Airway Management In The Repair of Craniofacial Defects

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The operative repair of *craniofacial defects* presents the surgeon with critical problems regarding *airway management.* Thirty-seven per cent of our series of 100 children operated upon for a variety of cranofacial deformities had some difficulty in airway management. Those patients with *mandibular dysostoses* and those requiring *midface advancement (Le Fort III)* had the highest incidence of airway problems. Our suggested management of the airway is described with emphasis upon the importance of close cooperation between the plastic surgeon, otolaryngologist and anesthesiologist.

Introduction

Since the pioneering work of Dr. Paul Tessier during the late 1960's (Tessier and Guiot, 1967) (Tessier, 1967) the field of craniofacial surgery has expanded tremendously. Several craniofacial terms in North America are now routinely performing these procedures. As more experience is gained, it is apparent that the proper management of these patients requires not only surgical expertise but a thorough understanding of the potential problems that can be associated with these patients and their operative procedures. Two recent airway complications prompted us to review our own series of craniofacial repairs. It was hoped that our experience would enable us to develop effective guidelines for airway management in these complex cases.

Materials and Methods

A chart review was conducted of all the patients who had craniofacial surgery at the Children's Hospital of Philadelphia from November 1972 through December 1977. There were 100 patients in this group who underwent 116 operative procedures. The average was 6.8 years (range 1 month to 19 years); there were 52 females and 48 males. Each patient was then evaluated for a history of preoperative, intraoperative and postoperative airway difficulties.

Results

The distribution of our patients by diagnostic criteria is seen in Table 1. There were no deaths in our series. The average incidence of airway problems was 37 per cent; their relationship to preoperative diagnosis is seen in Table 2.

Fifty-three per cent of those patients with the diagnosis of craniofacial dysostosis (Apert's, Crouzon's, etc.) had problems in airway management (Table 3).

Only three of 30 had difficult intubations, but eight had planned tracheostomies performed just prior to the craniofacial procedure. The tracheostomies were all for patients undergoing bilateral Le Fort III osteotomies with intermaxillary fixation (IMF) and major soft tissue work. There was one preexisting tracheostomy in a child with Crouzon's syndrome, choanal stenosis and tracheomaliacia. One intraoperative extubation required reintubation, and one patient had a temporary kinking of the tracheostomy tube that resulted in transient hypotension. Four patients had nasotracheal (NT) tubes postoperatively. One of these patients extubated himself but suf-

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TABLE 1. Distribution of craniofacial patients

craniofacial patients diagnosis	*N*
Craniofacial dysostosis	30
Plagiocephaly	19
Mandibular dysostosis	17
Hypertelorism	11
Maxillary retrusion	5
Misc	*18*
Total	100

TABLE 2. Airway problems occuring in each group of patients.

airway problems	
Craniofacial dysostosis	16 (53%)
Plagiocephaly	0 (0%)
Mandibular dysostosis	11 (65%)
Hypertelorism	2 (18%)
Maxillary retrusion	4 (80%)
Misc	*4 (22%)*
Total	37 (37%)

TABLE 3. Airway problems in patients with craniofacial dysostosis.

airway problems craniofacial dysostosis (N = 30)	
Difficult intubation	3
Postop NT tube	5
Planned tracheostomy	8
Preexist tracheostomy	1
Extubation intraop	1
Trach tube kinked	1
Extubation postop	1

fered no airway compromise. One patient had airway distress after placement of arch bars (without IMF) done as a separate procedure prior to his major operation. He required an NT tube for three days. This was converted to a tracheostomy at the time of his craniofacial repair.

Those patients with mandibular dysostoses (Treacher-Collins, Goldenhar, or Hemi-facial microsomia, etc.) had a high incidence of difficulties in airway management (Table 4). The major problem with this group of patients was that of tracheal intubation. Nine of 17 were difficult or impossible to intubate. The anesthetic record frequently reported

TABLE 4. Airway problems in patients with mandibular dysostosis.

airway problems mandibular dysostosis (N = 17)	
Difficult intubation	9
Postop NT tube	3
Extubation intraop	1
Planned tracheostomy	2
Emergency tracheostomy	1
Glossoptosis	1
Extubation postop	1
Needed to re-anesthetize	1

multiple intubation attempts, orally and nasally, with a variety of laryngoscope blades. Visualization of the larynx was usually limited to the tip of the epiglottis and, occasionally, to the posterior portion of the arytenoid cartilages. Mandibular excursion was minimal and protruding maxillary teeth hampered the intubation even more. Blind intubation was only seldom successful. Two patients could not be intubated at all, despite multiple attempts with various techniques and maneuvers. One had anesthesia administered by nasopharyngeal insufflation, and the other had a semi-emergent tracheostomy performed under local anesthesia. There was one intraoperative extubation that caused the procedure to be halted before its normal completion. Five patients had some type of postoperative airway difficulty. Three children required an NT tube for 24 hours. One of these extubated himself in the intensive care unit. Because of respiratory difficulties secondary to glossoptosis, one patient was treated with a suture through the tongue for 24 hours. A fifth child (post-mandibular osteotomy) came out of his IMF and required re-operation to apply his arch bars. A tracheostomy (planned) was in place at the time, and this insured airway control as well as facilitating the reanesthetization.

Patients with maxillary retrusion had a high incidence of airway difficulties (Table 5). Three out of five required NT tubes postoperatively. There was one difficult intubation and one emergency tracheostomy. The latter patient had undergone Le Fort III osteotomies with IMF and was maintained with an NT tube postoperatively. During the first postoperative night, a massive hemorrhage required ten units of blood replacement. The

next morning the patient was taken to the operating room where a tracheostomy was performed and a nasopharyngeal pack placed.

Two out of 11 patients with hypertelorism underwent planned preoperative tracheostomies (Table 6) prior to Le Fort III osteotomies and IMF.

Of the 18 patients with miscellaneous craniofacial diagnosis, three required tracheostomies, and one of those was emergent (Table 7). This patient, a 12-year-old boy with Down syndrome, underwent a maxillary advancement with IMF and a tongue reduction. An NT tube remained in place for three days. When the tube was removed, there was immediate airway obstruction. Multiple attempts at nasotracheal reintubation were unsuccessful. He was finally intubated with the aid of a flexible bronchoscope and then taken to the operating room where a tracheostomy was performed.

While several patients from each diagnostic group had positive past histories for airway obstruction such as croup, this was not associated with any increased problem during craniofacial repair. A history of previous difficult intubation was usually associated with airway problems during craniofacial procedures.

There were 12 patients who had NT tubes in place for 24 or more hours postoperatively. The average length of intubation was 1.6 days with a range of one to three days. One complication was noted; the child with Down syndrome who was intubated for three days postoperatively and then underwent an emergency tracheostomy to relieve airway obstruction was found to have a mild degree of subglottic stenosis. This responded to endoscopic dilation which then permitted decannulation of the tracheostomy tube in 2½ months. Two patients extubated themselves postoperatively.

There were 18 tracheostomies in our group of 100 patients: 14 planned, three emergent, one preexisting. No complications other than transient kinking of the tube occurred. Excluding two patients (the preexisting tracheostomy that was decannulated at one year and the patient with the subglottic stenosis from the NT tube), the average length of intubation via tracheostomy tube was 7.5 days with a range of three to 24 days. The lengthier periods of intubation were not a direct result of the tracheostomy. Rather they were due to the need for continued pulmonary support in several of the patients.

TABLE 5. Airway problems in patients with maxillary retrusion

airway problems maxillary retrusion (N = 5)	
Difficult intubation	1
Emergency tracheostomy	1
Postop NT tube	3

TABLE 6. Airway problems in patients with hypertelorism.

airway problems hypertelorism (N = 11)	
Planned tracheostomy	2

TABLE 7. Airway problems in patients with miscellaneous diagnoses.

airway problems misc. diagnoses (N = 18)	
Planned tracheostomy	2
Emergency tracheostomy	1
Postop NT tube	1

DISCUSSION AND REVIEW OF THE LITERATURE. Several large series of craniofacial operative procedures have been reported (Edgerton, Jane, Berry 1974) (Davies, Munro 1975) (Converse, Wood-Smith, McCarthy 1975) (Whitaker, Munro, Jackson, Salyer 1976), but the problem of airway management has not been previously addressed. While the overall major morbidity and mortality rates of these operations have been fairly low, a high percentage of the complications has been respiratory, as substantiated by our series.

Many factors contribute to the difficulties in airway management seen in craniofacial patients. The craniofacial defect itself has an obvious effect on the size and shape of the nasopharynx, pharynx and oral cavity (Figure 1), the mobility of the mandible and the position of the larynx. In addition, several not uncommonly associated defects such as

choanal atresia (or stenosis), diaphragmatic hernia, tracheoesophageal fistula and kyphoscoliosis may complicate airway management (Stool, Houlihan 1977). The effective airway may be further reduced by adenotonsillar hypertrophy.

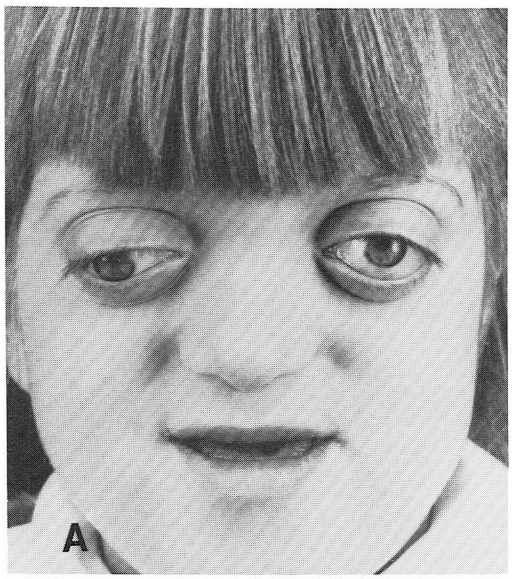

FIGURE 1a. Patient with Crouzon's syndrome demonstrating obvious mouth breathing.

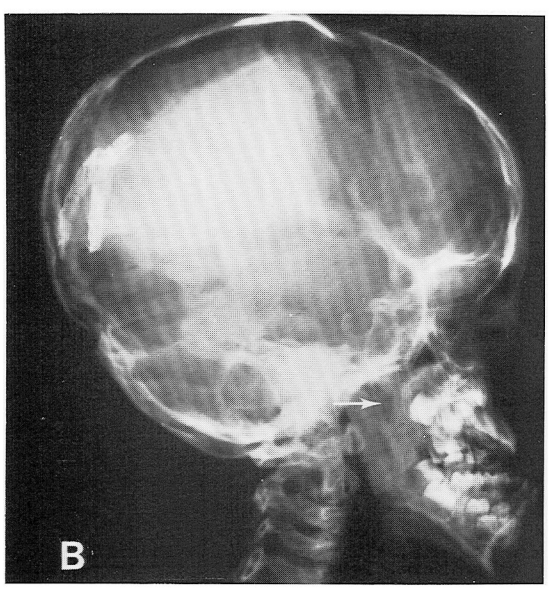

FIGURE 1b. Lateral x-ray of the same patient showing small nasopharyngeal space (arrow) caused by the hypoplastic maxilla and responsible for the obstruction to the nasal airway.

The anatomical configuration related to the craniofacial deformity and associated defects may cause sufficient respiratory distress that airway intervention may be required even before craniofacial repair is considered. This was the case in one of our infants who had a preexisting tracheostomy.

Hypoplasia of the mandible (Figure 2), de-

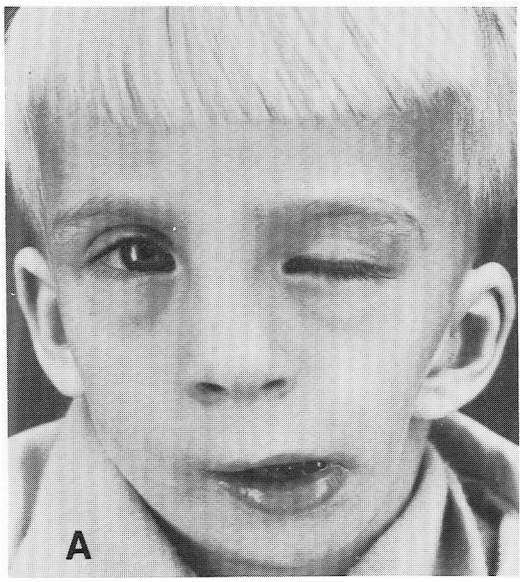

FIGURE 2a. Patient with left hemifacial microsomia.

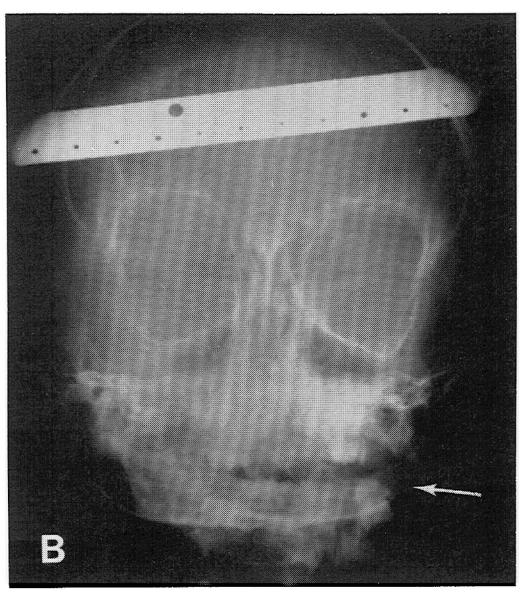

FIGURE 2b. AP x-ray of the same patient demonstrating hypoplasia of the left hemi-mandible (arrow).

creased mandibular excursion (Figure 3), microstomia, high arched palate and prominent central incisors can all make visualization of the larynx and oral intubation impossible (Divekab, Sircar 1965) (Ross, 1963). In Davies's series of 42 craniofacial osteotomies (Davies, Munro 1975), severe upper airway problems existed in seven, requiring four blind NT intubations and three elective tracheostomies.

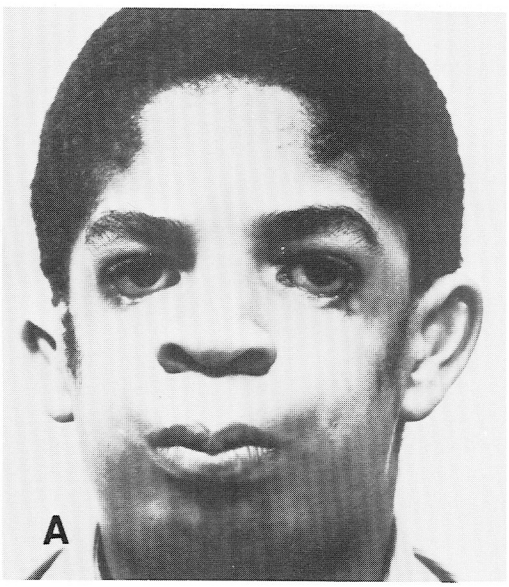

FIGURE 3a. Patient with Treacher-Collins syndrome.

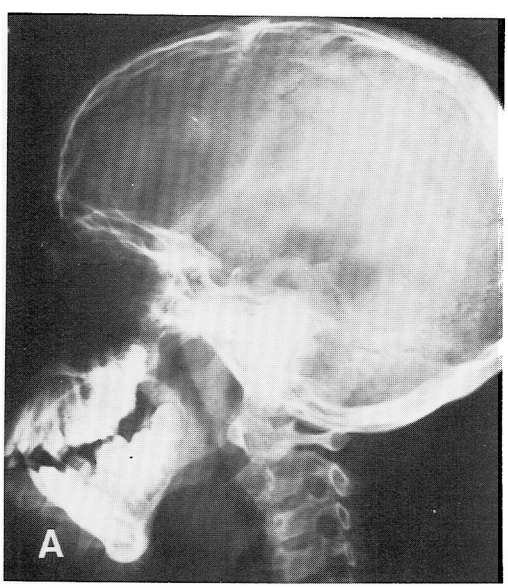

FIGURE 3b. Lateral x-ray of the same patient demonstrating the obtuse angle of the mandible often associated with decreased excursion during opening the jaw.

While tracheostomies are commonly performed with these procedures, the only reported complication of tracheostomy was a laceration of the posterior wall of the trachea that necessitated termination of the operation (Whitaker, Munro, Jackson, Salyer 1976).

Maintaining the patency of the airway intraoperatively is a difficult task. Maxillary or mandibular osteotomies and bone advancements can cause endotracheal tube obstruction and/or accidental extubation with potentially disasterous results. Two extubations occurred in our series without serious sequelae. Davies reports three instances of intraoperative endotracheal tube replacement; two tubes were severed by the osteotome, and one was dislodged during the maxillary advancement. In a large combined series of 149 patients reported by Whitaker (Whitaker, Munro, Jackson, Salyer 1976), several instances of intraoperative extubation are mentioned. Converse (Converse, Wood-Smith, McCarthy 1975) reports one death, which was due to massive hemorrhage combined with mechanical endotracheal tube obstruction during maxillary osteotomy.

Postoperative airway compromise was relatively common in our patients. Thirty per cent required the presence of an artificial airway (either tracheostomy or NT tube) for varying lengths of time postoperatively. While Davies removes all oral endotracheal tubes at the termination of the procedure, our NT tubes are kept in place for 24–48 hours. In some patients, especially those with bilateral mandibular osteotomies, intubation may last four to seven days.

Late postoperative airway obstruction has been described in cases of Pierre-Robin syndrome after intra-oral procedures (Jackson, Whitaker, Randall 1976). One mortality was reported in a patient with Treacher-Collins syndrome. She required tracheostomy for airway obstruction on the third postoperative day. Two days after the tracheostomy tube was removed on the 30th postoperative day, she had recurrent airway distress and died (Whitaker, Munro, Jackson, Salyer 1976).

It is interesting to note that the literature mentions little regarding postoperative airway protection in patients undergoing exten-

sive craniofacial procedures, yet tracheostomy is considered almost mandatory if similar bone and soft tissue injury occur as a result of an accident (Dingman, Natvig 1964).

Postoperative sequelae of the use of artificial airways appear to be minimal. Davies reported one case of superficial pressure necrosis of the nares and one with a superficial skin slough of the lower lip caused by the endotracheal tube. No tracheal or laryngeal damage related to the use of artificial airways has been described.

SUGGESTED MANAGEMENT. At the Children's Hospital of Philadelphia, all patients that are to undergo craniofacial surgery have comprehensive evaluations by the plastic surgeon, otolaryngolosist, anesthesiologist, neurosurgeon and pediatrician. A preoperative history of airway difficulties or previous difficult anesthetic is carefully sought.

In uncomplicated cases in which no intraoral work or IMF is planned, a standard orotracheal (OT) intubation is planned following a mask induction. Poor mask fit related to the facial deformity requires high flows of anesthetic gases. If intraoral work or IMF is planned, an NT tube is placed, usually under direct vision.

In those cases where a difficult intubation is anticipated, NT intubation or a planned tracheostomy is chosen as the method for obtaining control of the airway. If an NT intubation is chosen, the otolaryngologist is present in the operating room with the tracheostomy tray readied should intervention be required. Spontaneous respirations must be maintained during induction, and the use of muscle relaxants and intravenous barbiturates is contraindicated. Intubation may be facilitated by hyperventilation induced by inhalation of five per cent carbon dioxide or by doxapram parenterally (Salem, Mathrubhutham, Bennett 1976). A flexible fiberoptic bronchoscope or nasopharyngoscope is often useful.

In positioning the endotracheal tube, it must be remembered that maxillary or mandibular advancements of three centimeters are not uncommon. The endotracheal tube is carefully positioned so that head movement and jaw advancements do not cause accidental extubation or endobronchial intubation. Once the proper position is attained, the tube is securely fixed either with a suture through the nares or with a wire to a mandibular tooth.

Elective tracheostomy is often selected for those patients in whom a very difficult (or impossible) intubation is anticipated or for those who will require airway protection postoperatively. This latter group includes patients who undergo intraoral soft tissue work or maxillary and/or mandibular advancements with IMF. Tracheostomy moves the artificial airway out of the operative field in addition to providing postoperative airway protection.

It is preferable to perform the tracheostomy with an endotracheal tube or bronchoscope in place, thus assuring airway control. However, in the instance where intubation is impossible, the tracheostomy is done under local anesthesia. A vertical incision is made in the third and fourth tracheal rings, and no cartilage is removed. Silk stay sutures are placed in the trachea lateral to the tracheostomy incision (Stool, Houlihan 1977). These sutures facilitate replacement of the tracheostomy tube in the event of accidental decannulation.

Since we use cuffless endotracheal and tracheostomy tubes to prevent laryngeal and tracheal damage, the hypopharynx is carefully packed with a gauze sponge to prevent aspiration of blood and mucous into the trachea.

Administration of properly humidified anesthetic gases is mandatory to prevent dehydration of the tracheal mucosa and ineffective functioning of the mucociliary transport system (Chalon, Lowe, Malebranche 1972).

At the termination of the operative procedure, the nasopharynx, oral cavity and hypopharynx are visualized and cleared of blood, tissue fragments and bone chips prior to removal of the hypopharyngeal packing. The patient is then taken directly to the Pediatric Intensive Care Unit (PICU) by the anesthesiologist and the operating surgeon. Most patients still have artificial airways in place at this time.

In the PICU, the anesthesiologist continues to be primarily responsible for airway management. Continuous consultation and cooperation among the anesthesiologist, plastic surgeon, otolaryngologist and neurosurgeon is essential in the proper care of the patient.

Many factors are considered in the decision to remove the NT tube postoperatively. Of prime importance is the fact that the sensorium must be sufficiently cleared to allow the patient to breathe spontaneously and to maintain an unobstructed airway. Most patients satisfy this criteria and are extubated within the first 12 to 24 hours. However, there are other considerations which may delay extubation for several days. Continued significant oropharyngeal bleeding, massive soft tissue edema, or laryngeal edema secondary to a difficult intubation might lead to respiratory obstruction if extubation is performed prematurely.

Neurosurgical considerations may dictate the need for a prolonged artificial airway. Increased intracranial pressure can occur with these extensive craniofacial procedures, and this requires hyperventilation to reduce cerebral blood flow and edema. Care must be taken, however, to watch for the development of epidural emphysema or tension pneumocranium in patients who have had osteotomies of the anterior cranial floor and are being ventilated with positive pressure (Edgerton, Jane, Berry 1974).

Pulmonary problems may occur in the postoperative period, delaying NT extubation. Pneumothorax and atelectasis, not uncommon complications of rib graft removal, or copious tracheobronchial secretions may require extended pulmonary support with an artificial airway in place. Patients with IMF are not able to generate effective coughs and often need repeated tracheal suctioning for several days postoperatively.

Because airway access is severely limited by the presence of IMF, artificial airways are left in place for several days. Wire cutters are kept at the bedside should acute airway problems require intervention. A possible disaster was avoided in one of our patients when he came out of his IMF 48 hours postoperatively. Persistent intraoral edema along with posterior displacement of his mandibular fragment had completely obstructed his oropharynx. The presence of his planned tracheostomy not only protected his airway but permitted an easy re-anesthetization.

When the artificial airway is no longer needed, extubation may proceed. Extubation occurs in the PICU with the patient having been NPO for eight hours (should re-intubation be required). After extubation, he is kept NPO for another four hours and then observed for 24 hours prior to transfer to a regular ward. Again, wire cutters are always kept at the bedside.

The controversy over the relative safety of long term nasotracheal intubation versus tracheostomy cannot be settled here. We feel that a properly sized and secured nasotracheal tube can be safely left in place for up to seven days. Should an artificial airway be required for longer periods of time, a tracheostomy is performed. While many series of pediatric tracheostomies report complication rates as high as 40 per cent (Hawkins, Williams 1976) (Tucker, Silberman 1972), these were usually performed upon critically ill children on an emergency basis. Our series had no complications related to tracheostomy. We feel that an orderly tracheostomy performed under controlled circumstances by those experienced in pediatric otolaryngologic surgery, carries little morbidity. Extubation or decannulation takes place in the PICU with all materials readied for reintubation should intervention be required.

Summary

A series of 100 craniofacial patients was reviewed to determine the problems encountered in airway management. Thirty-seven per cent had some difficulty in airway management. Those with mandibular dysostoses and those who underwent maxillary and/or mandibular advancements with IMF had the highest incidence of problems. Our methods of airway management in these difficult patients was presented. Proper airway management requires a complete knowledge of the anatomy of the upper airway, both in the normal and in the pathological condition, and of the methods necessary to obtain and maintain an unobstructed airway. Close cooperation among plastic surgeon, otolaryngologist and anesthesiologist is mandatory in the effort to minimize and prevent airway complications in this select group of patients.

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