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Research Article

A study of submental intubation for anaesthesia in patients with faciomaxillary injuries

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ABSTRACT

Background: Surgical repair of faciomaxillary trauma requires intraoperative occlusion of teeth that precludes orotracheal intubation. Airway management options in these patients are either nasotracheal intubation or tracheostomy. However nasal intubation is contraindicated in nasal bone fractures, skull base fractures. Tracheostomy, being a morbid procedure is not always a good option. Submental intubation allows a safe alternative in such patients.
Methods: 25 Patients were studied with faciomaxillary trauma where submental intubation was indicated. After standard anesthesia induction patients were intubated with reinforced endotracheal tube (ETT), which is converted to submental route by a paramedian incision. At the end of the procedure, all patients had inter-maxillary wiring, were shifted to recovery room. Once they are recovered from the neuromuscular blockade ETT was removed through the submental tunnel.
Results: This was a prospective observational study in 25 adult patients undergoing faciomaxillary surgeries requiring submental intubation. The mean apnoea time was 1.28±0.38 minutes and induction to submental intubation time was 9.68±1.82 minutes. In one case there was damage to the pilot balloon while pulling the tube through the submental tunnel. Two patients had right endobronchial migration of the ETT. On postoperative follow up, one patient had infection at the submental incision site.
Conclusions: Submental intubation is a safe, effective, alternative for short term tracheostomy in faciomaxillary sugeries. Careful handling of the ETT is must to avoid damage while passing through the submental tunnel. Avoid extra length of the tube introrally to prevent endobronchial migration of the ETT.

Keywords: Maxillofacial trauma, Sub-mental intubation, Tracheostomy, Endobronchial migration

INTRODUCTION

Anaesthesia for faciomaxillary surgeries is a challenge because the anaesthesiologist has to share the upper airway with the surgeon. Surgical repair of faciomaxillary trauma requires modification of the standard anaesthesia technique. Conventional orotracheal intubation is inappropriate as temporary intraoperative occlusion of teeth is required to check the alignment of the fracture fragments. Airway management options in these patients are either nasotracheal intubation or tracheostomy. However nasal intubation is contraindicated in nasal bone fractures, skull base fractures and communited Le Fort's fractures II and III. Tracheostomy is the only option left for such patients. Tracheostomy, being a morbid procedure is not always a good option.[1] Submental intubation allows a safe alternative in such patients presenting for surgery.[2-10]

We studied the ease of submental intubation and complications associated with this technique, in patients coming for repair of faciomaxillary fractures.

METHODS

After approval from institutional ethics committee, all patients with faciomaxillary trauma where submental intubation was indicated were included in the study. Patients with severe neurological damage, polytrauma, anticipated prolonged ventilatory support, patients requiring multiple surgeries, anticipated difficult intubation, patients of ASA III and above, history suggestive of coagulopathy and non-consenting patients were excluded from the study.

A thorough preoperative evaluation was done. Airway was assessed. Any evidence of difficult intubation (other than restricted mouth opening due to pain) as shown by presence of two abnormal criteria (mallampatti criteria, head extension and thyromental distance) excluded the patient from the study. Starvation was confirmed. A written informed consent was taken.

The standard armoured endotracheal tube does not have markings over the surface to note the length of the tube below the level of cords (Figure 1). To denote the length of the flexometallic tube below the vocal cords, we marked the black line above the cuff on the flexometallic tube keeping the portex ETT of the same calibre as a reference (Figure 2). The connecter was checked for easy detachability and the cuff was also checked for any leak. Patient was taken in the operation theatre, monitors (pulse oximeter, electrocardiography, and noninvasive blood pressure) were attached and baseline vital parameters were noted. An intravenous access was secured using 20 gauge indwelling cannula. Ringer lactate 5 ml/kg was preloaded intravenously.

Figure 1: Flexometallic tube with detachable connector. black line above the cuff is absent.

Patients were premedicated with inj. Glycopyrolate 0.004 mg/kg, inj midazolam 0.05 mg/kg and fentanyl 2 µg/kg and preoxygenated with 100% oxygen. Anaesthesia was induced with inj. propofol 2 mg/kg till the loss of consciousness. Ventilation was checked. Inj. succinyl choline 1.5 mg/kg was given. Patients were ventilated with oxygen and intubated with appropriate size armoured ETT under direct laryngoscopic vision (Figure 3). The tube was positioned so that the black line marked on the tube was at the level of the cords. The tube was fixed temporarily at the angle of mouth after checking for bilateral equal air entry and square wave capnography. Anaesthesia was maintained with 60% N_2O in O_2, propofol infusion and intermittent inj. vecuronium on closed circuit on controlled mechanical ventilation. The throat was packed lightly to prevent aspiration of blood during conversion of oral to submental route.

Figure 2: Black line marked on flexometallic tube with reference to Portex tube.

Figure 3: Orotracheal intubation with flexometallic tube.

For submental intubation the patients were given a head extended position with the help of a shoulder pad. A surgical colleague trained in the technique of submental intubation made a 2 cm skin incision in the paramedian region, about 1 cm from the lower margin of mandible and parallel to it approximately one third of the distance from symphysis to the angle of the. Using a curved haemostat, a passage was created by blunt dissection near the lingual angle of the mandible. While the tongue was pushed backward, the tip of the haemostat was visible just below the mucosa of the floor of the mouth anterior to Wharton's duct papillae. A mucosal incision was made parallel with the gingival margin on top of the tip of the haemostat. A passage for the tube was created from the mouth, through the mylohyoid muscle to the submental incision. Patients were ventilated with 100% O_2 for 4 tidal volumes. The throat was sucked for any secretions

or blood and the pack was removed. The endotracheal tube was then disconnected from breathing circuit and the connector of the tube was detached. The pilot balloon was deflated, grasped with the haemostat and withdrawn through the submental tunnel gently followed by the endotracheal tube (Figure 4).

Figure 4: Conversion of oral intubation to submental intubation.

Figure 5: Fixation of the tube submentally.

The connector and the circuit were reconnected. When capnography, lungs auscultation and a check laryngoscopy confirmed the correct position of the tube (black line mark visualised at the level of cords), the tube was fixed and marked at submental level with 2-0 silk suture (Figure 5). Patency of tube following submental intubation was checked by smooth passage of an appropriate size suction catheter to rule out obstruction of the endotracheal tube. The throat was repacked. The position of the tube rechecked by auscultation and anaesthesia was continued. Throat pack was removed just before inter-maxillary fixation. Before the end of the surgical procedure a tongue stitch was taken.

At the end of the procedure, all patients had inter-maxillary wiring and were shifted to recovery room for further monitoring. Oxygen was supplemented through a T-piece. Once they are recovered adequately from the neuromuscular blockade ETT was removed through the submental tunnel. The tongue stitch was released once the patency of the airway was confirmed. The submental incision was sutured by the surgeon after infiltration with local anaesthetic. A wire cutter was kept ready for immediate opening of the jaw in situations where the airway is lost.

Noted parameters during procedure

Time required for submental intubation.

- Time from induction to fixation of the tube submentally.
- Time to convert the oral tube to a submental tube. (disconnection to reconnection of the circuit).

Technical difficulties seen during the procedure.

- Damage to the endotracheal tube and its parts.
- Surgical difficulty if any and complications like injury to submandibular and sublingual glands, damage to lingual nerve, bleeding.

Oxygen saturation and End-tidal CO_2 were monitored throughout the procedure and in the postoperative period.

Haemodynamics during entire procedure

Namely pulse rate, systolic and diastolic blood pressure were recorded every 5 minutes till submental intubation is done. Then every 15 minutes till the end of surgery.

Difficulties in extubation were also noted.

Patients were followed up for next 10 days and after one month postoperatively for any infection and difficulty in healing of submental incision.

Data thus obtained was analyzed using software version SPSS 12.0 (SPSS Inc., 233 South Wacker Drive, 11th Floor, Chicago, IL 60606- 6412). For each parameter mean and standard deviation were calculated and statistically analyzed using paired students T-test to estimate the significance. A p-value of <0.05 was considered significant.

RESULTS

This prospective observational study was conducted in 25 adult patients belonging to ASA physical status I and II undergoing faciomaxillary surgeries under general anaesthesia requiring submental intubation. Table 1 shows demographic details and type of fracture they had. All the patients had maxilla and nasal bone fracture while mandible, zygoma, orbital wall and skull base fractures were seen in 78%, 56%, 52%, and 16% of the patients respectively.

Table 1: Demographic data.

Parameter	Number
Age group (mean±sd)	30.12±10.3
Sex male/female	24/01
Asa classification i/ii	24/1
Type of fracture	
Maxilla fracture	25 (100%)
Mandible fracture	18 (78%)
Nasal bone fracture	25 (100%)
Zygoma fracture	14 (56%)
Orbital wall fracture	13 (52%)
Skull base fracture	4 (16%)

Table 2: Time required for submental intubation.

	Time for oral to submental intubation (min)	Time for induction to submental intubation(min)
Mean	1.28	9.68
Std deviation	0.38	1.82
Range	1-2	7-14

Table 3: Duration of surgery.

Duration of surgery	Mean±SD hours	Range hours
	5.642±0.75	4-6.55

The mean time required for oral to submental intubation and induction to submental intubation was 1.28±0.38 minutes and 9.68±1.82 minutes respectively (Table 2).

Mean duration of the surgery was 5.642±0.75 hours with range of 4-6.55 hours (Table3). In most of the cases the procedure of submental intubation was uneventful. But in one case there was damage to the pilot balloon while pulling the tube through the submental tunnel.

Table 4: Distribution of adverse events in the study group.

Adverse Events	Frequency	Percentage
Surgical difficulty	0	0
Damage to ET tube	1	4
Bleeding	0	0
Lingual nerve damage	0	0
Damage to salivary gland	0	0
Endobronchial migration of ET tube	2	8
Obstruction of ET tube	0	0
Accidental extubation	0	0
Difficulty in extubation	0	0
Fistula formation	0	0
Mucocele formation	0	0
Infection of the submental wound	1	4
Hypertrophic scarring	0	0

Table 5: Pulse rate at various stages of anaesthesia.

Pulse rate	Mean±SD	P-value
Baseline	83.92±9.372	
Induction	82.12±7.928	0.85
During submental tunnelling	84.32±9.459	0.72
5 min after submental intubation	82.08±8.737	0.40
10 min	82.20±7.703	0.7
15 min	81.00±7.649	0.13
20 min	81.04±7.765	0.11
30 min	81.88±8.182	0.90
1 hour	80.84±8.905	1
2 hour	81.32±8.325	0.59
3 hour	81.64±7.815	0.08
4 hour	81.92±8.893	0.75
At end of the surgery	83.76±7.828	0.23

P value statistically not significant.

Table 6: Blood pressure at various stages of anaesthesia.

Stage	Systolic blood pressure		Diastolic blood pressure	
	Mean±SD	P value	Mean±SD	P value
Baseline	121.76±5.333		78.72±4.50	
Induction	120.56±5.083	0.06	78.16±4.35	0.63
Submental tunnelling	120.88±4.729	0.13	77.92±4.53	0.12
5 min	122.00±5.323	0.42	78±4.28	0.33
10 min	121.68±4.785	0.79	78.08±4.45	0.53
15 min	120.80±4.933	0.05	77.84±4.9	0.44
20 min	122.16±5.565	0.09	77.76±4.50	0.15
30 min	121.28±5.564	0.11	78.16±4.54	0.06
1 hour	121.12±5.449	0.14	78.4±4.50	0.07
2 hour	116.64±22.463	0.25	78.4±4.50	0.09
3 hour	120.72±5.474	3.23	78.56±4.30	0.07
4 hour	120.80±5.447	8.75	78±4.08	0.08
End of surgery	122.00±4.899	0.45	78.24±4.52	0.16

P value statistically not significant

Two patients had right endobronchial migration of the ETT. On postoperative follow up, one patient had infection at the submental incision site. Other complications like bleeding, mucocele formation, hypertrophic scarring, fistula formation, accidental extubation, obstruction of ETT tube, damage to salivary gland and lingual nerve were not seen our study (Table 4).

All the patients maintained the saturation of 98% to 100% throughout the procedure. Two patients had fall in saturation till 96%. Hemodynamic were unremarkable throughout the procedure (Table 5, 6). There was minimal difference between mean of end tidal CO_2 at various stages of anaesthesia (Table 7).

Table 7: Trend of $EtCO_2$ during various stages of anesthesia.

$EtCO_2$	Mean±SD	P-value
Baseline	31.72±2.590	
Induction	31.88±1.986	0.61
During submental tunnelling	32.48±2.023	0.09
5 min after submental intubation	31.92±2.379	0.75
10 min	31.72±2.851	1
15 min	31.56±2.293	0.78
20 min	31.60±2.582	0.86
30 min	31.20±2.273	0.28
1 hour	31.36±2.271	0.52
2 hour	31.92±2.019	0.69
3 hour	32.12±1.922	0.36
4 hour	32.12±1.922	0.14
At end of the surgery	32.44±1.781	0.16

P value statistically not significant.

DISCUSSION

Faciomaxillary fractures present unique problems to the anaesthesiologist due to disruption of components of upper airway and sharing of airway with surgeons. Surgical management requires intraoperative maxillomandibular fixation to ensure restoration of pretraumatic occlusion that precludes orotracheal intubation.

Presence of panfacial fractures with skull base fracture with or without cerebrospinal fluid rhinorrhea, distorted nasal anatomy, and conditions where nasal packing is required precludes nasal intubation. Mucosal dissection, injury to adenoids, meningitis, sepsis, sinusitis, epistaxis, dislodgement of bony fragments and obstruction of the tube by distorted airway and rarely intracranial intubation are the potential complications of nasotracheal intubation.[11,12]

In such situations tracheostomy is conventional choice of securing airway. However tracheostomy is associated with its own complications. The procedure is difficult in obese patients, children, and patients with thyroid swelling. The complications of tracheostomy include haemorrhage, bleeding, surgical emphysema, pneumothorax, pneumomediastinum, recurrent laryngeal nerve palsy, stomal and respiratory tract infection, tracheal stenosis, tracheal erosions, dysphagia, tracheoesophageal fistula, problems with decannulation, suboptimal visible scar. Also it requires careful perioperative management.[1,13]

As an alternative to tracheostomy, Spanish faciomaxilary surgeon Francisco Altemier, first described the technique of submental intubation in 1986.[14] This technique provides a secure airway and at the same time allows an unobstructed surgical field for adequate reduction and fixation of panfacial fractures. It also avoids the potential complications associated with nasal intubation and tracheostomy. Many authors have studied the clinical use of this technique since its first application.

Despite the widespread use of this technique there are few published articles about the procedure. We report our experience of submental intubation in the airway management of patients with complex panfacial fractures. We studied 25 patients in the age group of 18-56 years with the average age of 30.12±10.3years. There was male preponderance in study group (24/1). Among them 24 (96%) were ASA I grade and 1 (4%) patient was of ASA II grade. The ASA II patient had h/o hypertension which was controlled with medications.

The force causing the facial injury is transmitted through the stronger portions of the facial skeleton and fractures tend to occur at weaker portions. The midfacial bones can be easily fractured by low impact forces while the frontal bone and mandible are stronger bones and require high impact forces.15 The distribution of the fractures in our study (Table 1) shows midfacial preponderance. Mandibular fracture were seen in 18 (72%) patients, zygoma fractures in 14 (56%) patients, orbital wall fracture in 13 (52%) patients and skull base fracture in 4 (16%) patients. And none of them had any associated major trauma.

Many authors have tried several modifications for submental intubation. These include modification of the incision use of 2 endotracheal tubes with non-detachable universal connector reinforced tube of laryngeal mask airway combitube RAE tube, use of Seldinger technique and percutaneous dilatational tracheostomy kit, cut finger of the sterile gloves to cover the tip of the tube while it is pulled through the tunnel to prevent blood entering into the tube to minimize the complications like bleeding, injury to important structures and damage to endotracheal tube.[3,16-26] But there is no sufficient evidence in the

literature to support a single modification to reduce the complications.[6] We used the original technique used by Altemir. In present study a paramedian incision was taken as it is a "clear" zone and less likely to cross significant structures such as muscular insertion zones.[27]

Flexometallic endotracheal tube was used for submental intubation due to its ability to maintain lumen patency at acute tube angles. The flexometallic tube (Rusch Woodbridge Silkolatex, Germany) does not have a black line that marks the length of the tube below the cords. Since these tubes are floppy, it is very easy for the tube to slip out of the cords if enough length is not present beyond the cords. There are high chances of inadvertent extubation as well as endobronchial intubation. To prevent such displacements of the tube, a black line was marked on the flexometallic tube with portex tube of same size as a reference (Figure 1 and 2).

Submental intubation involves disconnection of the ETT and subjects the patients to a period of apnoea. The mean time required for conversion of the oral tube to submental tube (disconnection to reconnection of the circuit) was 1.28±0.38 minutes with range of 1-2 minutes. The mean time required from induction to fixation of the endotracheal tube submentally was 9.68±1.82 minutes with range of 7-14 min (Table 2). Before disconnection from the circuit patients were oxygenated with 100% O_2 for few breaths. There were no episodes of arterial desaturation during the period of disconnection.

In the study done by Agarwal M et al the procedure took 7.08±0.81 min. Shenoi RS et al noted the total time of 10 min for the procedure and the disconnection time was 2 min.[9,28] Kishoria N et al evidenced the procedure time of 8-10 mins and disconnection time of 2 mins.[29] Valsa A et al noticed the procedure time of 8.9 min and apnea time of 1.5±0.35min.[30] Navaneetham A et al noted the mean time of 7 min for the procedure.[31] Tidke AS et al evidenced mean time of 15.51±1.85min for whole procedure of submental intubation and apnea time of 49.7±24.8 sec.[32] None of the studies evidenced hypoxia during disconnection of the tube from the circuit. A systematic search of submental intubation literatures done by Jundt JS et al showed average procedure time of 9.9 min which ranged from 4min to 30min.[6]

ETT is likely to get damaged during manipulation of the tube, to get it in the submental position.[33,34] The retrival of the pilot balloon and the ETT through the submental incision is crucial as excessive pulling or pressure can damage the pilot balloon, and there can be loss of airway seal and extubation can occur. Surgical dissection should ensure enough space to retrieve the pilot balloon and the tube easily.

In present study there was damage to the cap of the pilot balloon while pulling it out through the submental incision in one case. We could inflate the cuff and occluded the pilot balloon tip with artery forceps and we found the pilot balloon remained inflated. The throat was well packed. As there was no air leak, we fixed the endotracheal tube submentally and anesthesia was continued. Drolet et al evidenced damage to pilot cuff while pulling it through the submental incision.[33] They managed the case with exchanging the tube over tube exchanger. In a study done by Yoon K B et al the pilot balloon was accidentally detached from the endotracheal tube.[34] They managed the situation by cutting a pilot tube from a new, unused endotracheal tube and connecting it to the intubated tube using a needle connector.

Faciomaxillary surgeries require head extension and manipulation of head position during surgery. This may lead to increased chance of endotracheal tube disconnection, displacement, endobronchial migration and accidental extubation.[30,32,35-37]

Two cases of endobronchial migration of the tube during the surgical procedure were noted. This was recognised by changes in the end tidal carbon dioxide ($ETCO_2$) wave forms along with decrease in saturation to 96% intraoperatively. In a retrospective analysis by McCoy P et al found that 63.6% of patients with accidental endobronchial intubation were diagnosed by fall in saturation while capnography remained normal or unremarkable in 88.5%.[38] Tubes were repositioned immediately by surgeons. The possible cause could be, that there was an extra length of the tube (loop of the tube) intraorally that remained after fixation of the tube. During the course of the surgery this extra length might have migrated endobronchially. To prevent the endobronchial migration or accidental extubation it is important to do a laryngoscopy to make sure the black mark at the level of the cords and the absence of extra length or a loop of the tube just before fixing the tube submentally.

The haemodynamic parameters were stable throughout the course of the surgery. The presence of intermaxillary fixation, airway odema due to intraoral manipulation increases the chances of airway obstruction. In present study to prevent any airway obstruction we took tongue stitch and kept the patients on steroids to reduce airway oedema for the first 24 hours. The patients were shifted to the recovery room on T-piece. All the patients were extubated in the post anesthesia care unit once they were adequately recovered from the neuromuscular blockade. Extubation was carried out through the submental tunnel after gentle nasal suction, in presence of surgical team. Unlike the great majority of cases reported in the literature, where most authors have reversed the submental tube to intraoral position before extubation. The tongue stitch was removed after confirming the patency of the airway. The sutures were taken in the submental area after local infiltration. Any complications such as emesis with aspiration or laryngospasm would have proven disastrous, at this time as the patient was unable to open his mouth due to fixation. The communication and cooperation between the anaesthesia

and surgical teams is of paramount importance in this situation, as the surgical team was ready to immediately clip the fixation wires to allow for jaw opening, suction, and emergent reintubation if needed.

Infection of the submental wound is most frequent complication seen in previous studies. [9,13,19,32,37,39] In present study, in one case there was infection of the submental wound on fourth day postoperatively which was treated with broad spectrum antibiotics and chlorhexidine mouth washes.

There were no surgical complications like bleeding injury to nerves and salivary glands, mucocele formation fistula, lingual nerve injury, hypertrophic scarring as seen in other studies.[2,9,19,30,35,39,40] The submental incision scar is less visible than a tracheostomy scar and has been well tolerated by patients.[40]

However, these complications have proven to be quite rare according to data from various trials over the past 24 years. It is difficult to truly assess the overall incidence of complications that occur with submental intubation when most case series are only reporting 8-10 cases. Much more research into this area of airway management is warranted.

CONCLUSION

Submental intubation is a safe, effective, easy alternative for short term tracheostomy in major faciomaxillary sugeries that allows an uninterrupted surgical techniques and patent airway. Damage to the endotracheal tube is possible while conversion from oral to submental route. Therefore careful handling of the endotracheal tube is must.

There should be high index suspicion for endobronchial intubation. Confirmation of position of the tube is mandatory. Care should be taken to prevent an extra length of the tube introrally prior to fixation to prevent any displacement and migration of the endotracheal tube. Clinical monitoring is vital as pulseoximetry and capnography may not detect it.

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