Tracheo Oesophageal Puncture Voice: An Indian Perspective

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Abstract Author presents in this study 160 patients who underwent tracheoesophageal puncture (TEP) for voice rehabilitation after laryngectomy. This study represents authors experience in Indian perspective with regards to technique, timing of surgery, i.e., primary or secondary, effect of socioeconomic condition of the patients. Author also narrated complications secondary to the TEP voice and prosthesis, during long follow-up of 15 years. The primary and secondary TEP were compared in patients having good socio-economical status with that of relatively poor status patients. As compared to the western literature, this Indian study showed significant differences in success rate of achieving good TEP voice production and also continuing use of TEP voice. Author observed that despite, entirely different socio economic condition and lack of proper follow-up, the secondary TEP done after complete evaluation of the patient yields much better sustained results for successful voice acquisition and continuation of the use of acquired voice. Author has described in details about the surgical procedures for secondary TEP; the prosthesis, care of prosthesis, problems due to TEP and prosthesis and the ways to rectify these problems.

Keywords Tracheo-oesophageal puncture · TEP · Post laryngectomy surgical voice rehabilitation

Introduction

Although surgical voice rehabilitation after total laryngectomy has existed for almost 115 years, it has been only last 20 years, the technique of tracheoesophageal puncture (TEP) has been established as a main procedure and with continued development and knowhow in the technique, improvement in one way valve prosthesis design, material and increase in indwelling time, it has becomes an accepted procedure with very good long term successful continued use of voice as compared to other method of rehabilitation [1, 2].

Currently the most popular procedure is that of Singer and Blom. It is an endoscopic procedure utilizing simple valve prosthesis to solve the problem of leakage in tracheobronchial tree [3].

There are two main groups of patients undergoing voice restoration.

- (1) Those who have TEP performed at time of their initial surgery of laryngectomy: Primary.
- (2) Those who have TEP procedure performed some time after laryngectomy: Secondary.

Numerous studies of both TEP procedures have been reported with success rate that ranges from 30 to 93% [4]

If we look in the Indian contingent perspective, the first account of this procedure is available from Hazarika et al. in 1990 [5], since then many centers have taken this work but only few have reported their experiences [6–11].

The success of the TEP voice is predicted on several factors including the careful preoperative evaluation of patients and the knowledge, skill and experience of surgeon and speech pathologist. Blom and Remacle [12] reported several problems related to TEP.

Situation in India may be far different from the Western countries because of the factors like economy, habits,

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availability of expertise. It is therefore worthwhile to look into all aspects of TEP in comprehensive manner. TEP procedures has been started by author since 1988 and in last 20 years 160 patient have undergone this procedure with follow-up ranging from 6 months to 18 years. The problems, results and management have been closely monitored. Author has found few distinct and significant differences as compared to other workers especially from developed countries. These could easily be attributed to financial, social and physical differences.

Materials and methods

160 Patients were subjected to TEP procedure from 1988 to 2008, with minimum follow-up of 6 months and maximum follow-up being 18 years. These patients were operated in different setups. Initial surgeries were done in Government medical colleges, which cater mostly to very poor economic strata and these patient come from very long distances with tremendous financial hardship. Advanced disease and lack of proper follow-up has been commonly observed in these patients. In later half of this series author was operating in private paid setup and most of the patients had good economic status and they were willing for proper follow-up. This group of patients is comparable to western patient group. With distinct two groups of patients the comparison is quite interesting.

Initially first 45 patients underwent Primary TEP but later on practically all the patients underwent secondary TEP.

Secondary TEP

For successful TEP it is mandatory that one should assess the patient thoroughly. The key point is pharyngoesophageal (PE) segment functioning. Normally with functioning inferior constrictor, PE segment will go in spasm for upcoming fluid or food. Air coming up in either esophageal speech or TEP speech will then cause sudden contraction of PE segment and will result in either no voice or squeaky voice. Relaxation of this segment is thus necessary and can be achieved in most of the patient by long myotomy of inferior constrictor muscle and/or pharyngeal plexus neuromyotomy while performing laryngectomy.

It is also observed that patient undergoing repair of pharynx in one horizontal suture line and anchoring to base of tongue has better timber of voice and swallowing. This is usually possible in laryngectomy with minimal pharyngeal resection.

Comprehensive evaluation and motivation of patient and of close relation who will be involved in patient's care is very important for long term successful continuation of

voice. This is done with counseling, videos and interaction with other patients.

Other assessments are:

- (1) Tracheostoma assessment.
- (2) Neck contour.
- (3) Stoma occlusion ability.
- (4) Respiratory reserve.
- (5) Assessment of recurrence.

Tracheostoma and Neck Contour

The size and shape of the Tracheostoma should be such that with light pressure of his finger patient should be able to occlude it completely without air leakage. It should also be large enough to allow good placement of prosthesis and its cleaning. In Indian context the size of the stoma is usually 2 cm in diameter, oval shaped and may be placed 2 cm above sternal notch. This allows patient to use his finger for occlusion properly and without fatigue. To achieve this following surgical tips during laryngectomy are useful:

- (1) Tracheostoma is made oval with poster superior wall being larger than anteroinferior wall.
- (2) Initial size of the Tracheostoma should be at 30–50% larger than desired size as postoperatively and after radiation the stoma tends to reduce in size. This also happens after TEP.
- (3) Good approximation of mucocutaneous junction with 30 or 40 vicryl is necessary to avoid granulation and subsequent contraction.
- (4) Tenotomy of both sternocleidomastoid muscles is necessary if they are prominent. This prevents lateral pressure and also flattens the neck contour.
- (5) Lateralization of thyroid lobes under sternocleidomastoid muscle is done to prevent compression on Tracheostoma.
- (6) In case surgeon feels that the stoma will be smaller, then primary widening techniques can be employed.

Needless to say that meticulous preparation of Tracheostoma during tiring end of surgery, has no substitute for achieving successful TEP voicing.

In his series author encountered 20 patients of smaller stoma (8%). Most of them were post radiation patients. Only two patients had large sternocleidomastoid heads. The stenotic stoma was corrected by Y–V stomaplasty done at 3 and 6 o'clock position. V shaped flap was raised on these positions with apex of V at the Tracheostoma mucocutaneous junction and broad base of about 1 cm on lateral neck skin. The flap length is usually 15 mm. A straight incision is then given from apex of V into trachea, splitting it laterally. The broad based skin flap is then advanced in

Fig. 1 Showing Y–V tracheoplasty

the gap of trachea and sutured to tracheal wide opening. Thus, the initial Y incision on completion looks like V (Fig. 1).

Y–V tracheoplasty is a good procedure and can easily be done under local anesthesia. Author had 80% success results. Two of the failed procedures were revised successfully, while one patient was lost to follow-up. One patient on his own, devised a fenestrated tracheotomy tube with fenestra in superior flange to accommodate TEP prosthesis. The tracheotomy tube fitting was made airtight with sticking plaster. On blocking tube he could speak well (Fig. 2).

Patient's Factors

Ability to occlude the stoma properly and without air leakage is very important. Patients with arthritis of fingers, deformed fingers, tremors, and bad eyesight and general debility are bad candidates for successful production of TEP speech.

Pharyngoesophageal Segment Assessment

Dynamic assessment of PE segment can be made with Videofluoroscopy. The upper esophagus is lined by thin barium and then air insufflations is done through a nasogastric catheter, tip of which lies just below the site of proposed TEP. PE segment vibration during voicing attempt is observed

fluoroscopically and quality of voice produced is noted. Tonicity of PE segment is classified as follows [13]:

- (1) Hypotonic: these patients will have acceptable but very feeble voice and would need finger pressure to enhance PE segment and produce good voice.
- (2) Normotonic: good speakers.
- (3) Hypertonic and spastic: produce very squeaky or no voice. They need pre puncture myotomy or pharyngeal plexus neurectomy or botulinum injection in upper esophageal area. The success of these procedures can be judged by prior injection of local anesthesia which will lead to Normotonic voice.
- (4) Stricture: need repeated dilatation or surgical repair.

Videofluoroscopy is highly skilled procedure. As a part of clinical assessment before TEP, author recommends a simpler but equally reliable test of air insufflations where more emphasis is given on voice quality produced. This is similar air insufflations test as done in Videofluoroscopy except fluoroscopy [14].

Surgical Procedure for Secondary TEP (Fig. 3)

The procedure for TEP was first described by Singer and Blom in 1979 [3]. This technique has been modified by many clinicians over the years. Author has adopted technique described by A. Perry and Mr. Cheesman [15].

Under general anesthesia a distally lit Jessberg pharyngoscope or esophagoscope is passed into pharynx till the site of puncture in Tracheostoma is transilluminated. The TEP site is 1–1.5 cm below the mucocutaneous junction on posterior tracheal wall. The puncture is made by specially made Teflon rod trocar of 14FG having sharp metal inserter (14FG at maximum diameter) and other end has serrated adaptor for 14FG nasogastric tube. Very sharp cutting edges of inserter and essentially flexible Teflon rod makes it very easy to perforate tracheoesophageal party wall and deliver the rod along with nasogastric tube in waiting lumen of pharyngoscope. The pharyngoscope along with rod and nasogastric tube is then withdrawn and delivered

Fig. 2 Showing patient using his own modification to prevent stoma contraction and also effective use of TEP voice

Fig. 3 Special trocar and other instruments required for secondary TEP

out through mouth. The NG tube is then transferred through nose and out or transferred to stomach. The tube is left in situ as a stent for 48 h after which the voice prosthesis is fitted. The procedure is very simple, single staged, quick and can be done under local anesthesia in cooperative patients. The equal gauged inserter, rod and NG tube and very sharp cutting edged inserter, produces clean uniform fistula without any laceration. This reduces complication of granulations. In the large series author did not encounter any procedural complications.

Some patients with narrow esophagus or stricture may not allow sufficient sized scope to be passed in. In such cases TEP can be done with large curved hemostat or intestinal clamp passed in pharynx through mouth and the tip presses the posterior tracheal wall at puncture site. After giving small nick on tip it is delivered out in Tracheostoma and NG tube of 14FG is fed into it which then is delivered out to mouth and transferred through nose and out to the stomach. This procedure though simple, has a disadvantage of laceration of mucosa and granuloma formation.

Sizing and Fitting of Prosthesis

Fitting of the prosthesis can be done immediately after 48 h. After the NG tube is removed the open tract voice is tested by surgeon or speech therapist. The prosthesis is fitted next and patient is given training to speak with his own finger occluding the stoma. The essential things to teach is light but effective pressure on stoma to avoid air leakage, relaxed manner to speak without exerting much exhaled pressure, and regular practice. Most of the patients need either 2.2 or 1.8 cm sized prosthesis and party wall thickness can be gauged with seizer which in practice is rarely needed.

Prosthesis

Financial factor is a major factor for continuation of TEP voice as all the prostheses available all over world last only

Fig. 4 Showing indigenous prosthesis

for 3–4 months except recently developed indwelling prostheses which last little longer. To replace prosthesis every 3 months and spend substantial amount has been seen to be major deterrent to continue TEP voice in many patient especially from rural and economically compromised patients. This reduces success rate drastically in the initial phase. The indigenously developed and modified duck bill principled prosthesis has removed this problem in author's series. This silicon prosthesis has larger esophageal flaps and is impregnated with antifungal drug.

As all the patients are now being operated as secondary TEP, they are fully assessed for PE segment spasm and hence duck bill principle has worked very well and there was no need for low pressure prosthesis.

The indigenously produced speech pro mycostatic prosthesis (Fig. 4) has been very economical and accepted by patients easily. The quality of voice and life of the prosthesis is comparable to any other successful prosthesis. Despite being very economical some of the patients still find it difficult to replace it frequently and tend to tolerate minor leakages and come only when leakage becomes intolerable. Two of our patients have discarded use of prosthesis and uses open tract voice and plug the TEP with red rubber catheter when he is not speaking. An average life of silicon non indwelling prosthesis is 3–4 months with range from 2 months to even 1.5 years.

Voice Quality

The goal of voice restoration is to provide fluent, effortless and intelligible speech.

Quality of voice cannot be controlled. It is usually harsh and often loses its sexual characterization. This was the main reason of disliking and discarding TEP speech by 30% of the primary TEP patients. The speechless period for secondary TEP and proper counseling negated this problem, and none of the successful secondary TEP patients abandoned prosthetic voice due to disliking. Some of them initially used voice only occasionally but in later period they became fluent speakers.

Fig. 5 Showing incompetent prosthesis secondary to Candida deposit

The TEP voice usually has learning curve. The pitch and quality of voice improves over time. The problems of PE segment spasm or hyper tonicity were assessed and neutralized before surgery of secondary TEP hence author had immediate success rate of 100% for voice acquisition.

Availability of speech therapist no doubt lessen burden on surgeon but most of the patient learn very quickly. The use of right or left hand, which finger should be used to occlude the stoma is best left to the patients. They learn by their own experience. Interaction amongst the patients is the best training and formation of laryngectomy club is necessary.

Care of Prosthesis

The cause of leakage in prosthesis is incompetent valve and it is usually due to fungal deposit on valve at esophageal end of the prosthesis (Fig. 5). To increase the life of the prosthesis author finds following maintenance tips useful.

- (1) Initially patients were taught to take out prosthesis, clean it and replace it. It was found accidental breakage, improper handling and trauma to valvular mechanism while reinserting reduced life of the prosthesis. Hence now patients are advised to clean the lumen of prosthesis in situ regularly with antifungal solution with help of cotton wool carrying sticks.
- (2) Avoidance of non vegetarian food and alcohol.
- (3) Regular use of oral antifungal (clotrimazol) drops at least twice a week.

Observations and Discussion (Table 1)

It is well acknowledged that Primary TEP is a better choice as patient is not subjected to second surgical procedure and voice acquisition is quick. Author in his initial series of Primary TEP on 45 patients (belonging to poor group) found initial good acquisition of voice (85%). But on continued follow-up for next 2 years, the rate of successful and continued use of voice deteriorated to almost 40%. It was assessed to be due to:

- (1) Lack of follow-up because of long distances and poor economical conditions.
- (2) Disliking for the voice produced.
- (3) Inability to afford new prosthesis (cost being INR3000 every 3–4 months).
- (4) Recurrence.
- (5) Stoma stenosis.
- (6) Lack of social and familial support. Interestingly few of the successful speakers abandoned TEP as they lost sympathy from family members for having malignancy.

Alarmed with rapid deterioration of success rate, the strategy was changed to secondary TEP, and next group of 30 patients with similar economic strata were operated in same setup, i.e., Government Medical College.

The timing of secondary TEP depends on the extent of pharyngeal resection, complexity of reconstruction and need for post operative radiation. It was usually delayed by 2 months following radiation and/or complete recovery physically and psychologically. This time period also allowed us to reassess the patient properly for willingness of having TEP and proper follow-up.

This period also gives an opportunity to tentatively rule out recurrence from aggressive or residual disease. The aphonic period was also responsible for convincing patient to accept the quality of voice, which was not a case with primary TEP.

The second group of patients with good motivation and assessment had secondary TEP. Voice acquisition by these patients was 100% immediate post surgery, which reduced to 80% gradually in 2 years time. Encouraged by these results, it is recommended to do the secondary TEP as a routine, especially for patients with poor economic strata.

Table 1 Comparison of TEP in different socioeconomic status

Sr.no	No. of pts	Type of TEP	Set up	Success immediately after surgery (%)	Success after 2 years (%)	Remark
1.	45	Primary	GMC	85	40	Poor S-E status
2.	30	Secondary	GMC	100	60	Poor S-E status
3.	85	Secondary	Private	100	80	Good S-E status

S-E socioeconomic status

Fig. 6 Showing granuloma around TEP and after cauterization

Fig. 7 Showing migration of fistula

The cost of hospitalization and surgery is very minimal as patient need short stay and short anesthesia.

Trouble Shooting with Tracheoesophageal Prosthesis

The good account of the problems related to TEP and prosthesis has been described by A.Thakkar, S. Bahadure [10] and G. W. Bunting [16]. Former is using same prosthesis which author is using.

Leakage Through Prosthesis

This is due to incompetent valve mechanism. The most common cause being *Candida* deposit on one way valve which remains open during swallowing and fluid from esophagus leaks to tracheobronchial tree leading to cough while swallowing. Other causes are manufacturing defect (2%) where the leakage is usually immediate after replacement of prosthesis. Another common cause of temporary leakage is impaction of mucus or food material, which is solved when the prosthesis is cleaned. Ageing of prosthesis makes silicon material deteriorate and it whither with time and become incompetent.

Rare cause of incompetence of valve is pressure of posterior wall of pharynx touching it. This is seen with patients with cervical spondylosis and lordosis. Such patients may need short projected valve like low pressure valve.

Leakage Around Prosthesis

This can occur in patients who develop tissue necrosis around the prosthesis and fistulous tract becomes larger. This not so common complication is usually seen in post irradiate patients or patients with extensive pharyngeal excision. Removal of prosthesis and insertion smaller gauzed catheter for 1 week usually solves this problem. Rarely one needs to close the fistula and redo the TEP after 3 months.

Granulations around TEP (Fig. 6a, b)

One of the commonest problems in TEP site is granuloma and hypertrophy all around the fistula. This hypertrophic tissue tends to enter into the vents of the prosthesis and block them. Simple cauterization and application of the steroidal ointment solves this problem for some time.

Migration of Fistula Upwards (Fig. 7)

Another rare but frustrating problem is of shifting of the fistulous tract upwards causing leakage around the prosthesis and squeaky voice. This is mostly seen in post irradiate patients. Author advices to close this fistula and redo the TEP after 3 months.

Excessive Mucus Production

Very common after TEP but lasts for only few weeks and is due to irritation of mucosa by prosthesis.

Difficulty in Reinserting the Prosthesis

This problem is seen in some previously successful TEP speakers, when they come back for replacement of prosthesis.

The common causes are low placed fistula or a false passage created with original tract still intact.

The false passage can be obliterated by careful catheterization of the true passage and reinsertion of prosthesis after 3–4 days, by this time the false passage gets obliterated.

For inferiorly placed fistula reinsertion can be done after raising the shoulders upward.

Stenosis of the tract is encountered if there is expulsion of the prosthesis and tract has not been catheterized by the patient and reaches hospital late. Most of the time this small fistula can be dilated by Hagar's dilators and prosthesis can be reinserted. Rarely one has to redo the TEP for complete obliteration.

Spontaneous Expulsion of the Prosthesis

Severe bout of cough or for some unknown cause prosthesis can be expelled out and occasionally lodges in bronchial tree from where it can easily be remove by bronchoscopy.

Conclusion

While making a survey of patient operated at Charing Cross Hospital London, an apt comment from one of the patient was "The TEP voice invention is like invention of sliced bread".

This describes how patient rate TEP voice which is now the best postlaryngectomy rehabilitation.

New devices and prosthesis have been developed for better voicing quality and longer indwelling life, but the main problem still remain is economy, patients willingness to accept the harsh, asexual quality of voice and need to attend physician regularly.

The developing countries where incidence of laryngeal malignancy is very high, unfortunately faces this problem very often.

Development of indigenous, equally competent prosthesis has in long way helped to alleviate these difficulties. The complications of TEP fistula and prosthesis are very few and are easily manageable. Proper assessment of psychophysical condition of patient undergoing TEP and good counseling is the best way to attend high success rate of continued speech for long time, and author feels that this is best achieved by secondary TEP especially in poor economic strata.

This article has tried to summarize the experience of TEP procedure, complications and the problems of TEP

and prosthesis and how to manage them and increase the success rate of the TEP voicing.

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