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Review Paper
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Thirty years of submental intubation: a review

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Abstract. Submental intubation has been used as an alternative to conventional intubation in the field of oral and maxillofacial surgery since its introduction by Francisco Hernández Altemir in 1986. A review of submental intubation was performed using data from all case reports, case-series, and prospective and retrospective studies published between 1986 and 2016. The indications, variations in incision length, incision sites, types of endotracheal tube used, methods of exteriorization, and complications were recorded and analyzed. A total of 70 articles reporting 1021 patients were included. The main indication was maxillofacial trauma (86.9%, $n = 887$), followed by orthognathic surgery (5.8%, $n = 59$), skull base surgery (2.8%, $n = 29$), and rhinoplasty and rhytidectomy (1.5%, $n = 15$). The complication rate was relatively low: 91.0% of patients ($n = 929$) were complication-free. The most common complication was infection, occurring in 3.5% ($n = 36$) of the total number of patients, followed by scarring (1.2%, $n = 12$) and formation of an orocutaneous or salivary fistula (1.1%, $n = 11$). In summary, submental intubation is a good alternative airway with minimal complications.

Key words: submental route; intubation; maxillofacial surgery.

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In maxillofacial surgery, nasotracheal intubation has always been the preferred route of intubation. This remained the case following the introduction of submental intubation by Francisco Hernández Altemir in 1986, which was developed with the intention of avoiding tracheostomies in selected oral and maxillofacial cases[1]. The procedure originally described involved initial oral intubation with a flexometallic endotracheal tube, followed by exteriorization of the endotracheal tube through a soft tissue tunnel created via a sub-periosteal dissection through a 2-cm paramedian incision made on the skin in the submental region and mucosa on the lingual aspect of the mandible. The flexometallic endotracheal tube was exteriorized with a haemostat starting with the deflated pilot balloon followed by the tube itself. At the end of the surgery, the tube was then reversed to its initial oral position. The skin incision was closed with sutures, but not the intraoral wound.

The aim of this literature review is to provide an insight into the indications, variations in incision length, incision sites, types of tube used, methods of exteriorization, and complications of submental intubation.

Materials and methods

A search of the PubMed and Google Scholar databases was undertaken to identify all case reports, case-series, and prospective and retrospective studies on submental intubation. Only articles published in the English language with the full text available were included. The indications, variations in incision length, incision sites, types of endotracheal tube used, exteriorization methods, and complications were recorded and analyzed. This review included articles published over a 30-year period (1986–2016).

Results

A total of 70 articles were identified and included in this review: 21 case reports, 16 case-series, 11 prospective studies, 21 retrospective studies, and one technical note; a complete list of the 70 articles is provided in the **Supplementary Material**. A total of 1021 patients were reported in these 70 articles.

Indications

In the majority of cases, the submental intubation was used in maxillofacial trauma (86.9%, $n = 887$). This was followed by orthognathic surgery (5.8%, $n = 59$), skull base surgery (2.8%, $n = 29$), and rhinoplasty and rhytidectomy (1.5%, $n = 15$). Other rare indications for submental intubation included oronasal fistula, nasopalatine cyst, salivary gland tumour, alveolar bone grafting, premaxilla osteotomy, upper lip haemangioma, odontogenic fibromyxoma, ranula, ossifying fibroma, intranasal pathology, nasopharyngeal angiofibroma, antral cyst, massive obstructive maxillofacial tumour, and a patient history of nasal bleeding or cerebrospinal fluid leakage (Table 1).

Incision length and site

The preferred length of the skin incision for submental intubation was 2 cm, which was the length suggested by Altemir when he introduced the technique. This incision length was used in 612 of the patients (59.9%). A skin incision of 1.5 cm in length was used in 325 of the patients (31.8%). A few groups of authors tried a 1-cm skin incision (7.8% of the patients). One article reported the use of submental intubation on four patients using a percutaneous dilatational tracheostomy kit. The majority of the articles reported a preference for the paramedian incision (61.2% of the patients) over the median skin incision (38.4% of patients).

Type of endotracheal tube used

Flexometallic tubes were the tube of choice for submental intubation. Such tubes were used in 873 patients (85.5%). A two-tube technique was used in 11.9% of the patients. Preformed cuff tubes were used in nine patients. The type of tube used was not mentioned in 16 cases. Laryngeal mask airways (LMA) were used in 2 cases.

Methods of exteriorization

The use of a single haemostat was most popular among the authors; this was used in 84.0% of the patients. Double haemostats were used in only 10 patients. The use of a nasal speculum as suggested by Altemir was performed in only 2.4% of the patients. Exteriorization was accomplished using dilators in five cases, and in one case a pharyngeal loop was used. In the 121 cases undergoing the two-tube technique, exteriorization was not required. The exteriorization technique was not mentioned in one of the reported cases.

Complications

Of the 1021 cases of submental intubation, 92 presented complications either intraoperatively or postoperatively. The main complication was infection, which occurred in 36 (39.1%) of the cases with complications. This was followed by scarring ($n = 12$, 13.0%) and the formation of an orocutaneous or salivary fistula ($n = 11$, 12.0%). Other rare intraoperative complications included tube dislodgement, tube being pushed into the bronchus, damaged pilot balloon, and tube kinked or obstructed. Other rare postoperative complications included pain, sublingual haematoma, bleeding, sialocele, and mucocele (Table 2).

Table 1. Indications for submental intubation.

Indications	Number of cases
Maxillofacial fractures	887
Orthognathic surgery	59
Base of skull surgery	29
Rhinoplasty/rhytidectomy	15
Intranasal pathology	6
Massive obstructive maxillofacial tumour	6
History of cerebrospinal fluid leak	4
History of nasal bleeding	3
Oronasal fistula	1
Cancrum oris	1
Nasopalatine cyst	1
Salivary gland tumour	1
Alveolar bone grafting	1
Premaxilla osteotomy	1
Upper lip haemangioma	1
Odontogenic fibromyxoma	1
Ranula	1
Ossifying fibroma	1
Nasopharyngeal angiofibroma	1
Antral cyst	1

Discussion

Maxillofacial fractures were the most common indication for submental intubation. Besides concurrent base of skull fractures in some cases, which render nasal intubation unsafe, the involvement of nasal complex fractures also represents a possible contraindication to performing nasal intubation for the anaesthetist[2]. In most cases of maxillofacial fracture, achieving a good occlusion is important prior to fixation of the fractured bones[2]. In cases that do not require prolonged postoperative ventilation, submental intubation is a good alternative to tracheostomy. The tracheostomy itself is more surgically demanding and it can be complicated by a cosmetically unacceptable scar, pneumothorax, pneumonia, surgical emphysema, tracheal stenosis, and tracheomalacia[3]. Although submental intubation is not contraindicated in cases with a cervical injury as a result of trauma, this increases the difficulty of the technique.

The use of submental intubation in orthognathic surgery was restricted to patients with certain medical conditions and cases in which a concurrent rhinoplasty was performed during the same surgery. In the latter cases, submental intubation was performed to avoid the need to change from nasal intubation to oral intubation[3].

Table 2. Complications of submental intubation.

Complications	Number of cases
No complications	929
Infection	36
Scarring	12
Salivary fistula	11
Pain	8
Dislodged tube	6
Pilot balloon damage	5
Tube pushed into bronchus	4
Tube kinked	4
Sublingual haematoma	2
Mucocele	1
Tube obstruction	1
Sialocele	1
Bleeding	1

Submental intubation was also performed in cases of skull base surgery. In base of skull surgery, a transmaxillary approach via Le Fort I osteotomy was used to gain access to the tumour. As surgical manipulation was in the region of the upper airway, nasotracheal intubation was not considered favourable. Furthermore, orotracheal intubation was not considered feasible as the maxilla required fixation to its actual position at the end of the surgery based on dental occlusion[4–7].

Despite all of the indications, submental intubation can only be used intraoperatively. It is not intended to provide a prolonged airway and needs to be converted back to an orotracheal intubation at the end of surgery[3]. A tracheostomy may be the preferred airway if prolonged airway maintenance or ventilation is required[3]. A comparison between submental intubation and tracheostomy is detailed in Table 3.

The original incision length introduced by Altemir in 1986 was a 2-cm skin incision. While some surgeons were able to pass the tube through a 1-cm skin incision, most of them made a 1.5–2-cm skin incision. This length of incision was adequate to pass through the flexometallic tube with minimal trauma and stress to the skin during exteriorization.

The skin incision was originally placed in the paramedian plane. However, MacInnis and Baig modified this to a median approach after facing certain problems with the paramedian approach, such as difficulty in tube passage, haemorrhage, damage to the sublingual salivary gland or submandibular salivary duct, and mucocele formation[8]. The rationale behind the use of the median approach was the ability to avoid major anatomical structures, such as the sublingual salivary glands, submandibular salivary duct, and also the lingual neurovascular bundles. Furthermore, in the midline approach, the possibility of bleeding is reduced as the median raphe where both mylohyoid muscles meet is an avascular plane. The benefits of the median approach were later supported by Jin and Patil in 2015[9]. However, authors who used the paramedian approach were of the opinion that injury to these structures could be avoided if the dissection path adhered as closely as possible to the lingual aspect of the mandibular bone[10].

The most commonly used tubes were flexometallic tubes. This type of tube has superior flexibility, allowing it to be manipulated through the tunnel. Authors who used the two-tube technique also placed a flexometallic tube as the final (second) tube regardless of the type of first tube that they used. The reason behind the use of two tubes was less risk of compromising the patient's airway if difficulties were encountered during reattachment of the connectors or while passing the tube through the orocutaneous tunnel[2]. Altemir and Montero in 2000 introduced the use of a laryngeal mask airway for submental intubation[11]. In their technical note, it was suggested that this modification be used in cases of maxillofacial fractures associated with laryngotracheal trauma (which pose a higher risk with conventional endotracheal intubation), in singers or other voice professionals with maxillofacial fractures (as conventional endotracheal intubation might injure the vocal cords and larynx), and in patients with unstable cervical fractures who have to undergo maxillofacial surgery[11]. Despite being costly, Kim et al. reported the use of an LMA-Fastrach endotracheal tube in two patients and found this to be fast as well as safe, and it was reusable[12].

Almost all surgeons used a single haemostat, as described by Altemir in 1986, to exteriorize the tube through the soft tissue tunnel created. The use of this technique, although fast and convenient, carries the risk of a different path of exit for the tube and pilot balloon. This is because following exteriorization of the pilot balloon, reentry of the haemostat to grab the tube may not necessarily follow the same path. A loop of the inflation tube may become caught within the soft tissue as a result of the flexometallic tube and the cuff inflation tube taking a different path. This complication was reported by Langford in 2009[13], and has led some surgeons to suggest the use of a double haemostat. With this technique, the second haemostat is inserted while the first one is held in place maintaining the patency of the soft tissue tunnel. These haemostats will then grab the pilot balloon and tube, respectively, exteriorizing them one after the other. A small amount of blood entering the distal end of the tube is inevitable with this technique. However, this can easily be

Table 3. Comparison between submental intubation and tracheostomy in maxillofacial surgery.

	Submental intubation	Tracheostomy
Indication	Elective craniomaxillofacial surgeries that require achievement of occlusion intraoperatively when nasal intubation is contraindicated	Can be performed for emergency airway access Prolonged maintenance of airway or ventilation is needed
Contraindications	Prolonged maintenance of airway or ventilation is needed Local infection or injury Tendency for keloid formation Limited mouth opening Bleeding disorders	Local infection Anatomical abnormalities Bleeding disorders
Advantages	Easy to perform Allows achievement of occlusion No postoperative care for airway needed Shorter hospital stay Cost-effective	Allows prolonged airway maintenance
Disadvantages	Cannot be used for prolonged airway maintenance	Requires special postoperative care Expensive and time-consuming
Complications	Infection Scarring Salivary fistula Mucocele Dislodged tube Tube pushed into bronchus Tube kinking	Bleeding Infection Unaesthetic scar Surgical emphysema Pneumothorax Pneumonia Tracheal stenosis Tracheomalacia

cleaned. Tissue trauma during this process may not be significant.

Another suggested tool is the use of a nasal speculum[1]. After blunt dissection of the submental soft tissue and puncturing the floor of the mouth, a nasal speculum is inserted. The nasal speculum maintains the patency of the tunnel, easing the passage of the tube and pilot balloon. This technique prevents trauma to the soft tissue, as well as preventing blood and detached tissues from entering the tube during exteriorization[14].

During passing through of the endotracheal tube, some blood or soft tissue may inadvertently enter the tube. Various methods have been used to avoid this occurring. Lim et al. in 2003 used the blue cap of a 32-French-size thoracic catheter to cap both the endotracheal tube and deflated pilot tube to prevent soft tissue or blood from entering the endotracheal tube and to reduce injury to the surrounding tissues during exteriorization of the tube[15]. For the same purpose, Lima Júnior et al. used a sterile glove to cover the distal end of the endotracheal tube during exteriorization[16].

Lim et al. tried using a small copper malleable retractor inserted into the orocutaneous tunnel to retract the soft tissues at the medial aspect of the tunnel. By retracting these tissues, it kept the tunnel almost patent, as the soft tissue on the lateral aspect was held by the mandible. This helped to reduce trauma to the soft tissues. However, they reported that tissue retraction was not as effective as the nasal speculum[17].

Generally the rate of complications was low, at about 9.0% for the total number of submental intubation cases performed over the 30-year period. Although infection was the most common complication in submental intubation, the incidence was very low (3.5%). All infections were superficial and resolved either with wound dressing using antiseptic solution or with a course of antibiotics[18–20]. Trickling of saliva from an intraoral wound, poor oral hygiene, and an improper aseptic technique while performing the submental intubation may have contributed to these infections[21].

The postoperative hypertrophic scars were generally well tolerated by the patients[22,23]. No treatment was provided for any of the reported cases of hypertrophic scar. The reasons for acceptance of the scar may be due to its size, which was not more than 2 cm, correlating with the length of the incision made. Furthermore, all incisions were made following the skin crease and were hidden by the lower border of the mandible. The resulting scar was therefore less noticeable. Despite good acceptance of the hypertrophic scar, MacInnis and Baig considered the tendency to form a hypertrophic scar as a contraindication to the use of submental intubation in a patient[8].

Salivary or orocutaneous fistula occurred as a result of communication between the oral cavity and skin, with saliva leakage via the fistula. This may occur as a result of prolonged intubation or improper wound closure following the procedure[10,24]. It may present as a complication after extubation, although there may also be delayed presentation in some cases, with fistula occurring about 1 to 2 weeks after the procedure[10,24,25]. In the cases included in this review, watertight sutures were placed in the floor of the mouth and skin to close the fistula. However, in some cases the fistula closed spontaneously within 10 days[10,24].

Endotracheal tube dislodgement, either partial or complete, occurred as a result of manipulation of the mandible during surgery. An increase in airway pressure and decrease in end-tidal carbon dioxide value ($ETCO_2$) together with a transient drop in oxygen saturation (SpO_2) to 96% will alert the anaesthetist of the possibility of tube dislodgement[24]. This is usually managed by the anaesthetist repositioning the tube[21,24,26]. Instead of dislodging the tube, it may also be pushed inadvertently into the bronchus[18,23,26]. In all such cases in the present review, the tubes were displaced into the right bronchus. This is because of the anatomy of the right bronchus, which is wider and relatively straighter in relation to the trachea compared to the left bronchus. Dislodgement of the endotracheal tubes can easily be prevented by securing the tube to the skin in the submental area with a suture.

Kinking of the endotracheal tube rarely occurred. When this happened, it was characterized by a sudden increase in airway pressure[27–29]. The degree of curvature of the tube during intubation is so great that the tube is at risk of kinking. This can be prevented by using a flexometallic endotracheal tube. A shorter distance between the submental area and throat may cause a higher degree of curve, which may increase the risk of tube kinking. This can be seen in paediatric patients[28] and in patients with a retruded mandible. Two cases of tube obstruction were reported by Navaneetham et al. in 2010[30]. A detailed description of the obstruction was not given, although the authors mentioned that they managed it by just pulling the tube out through the skin.

During exteriorization, the pilot balloon may either be ruptured or become detached by the curved artery forceps. This complication can be avoided by careful and gentle exteriorization of the pilot balloon. A few methods to overcome this complication have been reported. A straightforward method of management would be the replacement of the tube with a new endotracheal tube[31,32]. Drolet et al. achieved this by using an endotracheal tube exchanger[31]. Instead of placing a new endotracheal tube, Patkar et al. were successful in inflating the cuff and occluding the pilot balloon tip with an artery forceps[18]. Yoon et al., on the other hand, cut a new pilot balloon from an unused endotracheal tube and connected it to the intubated endotracheal tube using a needle connector[33].

Salivary gland complications were extremely rare with submental intubation. Only one case of mucocele was reported, which occurred in 2016[25]. It has been suggested that mucoceles may form due to the incorporation of mucosal remnants in the orocutaneous tunnel when the endotracheal tube is passed from intraoral to the submental region[34]. Another reported salivary gland complication was sialocele. The authors who reported this attributed it to injury of the submandibular salivary gland as a result of a more posterior placement of the incision[24]. However, it is clear that these salivary gland complications are largely preventable with a careful and meticulous surgical technique.

Compared to tracheostomy, complications arising from submental intubation were mainly due to intraoperative procedures. Although the intraoperative complication rate of tracheostomy has been reported to be between 4% and 10%, the postoperative complication rate is as high as 63%[35]. These postoperative complications, such as tracheal stenosis, tracheomalacia, delayed stoma closure, unaesthetic scar, and airway symptoms (including stridor, hoarseness, and dyspnoea) result in significant patient morbidity[35].

From the limited number of available articles included in this review, it can be concluded that submental intubation is an easier and less risky alternative airway compared to tracheostomy, and can be performed in cases where there is a contraindication to nasotracheal intubation and when the maintenance of dental occlusion or manipulation of the nose are necessary during surgery. Although various modifications have been made to the original methods, none of these modifications has been shown to be superior. This

technique is also relatively safe, as the complication rate is low.

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Competing interests

None.

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Patient consent

Not required.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.ijom.2018.04.015.

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