Abstract: Tracheal webs are rare anomalies that can be either congenital (Legasto, A. C. et al., 2004) or acquired (Yin, Y., & Zhang, L. 2010) due to prolonged or traumatic endotracheal intubation (Linna, O. et al., 2002). Patients with tracheal webs present with shortness of breath especially during exertion, stridor, and recurrent chest infections. They are often misdiagnosed and treated as bronchial asthma (Zias, N. et al., 2008) with only minimal relief of symptoms with bronchodilators. Traumatic tracheal webs are very rare (Linna, O. et al., 2002). Here we present a 34 years old male patient who accidentally got strangulated while working in a factory workshop. Tracheal trauma and multiple manipulations of the tracheostomy tube led to tracheal web formation. Extreme narrowing of tracheal lumen posed a great challenge of maintaining the airway during surgical tracheal dilatation. We present here a case report of this surgical tracheal dilatation under general anaesthesia using the Jet Ventilation Technique.

Keywords: Anaesthesia, jet ventilation, stenosis, tracheostomy, tracheal web.

INTRODUCTION:
Tracheal stenosis is a well-known complication of tracheal trauma, tracheostomy, and tracheal intubation that occurs in approximately 1 % of patients. Here we present a 34 years old male patient, who got accidentally strangulated and was managed with a tracheostomy, its multiple manipulations, and subsequent tracheal web formation and respiratory distress.

CASE PRESENTATION:
A 34 years old male patient got strangulated accidentally in a factory workshop. He presented with complaints of breathlessness and change in voice only in an emergency. These changes were not associated with disorientation, any other site of injury, haemodynamic instability, or any other complication. Initial Tracheostomy was done under local anaesthesia in a minor operation theatre. It was followed by ultrasonography which showed the narrowest opening of 2.5mm. This led to severe respiratory discomfort to the patient. Surgery was planned for the dilatation of the trachea under general anaesthesia. The challenges identified were:

1. To maintain ventilation during anaesthesia with such narrow opening.
2. To carry out the procedure without interruption of the airway.
3. Since it was a complication of tracheostomy, the option of tracheostomy to maintain ventilation was not available.
It was planned to undertake the procedure using jet ventilation (Evans, E. et al., 2007). Good thing was that patient had no other comorbidities. It was planned to secure the airway while the patient was awake under surface anaesthesia and to ventilate the patient through the lumen of the Endotracheal Tube exchanger. Since its lumen is very narrow, the only way to achieve adequate ventilation was jet ventilation. On the day of the procedure, the patient was premedicated in the preoperative area with injection glycopyrrolate (0.2 mg) and was nebulized with 4% Lignocaine. The patient was shifted to the operation theatre. Bilateral Superior laryngeal block was given transmucosal with 4% Lignocaine swabs behind the posterior tonsillar pillars. The posterior pharyngeal wall was sprayed with 10% lignocaine and finally trans tracheal injection of 4% lignocaine 2 ml was given for infra glottis surface anaesthesia at the level well below the web. Injections Midazolam 1 mg and injection fentanyl (100 mcg) were given IV after preoxygenation for 3 min. Laryngoscopy was done and the only tip of arytenoids were visible. A tube exchanger (11fr) was introduced. The jet ventilator was connected and ventilation started, once adequacy of ventilation was confirmed by observing chest inflation, auscultation and saturation, general anaesthesia as total intravenous anaesthesia (TIVA) with propofol and patient was paralysed with atracurium. The patient was handed over to the surgeons to proceed. Ventilation was maintained by the venturi jet and the patient remained hemodynamically stable. Surgeons tried to dilate the orifice using initially with balloon dilators and then with bougies but unfortunately did not succeed as the webs were thick and cartilaginous. Hence they used punch biopsy forceps and slowly started chopping off the hard part of the web. It took almost forty to fifty minutes to widen the tracheal opening and surgeons successfully completed it. Throughout the procedure, the patient was comfortably ventilated by jet ventilation (Bourgain, J.-L. et al., 2010) and the patient remained haemodynamically stable.

Figure 1: Tracheal Web showing proline remaining from previous surgery

Figure 2: Tracheal lumen with Tube exchanger in situ
**DISCUSSION:**

Tracheal stenosis is a well-known complication of tracheal trauma (Linna, O. *et al.*, 2002), tracheostomy (Yin, Y., & Zhang, L. 2010), and prolonged tracheal intubation (Zias, N. *et al.*, 2008), which occurs in approximately 1% of patients. The cause is damage to the tracheal wall with resultant scarring. A 50% narrowing of the airway is necessary for a patient to become symptomatic. Stenosis may occur as a result of three mechanisms: -

1. Granuloma formation
2. A posteriorly depressed flap or anterior tracheal wall into the tracheal lumen
3. Anterolateral stenosis

The site of obstruction includes the glottis, the subglottic, the stoma, and the intrastromal trachea. Glottic injuries are related to the pressure from the endotracheal tube, whereas subglottic, stomal, and intrastromal lesions could result from the endotracheal tube or tracheostomy tube (Maddaus, M. A. *et al.*, 1992).

Subglottic stenosis occurs in the setting of a high tracheostomy or as a result of the superior erosion of the tracheostomy tube into the cricoid ring. High-pressure cuff tubes and rigid tubes. High-pressure tubes are being replaced by low pressure, large volume cuffs for a long period of intubation. These changes in tubes also do not reduce web formation in prolonged

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**figure 3**: Jet ventilator used in this surgery

**figure 4**: Nozzle tip used for ventilation

**figure 5**: Bernoulli’s principle

Granulation tissue can be identified while the tracheostomy tube is still in place or it may be noted weeks to months after decannulation. It results from mucosal injury and ulceration. As exuberant healing proceeds, it may obstruct the airway (Grillo, H. C. et al., 1995).

Anterolateral tracheal stenosis is the most common form of stenosis. The cause is thought to be an excessive opening of the tracheal wall caused either by the erosion of the tracheostomy tube towards the side, bacterial superinfection or retrogression of the tracheostomy as a result of the excessive weight of the connected tube (Lin, J. C. et al., 2000).

Tracheomalacia and tracheal ectasia also occur and their exact causes are unknown. The problem is associated with the need for an excessive cuff volume to create the seal (Stauffer, J. L. et al., 1981).

Our patient suffered severe tracheal trauma at the time of accidental stranulation in his factory. He was left with a small stretch of very narrow (2.5–4 mm) lumen of the trachea. We had to maintain the airway through this extremely narrow lumen and the surgeon had to operate in this very lumen. Jet ventilation is a very apt tool in the armamentarium of the Anaesthesiologist when he is forced to use a very narrow lumen.

Jet ventilation was developed in 1960, it is based on Bernoulli’s principle and its Venturi application. It provides good surgical access while performing rigid bronchoscopy. In 1967 Douglas Sangers described the technique which allowed uninterrupted patient ventilation, with unhindered surgical access through an open rigid bronchoscope (Carretta, A. et al., 2006). Oxygen delivered with supply pressure 50 lb/sq inch, in a jet through a 0.035 in diameter nozzle inside the lumen of bronchoscope & parallel to its long axis. This jet entrains surrounding air so the tidal volume delivered is much larger than the oxygen delivered through the jet. Pause between each jet delivery allowed passive expiration. Adequacy was being assessed by direct chest wall movements and confirmed by auscultation, pulse oximetry, and (arterial blood gas) ABG. An additional wide bore sidearm to a rigid bronchoscope may provide entrainment of anaesthetic vapours through it. Narrow, nondistensible catheters can be used alone or with bronchoscopes/laryngoscopes during jet ventilation. Exhalation takes place through the surrounding lumen. Had our tube exchanger catheter been very tight-fitting in the narrowed lumen then we would not have been able to ventilate the patient through this exchanger as there would not have been any space for air to entrain and also for expiration. Our plan for that situation was to keep the tip of the rigid laryngoscope very close to the glottis of the jet nozzle at its proximal end as is done during rigid bronchoscopy.

Key Take-home lessons:

1. Multiple manipulations of tracheostomy tubes can lead to the formation of tracheal webs.
2. CT scans can be used for screening for tracheal webs and other tracheal anomalies and can provide information about the morphology and extent of the lesion.
3. Bronchoscopy is the gold standard in diagnosing tracheal webs and can provide immediate therapy.

Jet ventilation can be used elective or emergency surgery and in the Intensive care unit (ICU). In our particular case, it was used electively for an hour-long surgical procedure with success.

Conclusion:

Benign central airway lesions frequently call for therapeutic bronchoscopy procedures for Anaesthesiologists. Treatment of these disorders requires immediate stabilization, detailed evaluation, meticulous planning, and tailored treatment. An evaluation of each lesion that encompasses physiopathology and the natural history of the disease is required. Treatment must be planned by a multidisciplinary team that includes interventional pulmonologists, radiologists, ear, nose, and throat specialists, and anaesthesiologist.

References: