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Case report

Submental tracheal intubation in a school-age child with maxillofacial trauma: Our techniques and devices

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ABSTRACT

Securing an airway in a severely school-age patient with maxillofacial trauma is quite challenging and is an important part of treatment. A particularly useful technique for airway management in pediatrics, planned submental tracheal intubation (STI), has often been reported. We employed this technique in an eight-year-old girl who required open reduction and internal fixation of the mandible fracture along with suffered midface and skull base fractures, leading to the prevention of serious complications, such as intracranial penetration, when manipulating a nasotracheal tube. We described the novel aspects of this technique, known as the 1–1–1 rule, in a school-age patient with severe maxillofacial injuries and demonstrated its utility along with a review of the literature.

1. Introduction

Pediatric panfacial fractures with extensive maxillofacial injuries, including midface and skull base fractures, are much less frequent than in adults; however, once treatment with open reduction and internal fixation (ORIF) is applied to pediatric patients, more interdisciplinary approaches are required due to the small size of the anatomic structures, high ratio of cancellous-to-cortical bone, and thickness of the overlying soft tissue and fat [1].

Airway management during ORIF is an important part of such treatment. Generally, both orotracheal and nasotracheal intubation are contraindicated, as there is interference with the intermaxillary fixation for correct occlusion and potential complication of cranial intubation in the presence of a basal fracture, respectively [2]. Although tracheostomy has instead been used as the conventional technique of airway management for these patients, some physicians may hesitate to perform it in certain cases due to various complications, such as hemorrhaging, recurrent laryngeal nerve damage, subcutaneous emphysema, tracheal stenosis, and aesthetic issues.

Submental tracheal intubation (STI), which involves introducing an endotracheal tube via the submental route, has been therefore receiving focus as an alternative technique providing a solution to most of the above-mentioned problems [3]. However, few case reports have described airway management by STI for pediatric panfacial fractures [4–10].

We herein report a clinical case of STI for airway management during ORIF for mandibular fracture in a school-age patient and describe our techniques and devices. Furthermore, we discuss the safety and usefulness of STI in pediatric patients with severe maxillofacial injuries along with a review of the literature.

2. Case description

An 8-year-old girl (height: 120 cm, body weight: 21 kg, Rohrer index: 121.53) was admitted to the emergency department with a diagnosis of bilateral pneumothorax and skull base fracture (middle cranial fossa) with extensive maxillofacial injuries, including fracture of the left mandibular body, bilateral temporal bone, anterior/posterior wall of right maxillary sinus, and butterfly occipital cartilage dissection, caused by a traffic accident. After performing emergency life-saving procedures and administering professional treatment by a respiratory and neurosurgery specialist, the patient was scheduled to undergo ORIF for jaw fracture on day 23 after the injury.

Intermaxillary fixation to achieve correct occlusion was necessary

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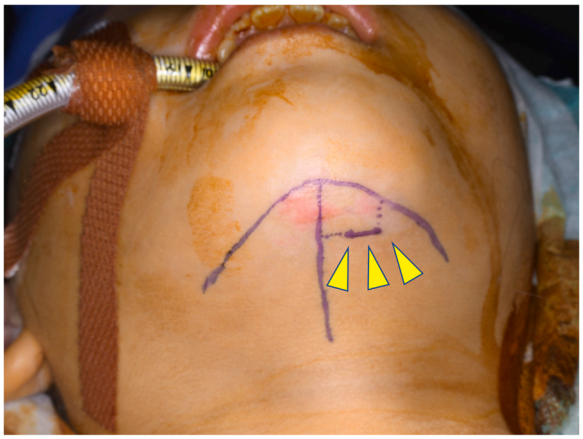

Fig. 1. Submental incision line of STI (yellow arrowheads). (For interpretation of the references to colour in this figure, the reader is referred to the web version of this article.)

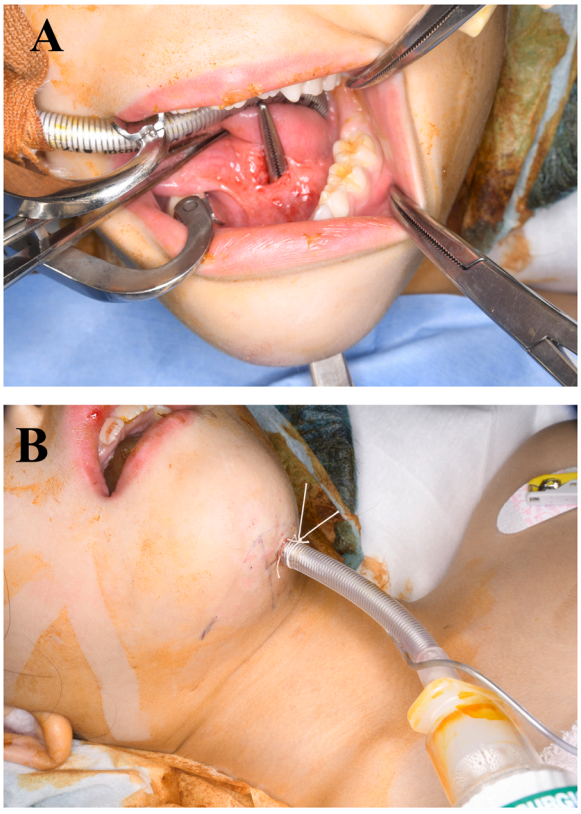

Fig. 2. Process of submental tracheal intubation (A). A pean was passed via the submental incision through the soft tissue of the floor of the mouth (B). An endotracheal tube was placed externally through the tunnel in the submental region and sutured with 2–0 silk.

because the occlusion was displaced, but nasotracheal intubation, including the fiberoptic method, was difficult due to the skull base fracture and the anterior/posterior wall of the right maxillary sinus. In addition, the absence of tissue damage to the floor of the mouth at the left or right side was confirmed, although left mandible fracture was noted. Respiratory management by STI was therefore selected to avoid complications that might occur during tracheostomy.

After pre-oxygenation and before intubation, the inhalation anesthetic 8 % sevoflurane was inhaled, and rocuronium bromide was injected intravenously to induce anesthesia. Anesthesia was maintained with 2 % sevoflurane with volume-controlled ventilation in a circle system and continuous infusion of remifentanil. Orotracheal intubation was performed using a video laryngoscope with a spiral endotracheal tube (5.5 mm). After orotracheal intubation, a 1-cm-long skin incision was made in the submental region, at a location 1 cm from the midline and 1 cm medial to and parallel with the mandible (Fig. 1). After proceeding with the incision of the subcutaneous fat, platysma, deep cervical fascia, and mylohyoid muscle, a slight-curved dissector was used to perform blunt dissection of the lingual surface while taking great care not to damage the salivary duct, and then penetrating the floor of the mouth to create a tunnel to allow the passage of the endotracheal tube (Fig. 2A). After the connector was removed, the end of the endotracheal tube was pulled out from the oral cavity. The endotracheal tube was then reconnected to the anesthetic tubing, and thereafter was secured to the skin using 2–0 silk sutures (Fig. 2B). The STI was completed in about 15 min. Thereafter, surgery was performed as planned. At the end of the surgery, the endotracheal tube was disconnected and pulled back into the oral cavity. Once the submental skin wound had been sutured to prevent wound infection, orotracheal extubation was uneventfully performed. The intraoral wound was left to heal secondarily. Complications due to STI did not occur during the perioperative period.

3. Discussion

STI to optimally secure an airway was first described as lacking the risk associated with nasal intubation and morbidity of tracheostomy by Altemir in 1986 [11]. In fact, STI is used not only for maxillofacial surgery with nasal or skull base fractures but also for orthognathic surgery that carries a potential risk, such as in cases of pharyngeal valve after palatal fissure or acromegaly patients with a history of cranial floor surgery [4–10,12,13]. The success rate of STI is 100 %, and only minor complications have been noted by numerous researchers, with no associated deaths reported [4]. However, the value and safety of this method have not been verified in cases of pediatric maxillofacial surgery.

Generally, four typical complications of STI are noted in adult patients: a risk of skin infection, intraoperative bleeding, damage to anatomic structures on the mouth floor, and tube damage [4,14,15]. The proportions of these complications are as follows: superficial skin infection (38.3 %), damage to the tube apparatus (16.7 %), venous bleeding (3.3 %), damage to anatomic structures on the mouth floor (3.3 %) [4]. In pediatric patients, it was expected to be challenging to pass the tube through the skin into the floor of the oral cavity for the STI technique due to the narrow space available in the submental region. However, contrary to expectations, relatively few complications have been reported in pediatric cases. In fact, although the total sample number is small, the majority of complications have been reported to be wound infection and accidental extubation (Table 1). Conversely, tracheostomy in pediatric patients can be fatal due to these patients' lack of resilience and robustness when complications such as hemorrhaging or tracheal stenosis occur unexpectedly [16].

The STI technique involves introducing an endotracheal tube via the submental route to secure the airway. In brief, after orotracheal intubation is performed by standard direct laryngoscopy, the endotracheal tube is inserted outwards of the submental region by creating a penetrating tunnel from the floor of the mouth [11,13]. Regarding the technical points of STI procedure in the adult case, the 2–2–2 rule (incision line 2 cm from the midline and 2 cm medial to the mandible in the submental region, 2 cm long) is frequently used to ensure the safety of the STI technique in adults [4,14,15]. This rule should be applied to pediatric cases in the same manner as in adults to avoid the above-mentioned complications of pediatric STI procedures. However, procedures should be modified depending on the size and tissue fragility. For example, the length of the submental incision might be shortened in smaller patients, such as 1–1.5 cm, to avoid bleeding and prevent slack in the endotracheal tube at the tunnel route through the

Table 1
Reported cases of STI of early childhood and school age.

Author	Age (yr)	Gender	Disease	Reason of choosing	Incision length (cm)	Complications
Amin M	6	No describe	Facial fractures	No describe	1.5	Extubation
Sharma RK	10	No describe	Clival chordoma	No describe	1.5	Wound infection
Adeyemo WL	10	M	Cancrum oris	Impossible to nasotracheal intubation	2.0	None
Taiwo OA	5	F	Odontogenic fibromyxoma	To perform mandibular resection	1.5–2.0	None
Taiwo OA	9	M	Ranula	Owing to intubation challenges	1.5–2.0	None
Tiwari P	12	M	Mandibuar parasymphysis and zygomatic complex fracture	No describe	2.0	None
Alejandri-Gamboa V	7	M	Mandibular fracture	Nasal fracture	2.0	No describe

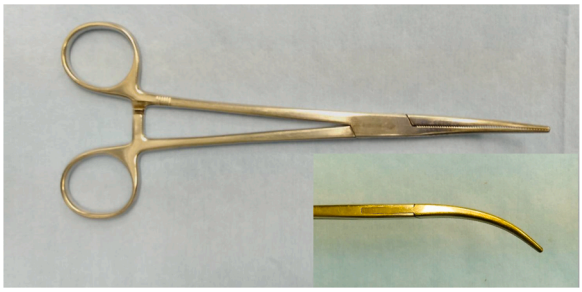

Fig. 3. A slightly curved dissector with a long handle and delicate tip (Product No. 06–692–00; Mizuho Medical Co., Ltd., Tokyo, Japan).

submental skin into the floor of the oral cavity due to unnecessary over-incision. Indeed, Taiwo et al. recommended this approach to reduce accidental extubation [8]. Furthermore, when creating a tunnel where the endotracheal tube is inserted outwards, we must pay take care with our instruments to ensure that we penetrate the submental skin at the floor of the mouth, accurately aligning the tip of the instruments using a targeted point between the submandibular duct and lingual gum. A slight-curved dissector (Product No 06–692–00; Mizuho Medical Co., Ltd., Tokyo, Japan) with a long handle and delicate tip was used to avoid tissue damage in the present case (Fig. 3). We have clearly conceptualized our method as the 1–1–1 rule (incision line 1 cm from the midline and 1 cm medial to the mandible in the submental region, 1 cm long), rather than applying the STI method mimicking the 2–2–2 rule, as in Table 1. Therefore, in our case, we made a 1-cm intra-extra-oral incision and performed the operation using the dissector described above to decrease bleeding and avoid contact with any important structures of the floor of the mouth. Furthermore, the submental tracheal tube was secured to the skin with 2–0 silk sutures (Fig. 2B). As a result, no complications, such as unexpected bleeding, detrition of tissue, or accidental extubation, were observed in our case.

4. Conclusion

In conclusion, we described the successful use of STI in a pediatric patient requiring reconstruction of mandible fractures with a demonstration of our technique, known as the 1–1–1 rule, and devices to avoid some of the problems inherent with nasotracheal and direct tracheostomy.

Ethics approval and consent to participate

Written informed consent was received from the parents of the present patient for the presentation of this case.

Declaration of Competing Interest

The authors have no conflicts of interest to declare.

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