creating a tunnel away from the lingual nerve. The width of the submental access should be sufficient to pass the tube without any interference. A good parameter was that internal planes should be dissected in such a way as to ensure the same size of the skin incision.

The patient's lungs were then ventilated with 100 % oxygen for several minutes and then tracheal tube briefly disconnected from the breathing circuit. The universal connector was removed and the pilot cuff (deflated) was

grasped by the artery forceps and pulled through the passage in the floor of the mouth (Fig. 3). The tip of the artery forceps were then quickly re-inserted through the submental incision to grasp the free end of tracheal tube (Fig. 4), which was also pulled through in a similar way.

Finally, the tube was positioned, the connection tube restored and the circuit was reestablished. Sutures were used to fix the tube in position (Fig. 5). It is important to make sure that the tube is not displaced during its passage through the submental tunnel. This can be checked using the position of the tube with regard to the teeth before and after submental procedure and by using laryngoscope at the end of intubation and verifying whether the airway is patent. A throat pack was placed.

Table 1 Results

Case no.	Diagnosis	Time required for intubation	Time required for extubation	Duration of surgery	Restoration of occlusion	Scar	Infection	Salivary fistula
1	Lefort I #	6 min	3 min	2 ½ hrs	Good	Thin linear scar	Absent	Absent
2	Lefort II #, left ZMC#	5 min	4 min	3 ½ hrs	Good	Thin linear scar	Absent	Absent
3	Lefort I #	5 min	3 min	3 ½ hrs	Good	Thin linear scar	Absent	Absent
4	Lefort I #	4 min	4 min	3 h	Good	Wide scar	Present	Absent
5	Lefort I #	5 min	4 min	2 ½ hrs	Good	Imperceptible	Absent	Absent
6	Lefort I #	8 min	4 min	2 ½ hrs	Good	Wide scar	Absent	Absent
7	Lefort I # Left Subcondylar #	6 min	3 min	4 h	Good	Thin linear scar	Absent	Absent
8	Lefort I #	4 min	4 min	4 h	Good	Imperceptible	Absent	Absent
9	Lefort I #	4 min	4 min	2 ½ hrs	Good	Thin linear scar	Absent	Absent
10	Lefort I #, left Angle #	5 min	3 min	3 ½ hrs	Good	Thin linear scar	Absent	Absent
11	Left ZMC #, Mid-palatal split#, B/L parasymphysis#	7 min	3 min	4 h	Good	Hyperpigmented	Absent	Present
12	Lefort I #	6 min	4 min	3 h	Good	Thin linear scar	Absent	Absent
13	Lefort II#	4 min	3 min	3 ½ hrs	Good	Thin linear scar	Absent	Absent
14	Lefort I #	5 min	3 min	3 h	Good	Thin linear scar	Absent	Absent
15	Nasal bone#, Symphysis #	5 min	3 min	2 h	Good	Thin linear scar	Absent	Absent
16	Rt ZMC #, Lt Angle #	4 min	3 min	2 ½ hrs	Good	Thin linear scar	Absent	Absent
17	Lefort I #, Rt ZMC #	5 min	4 min	3 h	Good	Thin linear scar	Absent	Absent
18	Lefort II #, Symphysis #	5 min	3 min	3 ½ hrs	Good	Thin linear scar	Absent	Absent
19	Lefort I #	4 min	3 min	2 h	Good	Thin linear scar	Absent	Absent
20	Lefort II #, Symphysis #	6 min	3 min	3 ½ hrs	Good	Thin linear scar	Absent	Absent

Extubation, when indicated, is done in reverse order, that is, after cutting the skin sutures, the deflated pilot cuff was passed intraorally. The endotracheal tube was then passed intraorally and can be left in place or removed when appropriate. No attempt was made to close the intra-oral incision. The skin was however closed using 5-0 prolene. If the patient needs long period post-operative ventilation, the orotracheal intubation will be maintained until extubation is complete.

Post-operative Assessment

Patients following surgery were assessed regularly at 4, 8, 12 weeks and after 6 months post-operatively. The following criteria were used to assess the efficacy, (1) restoration of the occlusion, (2) duration of the surgery, (3) presence of scar, (4) presence of any infection, (5) damage to any vital structures and (6) post-operative salivary fistula.

The scars were assessed based on their character and colour. Character of the scar was scored as: 1-No

perceptible scar, 2-Visible but thin and linear scar, 3-Wide scar, 4-Hypertrophic scar or keloid. Colour of the scar was scored as: 1-Not perceptible, 2-Normal skin color, 3-Red, 4-Hyperpigmented, 5-Hypopigmented.

Results (Table 1)

During the submental intubation no additional difficulties were encountered when passing the tube through the floor of the mouth. The mean duration for submental intubation procedure to be performed was 5.2 min. Average time for extubation of tube was 4 min. There was no significant oxygen desaturation in any patient during the procedure. The mean duration of the surgical procedure was about 3 h. The maximum duration of intubation observed was for about 4 h. The minimum duration of intubation was for about 2 h. In all patients submental intubation permitted simultaneous reduction and fixation of all fractures and intraoperative control of the dental occlusion without

Fig. 6 Infection of submental site

Fig. 8 Scar after healing

Fig. 7 Opening of submental wound leading to fistula

interference from the tube during the procedure. In our study, all cases had achieved good occlusal restoration. No motor or sensory deficit were encountered. Normal healing of mucosa of the floor of the mouth was observed.

In one of our cases, superficial infection was observed on 4th post-operative day at submental incision site. The submental wound had an oval swelling due to the collection of pus and the swelling was slight tender on palpation (Fig. 6). It was subsequently managed by opening the sutures in the area followed by debridement. The wound

was left open and proper wound care was taken subsequently by using povidone iodine ointment and with pressure dressing. Patient was kept on oral antibiotics for another 5 days. The wound was completely healed in a week's time. It left a wide scar.

In another case, salivary fistula was formed 7th day post-operatively (Fig. 7). It was then managed by placing intra-oral resorbable sutures in the floor of the mouth, followed by water tight closure of the skin wound using 5-0 prolene.

The post-operative scar was well accepted by all the patients. No cases of hypertrophic scarring were reported. Most of the cases, about sixteen of them had visible thin linear scars (80 %). Two patients had almost imperceptible scars (10 %) while two patients had wide scars (10 %) (Fig. 8). Although the scar was wide, it was well accepted by the patients, because of its small size (<2 cm) which makes it less prominent and not visible. Even the color of the scar matched the skin colour in most of the patients (seventeen), not perceptible at all in two patients, and hyperpigmented in one patient.

Discussion

Airway management in patients with maxillofacial trauma is a challenge for both the anesthesiologist and the surgeon, and requires good communication between them [2, 16–18]. Various techniques of airway management have been used. In many cases, naso-endotracheal intubation will secure the airway without interfering with maxillomandibular fixation and the surgical procedure for

immobilization of fractured segments. However, in patients with facial fractures involving the NOE complex, surgical reconstruction often requires switching the endotracheal tube from the nasal to the oral route, which may compromise the airway. Furthermore, fractures of the midface (Le Fort II or III) are frequently associated with skull base fractures, involving the cribriform plate of the ethmoid, potentially creating a communication between the nasal cavity and the anterior cranial fossa with cerebrospinal fluid leakage [19–21]. In such cases, attempts at naso-endotracheal intubation may lead to a major complication, i.e., passage of the tube into the cranium [24–27]. Other potential complications include meningitis, sepsis, sinusitis, and epistaxis. Therefore, naso-endotracheal intubation is considered to be relatively or even absolutely contraindicated in these patients [22–25].

An alternate technique for airway control is to perform a tracheostomy, considered the method of choice by many surgeons and anesthesiologists. However, tracheotomy also carries its own morbidity [26–32]. Caron et al. [2] quoted the complications of tracheostomy.

According to Figueiredo et al. [7], submental intubation combines the advantages of nasoendotracheal intubation, which allows the mobilisation of fracture segments to dental occlusion, and those of orotracheal intubation, which allows access to frontonasal fractures. It also avoids the risks of iatrogenic meningitis or trauma of the anterior skull base after nasotracheal intubation, as well as complications, such as tracheal stenosis, injury to cervical vessels or the thyroid gland, related to tracheotomy.

According to MacInnis and Baig [33]. Indications include patients with minimal neurological deficit, cranio-maxillofacial traumatic injuries, when short-term intraoperative IMF is required and rigid fixation of fractures, patients with large pharyngeal flaps, combined cranio-maxillofacial surgery and rhinoplasty cases. Contraindications include, patients with a severe neurological deficit, with multisystem trauma, long term airway support and maintenance required and known, severe keloid formers.

Macinnis and Baig [33] gave a 2 cm midline incision posterior to Wharton's ducts between geniohyoid, genioglossus and anterior belly of digastric muscles which decreased the amount of bleeding. Altemir and Montero [14] utilized a laryngeal mask airway in the submental approach which allowed its usage in severe laryngotracheal trauma, singers and patients with unstable cervical fractures. Mahmood and Lello [34] used a 1 cm midline incision between Wharton's duct and the reflection of the lingual gingivae and the floor of the mouth which according to the authors decreased bleeding and avoided important structures. Altemir et al. [35] again gave a modification where they utilized a reinforced combitube in the submental approach which assisted in tamponade of

pharyngeal haemorrhage. Ball et al. [36] used a flexible tracheal tube with an intubating laryngeal mask with an advantage of connector being easily removed and refitted and the tube tip design eases intubation.

Nyarady et al. [37] proposed the usage of a sterile nylon guiding tube which was placed over the distal end of the tube incorporating the pilot balloon and tube which again reduced the complications associated with tube damage. The morbidity associated with submental endotracheal intubation seems to be very low. In our study, no episode of compromised airway or arterial desaturation occurred during the procedure.

Schutz and Hamed [38] reported in their literature that the midline approach can traumatize the Wharton's duct, interfere with attachment of genioglossus and geniohyoid muscles and snug placement of the tube to the paralingual groove might also be compromised. Injury to the mandibular lingual perforating vessels, which are present in the midline in 98 % of instances, could lead to bleeding. Hence, the authors followed the standard latero-submental approach in their series. In our study we followed the same latero-submental approach.

Right side incision is always advantageous as it permits better visualization of the intra-oral part of the ETT by left handed laryngoscopy. However, selection of the side is usually done so as to avoid the site of injury and mandibular fracture. In all our cases we used a right sided incision.

Altemir et al. [10] emphasized the surgical performance of submental incision. According to them the incision should be made in the paramedian region, in the anterior vertex of the submandibular triangle parallel to the mandibular lower border, which is an anatomically "clear zone." The dissection in which the passage is created is also important. Development of mucocele has been reported by Stranc and Skoracki [39] in a case where submandibular intubation was done.

We had no difficulty in passing the tube through the incision, the endotracheal tube connector could be easily detached and reattached and there was no bleeding observed. We preferred to pass the tube in two steps, the tube cuff was first introduced into the mouth, being passed through the tunnel with forceps. The same manoeuvre was then carried out with the proximal end of the tube itself, after disconnection from the ventilator and the connection tube. After the tube was positioned, the connection tube was restored and the circuit re-established. Endotracheal suction could be easily done through the submental route. The submental intubation is always a second step after the airway has been secured. During the submental intubation procedure, the endotracheal tube must be firmly secured intraorally to prevent accidental extubation. Chandu et al. [40] in their experience met with two episodes of

dislodgement of tube from trachea. One of these happened intra-operatively, and the other during reversal. They were promptly recognised and the patients were re-intubated. In our study due to meticulous technique and absolute care taken by us throughout the procedure, we never encountered such problems.

In all our cases we used a single flexometallic tube with average sizes of 7 and 7.5. Some workers like Green and Moore [41] suggested use of two tubes: a conventional oro-tracheal tube securing the patient's airway and a second armoured tube passed through the incision, from exterior to interior. Amin et al. [42] have described the use of capnography during the process of conversion of oro-tracheal to submental and throughout the surgery to confirm the position of the tube and to serve as a warning tool against accidental extubation. Therefore, we have used a single tube in our study for all the cases.

Schutz and Hamed [38] reported complications of submental intubation which include detachment of pilot balloon or its damage during externalization, damage to the cuff of the tracheal tube, infection of the submental wound, abscess formation in the floor of the mouth, salivary fistula, development of mucocele, and hypertrophic scarring. In our series of cases, we did not encounter any of these complications except one case of infection of submental and one case of salivary fistula.

Intra-operatively we achieved good reduction of fracture segments and occlusion of teeth without interference from the intubation. In our series of cases none of the patients required post-operative ventilation and intubation. Post-operatively the occlusion was well maintained. Some patients required post-operative intermaxillary fixation. The incision left a little scar which further decreased in intensity as the duration increased. All the patients accepted the scar left behind by the submental intubation. Scar in our study was analysed based on its character and colour. Scar initially was prominent but became inconspicuous as time progressed. After 6 months of follow-up most of them had visible but thin linear scar which matched their skin colour. Character and colour were almost imperceptible in two of our cases. However, two patients had wide scar, one of whom had an infection of the submental wound. One patient had hyperpigmented scar who previously had a salivary fistula formation which was managed subsequently.

Submental intubation should be chosen whenever possible in cases of purely maxillofacial trauma. It allows operative control of the dental occlusion and concomitant surgery of the nasal pyramid in major maxillofacial traumas and avoids iatrogenic placement of the tube in skull base fractures. Despite significant advances in anaesthesia and trauma airway management, the panfacial fracture patient continues to pose a challenge. We believe,

however, after this study that for the patients with panfacial or midfacial fracture, submental intubation procedure remains a useful and one of the best procedures available.

Conclusion

The following conclusions can be drawn from our study: It has proved to be a simple solution for many difficult problems one would encounter during maxillofacial surgical procedures. It is a safe and reliable route for endotracheal tube during intubation while staying clear of the surgical field and permitting the checking of dental occlusion. The simplicity of the technique with no specialized equipment or technical expertise required makes it especially advantageous. The technique, therefore, when used in appropriate cases, allows both the surgeon and the anesthetist to deliver a better quality of patient care. Finally it presents a low incidence of operative and post operative complications and eliminates the risks and side effects of tracheostomy.

References

1. Rungta N (2007) Technique of retromolar and submental intubation in facio-maxillary trauma patients. *Ind J Trauma Anaesth Crit Care* 8(1):573–575
2. Caron G, Paquin R, Lesard MR et al (2000) Submental endotracheal intubation: an alternative to tracheotomy in patients with midfacial and panfacial fractures. *J Trauma Injury Infect Crit Care* 48(2):235–240
3. Das S, Das TP, Ghosh PS (2012) Submental intubation: a journey over the last 25 years. *J Anaesthesiol Clin Pharmacol* 28(3):291–302
4. Malhotra N, Bhardwaj N, Chari P (2002) Submental endotracheal intubation: a useful alternative to tracheostomy. *Indian J Anaesth* 46:400–402
5. Vashishta A, Sharma S, Chugh A, Jain D et al (2010) Submental intubation: a useful adjunct in panfacial trauma. *Natl J Maxillofac Surg* 1(1):74–77
6. Gordon NC, Tolstunov L (1995) Submental approach to oroendotracheal intubation in patients with midfacial fractures. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 79:269–272
7. Figueiredo CA, Vasconcelos BC, Vasconcellos RJ, de Morias HH, Rocha NS (2008) Submental intubation in oral maxillofacial surgery: review of the literature and analysis of 13 cases. *Med Oral Patol Oral Cir Buccal* 13:E197–E200
8. TaglialatelaScafati C, Mario G, Alberti F, TaglialatelaScafati S, Grimaldi PL (2006) Submento-submandibular intubation: is the subperiosteal passage essential? Experience in 107 consecutive cases. *Br J Oral Maxillofac Surg* 44:12–14
9. Altemir FH (1986) The submental route for endotracheal intubation. A new technique. *J Maxillofac Surg* 14:64–65
10. Altemir FH, Montero SH, Moros Pena MM (2003) About submental intubation. *Anaesthesia* 58:496–497
11. Jundt JS, Cattano D, Hagberg CA, Wilson JW (2012) Submental intubation: a literature review. *Int J Oral Maxillofac Surg* 41:46–54

12. Lazaridis N, Zouloumis L (2012) Retrotuberosity versus submentosubmandibular and median submental intubation: patients with maxillofacial surgery. *Oral Surg Oral Med Oral Pathol Oral Radiol* 114(5):S209–S215
13. Malhotra N (2005) Retromolar intubation: a Technical Note. *Indian J. Anaesth* 49(6):467–468
14. Altemir FH, Montero SH (2000) The submental route revisited using the laryngeal mask airway: a technical note. *J Craniomaxillofac Surg* 28:343–344
15. Junior SM, Aspirino L, Moreira RW, Moraes MD (2011) A retrospective analysis of submental intubation in maxillofacial trauma patients. *J Oral Maxillofac Surg* [Epub ahead of print]
16. Gotta AW (1987) Maxillofacial trauma: anaesthetic considerations. ASA refresher courses in anaesthesiology. Am society Anaesthesiol 15:39–50
17. Grande CM, Wyman CI, Bernhard WN (1991) Perioperative anesthetic management of maxillofacial and ocular trauma; injuries of the craniocervicofacial complex. In: Stene JK, Grande CM (eds) *Trauma anesthesia*. Williams and Wilkins, Baltimore, pp 266–285
18. Cicala RS (1996) The traumatized airway. In: Benumof JL (ed) *Airway management: principles and practice*. CV Mosby, St. Louis, pp 736–759
19. Markowitz BL, Manson PN (1989) Panfacial fractures: organization of treatment. *Clin Plast Surg* 16:105–114
20. Haug RH, Indresano AT (1992) Management of maxillary fractures. In: Peterson LJ (ed) *Principles of oral and maxillofacial surgery*. JB Lippincott, Philadelphia, pp 469–488
21. Lew D, Sinn DP (1991) Diagnosis and treatment of midface fractures. In: Fonseca RJ, Walker RV (eds) *Oral and maxillofacial trauma*. WB Saunders, Philadelphia, pp 515–542
22. Horellou MF, Mathe D (1978) Feiss P. A hazard of nasotracheal intubation [Letter]. *Anaesthesia* 33:73–74
23. Mr Patrick (1987) Airway manipulations. In: Taylor TH, Mayor E (eds) *Hazards and complications of anaesthesia*. Churchill Livingstone, New York, pp 329–355
24. Muzzi DA, Losasso TJ, Cucchiara RF (1991) Complications from a nasopharyngeal airway in a patient with a basilar skull fracture. *Anesthesiology* 74:366–368
25. Rajchel JL, Scully JR (1991) Emergency airway management in the traumatized patient. In: Fonseca RJ, Walker RV (eds) *Oral and maxillofacial trauma*. WB Saunders, Philadelphia, pp 114–136
26. Stone DJ, Bogdonoff DL (1992) Airway considerations in the management of patients requiring long-term endotracheal intubation. *Anesth Analg* 74:276–287
27. Helfrick JF (1991) Early assessment and treatment planning of the maxillofacial trauma patient. In: Fonseca RJ, Walker RV (eds) *Oral and maxillofacial trauma*. WB Saunders, Philadelphia, pp 279–300
28. Demas PN, Sotereanos GC (1988) The use of tracheostomy in oral and maxillofacial surgery. *J Oral Maxillofac Surg* 46:483–486
29. Chew JY, Cantrell RW (1972) Tracheostomy complications and their management. *Arch Otolaryngol* 96:538–545
30. Walker DG (1973) Complications of tracheostomy: their prevention and treatment. *J Oral Surg* 31:480–482
31. el-Kilany SM (1980) Complications of tracheostomy. *Ear Nose Throat J* 59:123–129
32. Stauffer JL, Olson DE, Petty TL (1981) Complications and consequences of endotracheal intubation and tracheostomy. *Am J Med* 70:65–76
33. MacInnis E, Baig M (1999) A modified submental approach for oral endotracheal intubation. *Int J Oral Maxillofac Surg* 28:344–346
34. Mahmood S, Lello GE (2002) Oral endotracheal intubation: median submental (retrogenial) approach. *J Oral Maxillofac Surg* 60:473–474
35. Altemir FH, Montero SH, MorosPeña M (2003) Combite SA through submental route. A technical innovation. *J Craniomaxillofac Surg* 31:257–259
36. Ball DR, Clark M, Jefferson P, Stewart T (2003) Improved submental intubation. *Anaesthesia* 58:189
37. Nyárády Z, Sári F, Olasz L, Nyárády J (2006) Submental endotracheal intubation in concurrent orthognathic surgery: a technical note. *J Craniomaxillofac Surg* 34:362–365
38. Schütz P, Hamed HH (2008) Submental intubation versus tracheostomy in maxillofacial trauma patients. *J Oral Maxillofac Surg* 66:1404–1409
39. Stranc MF, Skoracki R (2001) A complication of submandibular intubation in a panfacial fracture patient. *J Craniomaxillofac Surg* 29:174–176
40. Chandu A, Smith AC, Gebert R (2000) Submental intubation: an alternative to short-term tracheostomy. *Anaesth Intensiv Care* 28:193–195
41. Green JD, Moore UJ (1996) A modification of submental intubation. *Br J Anaesth* 77:789–791
42. Amin M, Dill-Russell P, Manisali M, Lee R, Sinton I (2002) Facial fractures and submental tracheal intubation. *Anaesthesia* 57:1195–1199