An Innovative Operative Method for Correction of Tracheal Stenosis

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Abstract This is a case of failed attempt of hanging, resulted into cervical injury & injury to the trachea. Patient was put on the ventilator for respiratory support for long period. Poor recovery of the patient resulted into prolong tracheostomy tube. Combine effect of all resulted into suprastomal tracheal stenosis. Due to complexity of the problem a novel method was customized to correct the tracheal stenosis. Strap muscle (Sternohyoid & Sternothyroid) was raised as a flap; free cartilage was sandwiched in between and sutured to the created tracheal defect. Bovine collagen was placed over a stent and placed in the tracheal lumen. Good result was achieved post operatively in the form of adequate lumen, rigid anterior wall during respiration, good mucosal lining without fibrosis and normal speech.

Keywords Tracheal stenosis · Sandwich flap · In-situ tissue engineering

Introduction

Tracheal trauma is supposed to be common cause of tracheal stenosis. It can occur by direct trauma to the trachea or following difficult intubation in emergency by inflicting injury to the trachea or due to high tracheostomy. It can

also occur due to prolong hyperinflated ET tube cuff. Stomal strictures also occurs in patients requiring prolong mechanical ventilatory support. So, tracheal injury can have varied etiology in a seriously ill patient requiring emergency intubation, ventilatory support and tracheostomy. This injury can be represented later as segmental stenosis, areas of tracheomalacia and granulation tissue.

We report an innovative surgical technique for the correction of supra stomal tracheal stenosis by using strap muscle flap with free cartilage graft sandwiched in between muscle flap with novel in situ tissue engineering method for respiratory epithelium of the trachea.

Materials and Method

Technique

Case 1. A 25 year old male attempted suicide by hanging from ceiling resulted into injury to cervical cord, trachea & cricoid cartilage. Patient survived and was brought to a private hospital and primary treatment was given there. Emergency intubation was performed and patient was placed on ventilatory support for poor respiration. Tracheostomy was performed later on for the need of prolong ventilatory support. After stabilization of general condition of the patient 2 months later attempt for decannulation was performed, this resulted into dyspnea. Tracheostomy tube was placed once again. On endoscopic examination tracheal narrowing was found. Month after tracheoplasty was attempted which was unsuccessful. Patient was referred to ENT & Plastic surgery department of our hospital.

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Clinical examination revealed irregular anterior wall & scarring over trachea. **CT scan** (Fig. 1) was performed, revealing damaged cricoid cartilage, upper tracheal rings & the supra stomal stenosis of the trachea. Extent of the stenosis was approximately 2.5 cm in length. **Endoscopy** was performed which revealed the narrowing of the lumen below the vocal cords & above the tracheostomy opening. Hyper granulating tissue was present just below the vocal cord & just above the tracheostomy opening.

Staged surgeries were planned for the above problems. Anterior approach was made and midline longitudinal incision was given in suprastomal area, deep through the skin and scar tissue down till the tracheal lumen. All fibrotic tissue was excised with preservation of as much vital tissue as possible. Also, all the hypergranulation tissue was excised & saucerization of the wound was performed

Fig. 1 Sagittal section showing stenosis at the site of tracheostomy as well as supra stomally

Fig.2 Clinical photograph of the patient after first stage correction of the stenosis, anterior tracheal wall reconstruction

(Fig. 2). The anterior tracheal wall was freely mobilized to obtain good lumen. A triangular defect with 2.5 cm wide base caudally was created.

Meanwhile the 2.5 cm × 2.5 cm septal cartilage was harvested from the nasal septum. The strap muscle (Sternohyoid & Sternothyroid) was mobilized from the margin on both sides of the incised & freshened out wound. Minimum dissection was performed to separate the Sternohyoid & Sternothyroid muscle. Next the mobilized Sternothyroid muscle sutured to the triangular defect in the anterior wall of trachea & in the midline. The cartilage graft was then sutured to the Sternothyroid muscle & the tracheal cartilage to reconstruct the anterior tracheal wall. The tracheal defect filled up with muscle & cartilage is now covered with Sternohyoid muscle. Platysma layer was approximated in the midline. Skin was approximated and midline closure was performed.

Now the lumen was graded by passing red endotracheal tube through stomal site. 9F tube was found snugly fitting into the lumen. Stent was customized from the part of the tube for proper stenting, holding to prevent accidental removal and easy removal once its function is over. Proximal portion of prepared T shaped stent was now covered with bovine collagen stitched, fixed over stent & placed gently into the reconstructed trachea.

Post operative check dressing was done on 5th day under anesthesia. The T-stent was removed. Lavage was given. At most of the places epithelium was found. The stent was replaced back Check endoscopy was performed at routine interval. After 1 month granulation tissue was found at tracheostomy site which was probably due to friction injury caused by cleaning & changing of the stent.

After a week Patient was taken for excision of hyper granulation tissue under general anesthesia given through tracheostomy tube. Hyper granulation tissue was excised &

Fig.3 The tracheal stenosis after correction

saucerization of the wound was performed. The stent planned this time was made from Cuffed portex endo tracheal tube. This Cuffed portex endo tracheal tube was now placed per orally. The distal end was pulled out from the tracheostomy wound. Bovine collagen was wrapped over the inflatable balloon and was fixed above & below the balloon by silk suture to prevent dislodgement during insertion or removal. The stent was then placed over the saucerized wound and the distal end of the ET tube was placed into distal trachea after removal of tracheostomy tube. General anesthesia now switched over & provided through ET tube. The Endo tracheal tube was inflated. Compression dressing was given from above. Intermittent deflation of the tube was performed post operatively. Dressing was done after 48 h. ET tube was withdrawn on 5th day and the decannulation underwent successfully. Endoscopy was performed at the end of the week. A good quality epithelium was found over all area along with good lumen.

After 15 days tracheostomy site was planned for closure. Circumferential incision was given around the tracheostomy wound. Two flaps were raised, one to provide lining for trachea and another to provide skin closure. The inverting skin epithelium was de-epithelized and closed over the endotracheal tube. The anterior wall was further strengthened by suturing Poly propylene mesh. It was fixed to the surrounding cartilage as well as to the soft tissue beneath to prevent movement of anterior wall during respiration. Surrounding skin was mobilized and closed in the midline. Endo tracheal tube was removed after 48 h (Fig. 3). Good air flow was achieved along with good speech. The anterior wall was standing rigid during inspiration & expiration (Fig. 4).

Case 2. A 35 year old male prisoner presented with stenotic tracheal stoma & lumen filled with

hypergranulation tissue. Decannulation was failed twice after excision of hypergranulation tissue. The size of the tracheal lumen was found satisfactory in CT Scan examination. General anesthesia was provided through tracheostomy tube. All the fibrotic tissue was excised from the margin which is causing narrowing of the lumen. All hyper granulations was excised thoroughly and saucerization was performed. Haemostasis was achieved and the lumen was calliberated with 9.5F Cuffed portex endo tracheal tube which was passed par orally and was found passing satisfactorily into the lumen.

The distal end was pulled out from the tracheostomy wound and Bovine collagen was wrapped over the inflatable balloon in the same manner as discussed above. The customized stent was then placed over the saucerized wound and the distal end of the ET tube was placed into distal trachea after removal of tracheostomy tube. General anesthesia was now switched over & provided through ET tube. The Endo tracheal tube was inflated so that the balloon distributes even pressure over saucerized wound. Moderate compression dressing was given from above. Intermittent partial deflation of the balloon was performed post operatively. Dressing was done after 48 h. ET tube was withdrawn on 5th day and the decannulation underwent successfully. Endoscopy was performed simultaneously and good quality epithelium was found over all area along with good lumen. Tracheostomy tube was not replaced nor the endotracheal tube and the closed dressing was provided over the wound. The wound was left for secondary contraction. Intermittent endoscopy was performed—the epithelium & the lumen found satisfactory at the end of 3 months post operatively.

Discussion

Prefabricated composite graft of cartilage and mucosa beneath laterothoracia fascia for tracheal reconstruction was performed by Jaquet et al. [1] found mucosal survival variable. In situ tissue engineering to regenerate tissue like skin and mucosa has been practiced since long in animals. Omori [2] had used this technique for airway reconstruction. A marlex mesh tube covered by collagen sponge was used as a tissue scaffold. Berkovits et al. [3] also used naso tracheal tube that was non toxic, having low friction and were made of silicone. We had used a stent covered by collagen placed and placed beneath the reconstructed trachea after correction of the tracheal stenosis. Vascularized tissue in the form of strap muscle flap was used for reconstruction of anterior wall of the trachea. Free costal cartilage graft when used as such may result into graft necrosis as it was pointed by Han et al. [4]. We had used a vascular flap to support the free cartilage graft from all

Fig. 4 Photograph of the patient after closure of tracheostomy site and decannulation

around by sandwiching it in the strap muscle. It was found the cartilage strengthened the anterior wall and resisted absorption and change in configuration even after 3 months of the surgery. The vascular flap also supported the regenerated mucosal epithelium and was found stable after serial endoscopy at the end of 3 month.

We believe our new technique will open new avenues for in situ tissue engineering simultaneously simplifying the technique for tracheal reconstruction.

Compliance with Ethical Standards

Conflict of interest None.

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