Malignancy of the Larynx

(Experimentation on Animal, Construction of Biologic Neo-Larynx and Rehabilitation of the Laryngectomee—20 Years Experience)

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Summary

Squamous cell carcinoma is by far the commonest malignancy of the larynx and I would confine my present paper mainly to this along with the management and post-operative rehabilitation after total laryngectomy. High survival rate in majority of the cases, if diagnosed and treated early and adequately, provokes and encourages the interested laryngologist to consider not only about performing effective surgery, including on those cases where radiotherapy is inadequate or has failed, but also resorting to rehabilitative surgical procedures after total laryngectomy with or without neck dissection, offering to the laryngectomee a 'Biologic' Neo-Larynx, created from the patients own tissues, for tracheo-oesopharyngeal phonation.

I am of the opinion that if a Neo-Larynx is constructed from the upper parts of the patient's own trachea and oesophagus without using any extraneous synthetic material, the patient would be happy to learn that the new voice box has been created out of his own tissues and no extraneous foreign material has been implanted and left in his body and he can effortlessly phonate 'tracheo-oesophageally' instantaneously after removal of the silastic sheet from the Neo-glottis five weeks after the operation without any rigorous training and the voice is better than the conventional alaryngeal 'pharyngo-oesophageal' one after total laryngectomy. Moreover, the complications associated with the prostheses viz. fungal and bacterial invasion with subsequent leakage around it and its displacement, and the

tedious maintenance and replacement problems can be obviated by providing the patient with a 'biologic' Neo-Larynx of viable tissues.

Therefore, my present paper will deal with the construction of Neo-Larynx after conducting experiments on animals. In the Neo-Larynx, a Neo-Epiglottis (hitherto not reported in the literature to my knowledge) and a Neo-Glottis are ingeniously constructed in order to enable the laryngectomee to phonate tracheo-oesophageally (c.f. pharyngoesophageally). The Neo-Glottis is transversely disposed since it offers better protection against aspiration than the vertically disposed one. The Neo-Epiglottis is constructed from the posterior tracheal wall, inferiorly based, or from the superiorly based tongue-shaped flap, raised from the full-thickness membranous posterior tracheal wall, or from the anterior tracheal wall, folded posteriorly (as in 'Duck-Bill' Neo-Larynx), for preventing aspiration through the Neo-Glottis into the tracheo-bronchial tree during deglutition. In addition, a statico-dynamic sphincter or sling, reminiscent of the original primitive one, has been constructed around the Neo-Larynx, utilizing the strap muscles of the neck, in order to bring about competency of the Neo-Larynx for preventing aspiration through the Neo-Glottis. By this operation the problems of aspiration and stenosis of the Neo-Glottis have been largely solved. The Neo-Glottis is constructed in a transverse slit in the anterior oesophageal wall in a protective gutter in the anterior wall of the oesophageal lumen and the inferior lip of the slit is reinforced with a small cartilage bar in order to make it a stiff neo-vocal cord for producing stronger and

better voice than pharyngo-oesophageal one which (i.e. tracheo-oesophageal one) is akin to normal voice. Presumably, the sphincter influences the voice quality by its continuously changing tension. The upper end of the trachea is closed to form a cul-de-sac and the phonetic stream is stopped here and channelised through the only available outlet i.e. the tracheo-oesophageal fistula (Neo-Glottis) into the oesophagus and pharynx for articulation.

The latest proposed procedure is easier than the previous ones in which a biologic 'Duck-Bill' Neo-larynx is constructed from the upper parts of the trachea and oesophagus. Neo-Epiglottis and Neo-Vocal cords are incorporated in this. The Neo-Glottis is situated in the trachea anterior to the tracheo-oesophageal fistula. In this there are two additional phonatory mechanisms through which the phonetic stream passes :

- a) The two tracheal flaps, projecting into the oesophageal lumen, vibrate during phonation.
- b) Pseudoglottis at cricopharyngeus level.

It is presumed that these, by producing harmonics, enrich the voice produced by the Neo-Glottis. Voice would be good with inflectional patterns and aspiration and stenosis problems would be significantly minimized.

INTRODUCTION

In this report I humbly present a distillation of the learning process with regard to construction of a biologic Neo-larynx for alaryngeal phonation after total laryngectomy, extending over a period of two decades and conclusions derived from it for the readers' criticism towards improving our research for a better understanding and solution of this very difficult problem of rehabilitation of the laryngectomee. Voice is the mirror of soul and speech is the music of language. Neo-Larynx tends to offer both.

In our studies on whole-organ serial sections of the removed larynxes (Deka et al, 1974, 1974,

1976, 1977 & 1979), and in others (Delhaunty, 1969); Kirchner, 1969 & 1977; Norris, 1970) it has been found that though there are good barriers against spread of cancer viz. conus elasticus, perichondrium, ligaments and membranes, lymphatics and mucous glands, especially in the vicinity of the anterior commissure ligament, there is often invasion of the pre-epiglottic space, para-glottic space, the opposite vocal cord through the anterior commissure and subglottic larynx and therefore majority of the cases who present themselves quite late in our country, require total laryngectomy. It has also been shown that glandular spread from the supraglottis and glottis may involve the subglottic region (Deka et al, 1976). And so following total laryngectomy postoperative rehabilitation offering alaryngeal phonation, assumes an important and indispensable aspect in the management.

Vocal rehabilitation after total laryngectomy is a problem for the laryngectomee who is already deprived of his priceless phonatory organ, a unique gift given to human beings, and consequently often goes into a state of profound depression which contributes towards delayed and unsatisfactory development of alaryngeal speech which compounds the psychological problems leading to lack of motivation. At best only 50-60% of the laryngectomees develop pharyngo-oesophageal phonation. The rest have to use some voice prosthesis or an electrolarynx.

Considering the fact that laryngeal function of phonation is largely redundant as evidenced by the acquired ability to speak even after total laryngectomy, it was felt that substitution of such an organ, with an acquired and overlaid function of speech over the original vital sphincteric function of protecting the lungs, is possible by offering the patient a 'Biologic' Neo-Larynx. In lower animals there is a rudimentary larynx which has a sphincteric function only for protection of the lower respiratory tract; but no phonatory one. With the evolution, phonatory larynx has appeared and the function of

phonation has been overlaid on the vital protective function. Likewise, speech, the most complicated semi-automatic acquired function of the human brain, is an overlaid one. No one is a born speaker; one has to acquire and develop it. This process is intimately associated with the development of phonatory function and therefore both have a lot of redundancy. Perhaps, these aspects tend to substantiate the concept that the originally 'dispensable' larynx, which is to develop into the latter varieties of phonatory larynx with secondarily acquired redundant function of phonation, is amenable to substitution and or modification more easily by constructing an organ with a simpler function viz. the Biologic 'Neo-Larynx' for phonatory purpose than an organ with the primary vital function of phonation.

"Just for heuristic purposes" as Wind (1976) expressed, "We may extend our fantasy into the realm of pure science-fiction of transplanting a chimpanzee larynx on to a human individual while the nervous control would remain human which, perhaps, would one day be a reality". Till then, substitution of the 'sick' cancerous larynx by an autogenous biologic 'Neo-Larynx' following total laryngectomy offers the best answer for developing alaryngeal 'Tracheo-oesophageal' speech (c.f. conventional Pharyngo-oesophageal one Ghosh, 1977).

Several prosthetic devices have been used with benefit for developing alaryngeal speech (Czerny, 1870; Gussenbauer, 1874; Czermak, 1889; Mackenty, 1926 & 1929; Bell Laboratories, 1959; Singer, 1979 & 1981; Panje, 1981 & 1983; Blom, 1982; Shapiro & Ramanathan, 1982); but these are in the process of improving towards perfection with a view to preventing complications and easy usability by the laryngectomee.

The basic principles of phonosurgery as applied to the laryngeal mechanism or palatopharyngeal incompetence, are : (1) Construction of a complete stop, static or dynamic, in the phonetic

passage at the upper end of the phonetic tract i.e. trachea or palatopharyngeal isthmus and (2) Properly channelising the phonetic stream through the Neo-glottis or away from the modified palatopharyngeal isthmus through the mouth (Ghosh, 1980) (Fig.1). The phonosurgery for palatopharyngeal incompetence is outside the domain of the present paper. It is just mentioned because the same diagram (Fig.1) is applicable to both.

Fig.1:

P.S. – Phonetic stream VS – speaking valve S – Stop

It is essential that after total laryngectomy, a procedure has to be adopted by which the airway and the pharynx or oesophagus are to be reconnected by constructing a fistula which was realised long back (Gussenbauer, 1874, Guttman, 1932). Subsequently many a surgical technique has been mentioned (Conley, 1958 & 1959; Asai, 1972; Miller, 1967; Montgomery, 1968; Taub & Spiro, 1972; Calcaterra & Jafek, 1971; Staffieri, 1969; Arslan & Serafini, 1971; Vega, 1975; Amatsu, 1977; Pearson, 1980; Tiwari, 1982; Ghosh, 1977 & 1986). They all have the problems of stenosis and or aspiration.

SURGICAL PROCEDURES (Chronological Description)

Keeping these in view I had contemplated seven surgical procedures as an otolaryngologist-artist's perspective for constructing a biologic Neo-Larynx after total laryngectomy in 1974 and reported later (Ghosh, 1980). Prior to that I had modified ASAI Laryngoplasty by inserting tiny pieces of cartilage bars in the lateral walls of the skin tube to make the pseudoglottic margins rigid so that the voice was made better (Ghosh, 1974). This was 'tracheo-dermo-pharyngeal' phonation. This operation has largely been abandoned for various reasons especially, subsequent development of stenosis and obstruction by growth of hair in the dermal conduit.

The following is the account of a varieties of

Fig. 2:

Animal experiment: Oesophagus opened up from anterior aspect and the cut margins retracted laterally showing the lumen. Needle-in the Neo-Glottis. Pointer (P)-Anterior tracheal wall.

operations, successively performed since 1976, in an attempt at improving the technique for preventing stenosis of the neo-glottis and aspiration of food into the lungs during deglutition.

With these in view an experimental surgical procedure was performed on dog (Ghosh 1976) which gave me requisite confidence that the same was feasible on human beings (Fig. 2). In the dog, after total laryngectomy under general anesthesia, a Neo-Larynx was constructed from the upper parts of the trachea and oesophagus with a vertically disposed Neo-Glottis, retaining the epiglottis for protecting the lower respiratory tract from aspiration through the Neo-glottis into the lungs during deglutition.

In this experiment for constructing an autogenous

Fig. 3:

Lateral view of Vertical Tracheo-oesophagoplasty H-Hyoid bone. E-epiglottis, HP-Anterior Hypopharyngeal wall above Neo-Glottis. NG1-Neo-Glottis (Staffieri). NG2-Neo-Glottis (Ghosh) T- Trachea. TT-Tracheostomy tube. O-Oesophagus.

biologic Neo-Larynx (Ghosh, 1976) after total laryngectomy, a one-state procedure was devised, unaware of Staffieri technique. Great men think alike; but as an exception, sometimes a great and a small man may think alike. Staffieri, the great man, and Ghosh, the small man, thought alike without being aware of each others work since the author did not have access to the non-

Fig. 4:

Vertical Tracheo-Oesophagoplasty (front view): PD-Pharyngeal defect, NG-Neo-Glottis. EM-Everted mucosa. E-Free edge of Neo-Vocal cord (mucosalined). O (AS)-Oesophagus (anterior surface). ST-stitch. CB-Cartilage bar. PWT-Posterior Wall of trachea. SM-Slant cut margin of upper end of trachea. A-Anterior and P-Posterior walls of trachea. A1 & P1-Upper and lower ends of Neo-Glottis., L-Anteroposterior diameter of trachea.

English literature in which Staffieri had reported his operation. In this, after a preliminary tracheostomy, I performed a total laryngectomy retaining the suprahyoid part of the epiglottis, attached to the hyoid bone (Fig.3). A vertical slit was made in the anterior wall of the hypopharynx or oesophagus after separating the upper part of the trachea from the oesophagus for better and easy manipulations and two cartilage bars, procured from the ala of the thyroid cartilage (in humans from the unaffected side), was incorporated in the margins of the slit and covered with everted oesophageal mucosa which was intended to form the Neo-glottis (Fig.4). The obliquely cut trachea (anterior wall longer than the posterior one) was then swung posteriorly and

stitched to the anterior wall of the hypopharynx or oesophagus, as the case may be, so that the vertical slit with the cartilage bars (Neo-Glottis)

Fig.5:

SVE-Supra vallicular epiglottis. EC-Epiglottic Cartilage.

Fig.6:

SVE-Supra vallicular epiglottis. PM-Pharyngeal mucosa. O-Anterior Oesophageal wall, NE-Neo-Epiglottis. TS-Transverse slit in anterior oesophageal wall with the tip of artery forceps in TS. (At operation).

lay within the circumference of the upper cut margins of the trachea (Fig-3 & 4). The air (Phonetic stream) from the trachea was meant to enter the oesophagus/hypopharynx through the Neo-Glottis for final articulation. The dog had postoperative husky barking.

The same was then performed on a human, suffering from adenocarcinoma of the larynx (Ghosh, 1976) using cartilage bars, harvested from preserved septal cartilage, but there was post-operative aspiration during swallowing because the hanging suprahyoid epiglottis apparently could not offer adequate protection to the Neo-Glottis and the Neo-Glottis did not have a sphincteric function. Voice, though husky, was fair and the tracheo-oesophageal speech was loud, strong, and intelligible. But he died of multiple distant metastases within one month. My subsequent experience with this operation was unsatisfactory and therefore I have given up this procedure. Here the Neo-Glottis has a vertical disposition in the slant coronal plane (Fig.3B) whereas in Staffieri's, a horizontal one (Fig.3A) with expected more aspiration than in the former. In the latter (Fig-3A) the foodstuff hits the Neo-Glottis directly; but in the former (Fig.3B) the same simply glides down over the Neo-Glottis because of its slant with expected less aspiration.

Fig.7:

NE-Neo-Epiglottis. SpV-Speaking valve. T-Trachea. F-Fenestra in tracheostomy tube. SS-Silastic sheet, NG-Neo-Glottis with slant. TS-Transverse slit in anterior oesophageal wall.

Fig.8:

SV-Supravallecular epiglottis. PM-Pharyngeal mucosa. SC-Scissors. O-Oesophagus. TS-Transverse slit. T.SC-Tip of artery forceps. NE-Neo-Epiglottis (diagrammatic representation of Fig-6)

After a good deal of thought, another operation was designed (Ghosh, 1977) for construction of a Neo-Larynx with transversely disposed Neo-Glottis, protected by the suprahyoid part of the epiglottis which was left attached to the vallecular mucosa only (Fig. 5 & 6) and a Neo-Epiglottis, created from the posterior tracheal wall (Fig. 7). Thus the Neo-Glottis, was protected by a two tier mechanism viz. a) suprahyoid epiglottis above and b) Neo-Epiglottis below (hitherto not mentioned in the literature to my knowledge). At direct hypopharyngoscopy at a later date, the epiglottis, only attached to the vallecular mucosa, was found to be healthy. The Neo-Epiglottis, constructed from the posterior wall of the trachea, was inserted into the oesophagus through a transverse slip in its anterior wall (Fig.6, 7B & 8). Below this another transverse slit was made in the tracheo-oesophageal partition wall obliquely in such a way that the anterior lip of the cut is at a higher level than the posterior one (Fig.7 & 9)

Fig.9:

CDS-Cul-de-sac. O-Oesophagus. TE-Tracheo-Oesophageal partition wall. LM-Longitudinal muscle. CM-Circular muscle. NG-Neo-Glottis. F-Fenestra. TT-Tracheostomy tube. T-Trachea. St-Stitch. Direction of contractions of muscles.

which would eventually become the 'valvular' Neo-Glottis. A silastic sheet was inserted into this Neo-Glottis and retained there for five weeks (Fig. 7A). This slant was meant to ensure protection from aspiration into the trachea during swallowing because of its valvular mechanism in which the longer posterior lip jams shut on the slant anterior lip when the food simply glides down over it. Moreover, it was proposed that circular and longitudinal muscle fibres of the oesophagus act as a sphincter to close the Neo-Glottis (Ghosh, 1984) during deglutition (Fig.9). The circular fibres, situated posterosuperior to the Neo-Glottis, contract and swell up thereby actively moving the upper lip anteriorly and inferiorly towards the lower one and the posterior tracheal wall, thus closing it and those, anteroinferior to the Neo-Glottis, swell up pushing the lower lip posteriorly and superiorly thus closing it actively (Fig. 9). The unsevered longitudinal fibres on either side of the Neo-Glottis contract thereby shortening the length of the oesophagus which brings the segments of

Fig.10:

Lateral skiagraph of neck at rest (R) showing air shadow (discontinuous) in trachea & hypopharynx.

oesophagus above and below the Neo-Glottis, closer to each other thereby actively bringing about tighter closure between the upper and lower lips closing the Neo-Glottis completely (Fig.9). After five weeks the silastic sheet was removed and the patient asked to phonate and he did so instantaneously with immense pleasure. At rest and on tracheo-oesophageal phonation the skiagraphs showed discontinuous and continuous phonetic stream respectively (Fig.10 & 11) with the cricopharyngeal bulge posteriorly acting as the pseudoglottis. So in this operation two phonatory mechanisms were there, one lower i.e. the Neo-Glottis and one upper i.e. the pseudoglottis, much like the true and the false cords in the normal larynx. For phonating one can gently close the tracheostomy tube with a finger-tip or use a tracheostomy tube with a speaking valve. It is heartening to note that the laryngectomee could phonate with minimal

Fig.11:

Lateral skiagraph of neck: Continuous air shadow during phonation. P.S.—Phonetic stream. P—During phonation. CB—Cricopharyngeal bulge.

training instantaneously after removal of the silastic sheet from the Neo-Glottis. In this procedure adequate surgical ablation including the pre-epiglottic space with or without radical neck

Fig.12:

PWT—Posterior wall of trachea. FM—Mucosal flap. NG—Neo-Glottis. RA—Raw area left after raising FM. T—Trachea. O—Oesophagus. SS—Silastic sheet. TE—Tracheo-oesophageal partition wall. TrS—Tracheostome.

dissection was ensured and at the same time a good functional rehabilitation was offered without compromising the principles of cancer surgery i.e. to be on the overdoing side rather than on the underdoing one in an irresistible futile attempt at retaining the function of the 'sick' cancerous larynx (Ghosh, 1977). But in this case an undesirable sequela of stenosis of the Neo-Glottis, developing after initially acquiring acceptable phonation, was encountered in a number of cases. This was extremely depressing for the patients and more so in them who developed phonation than in those who did not acquire a satisfactory and acceptable tracheo-oesophageal phonation at all after operation. And alas, Nature is so capricious that when one desires to keep an opening patent it closes and vice versa. Another relevant fact, as mentioned by Goldstein (1981), is that "In too many cases a fistula large enough to allow adequate speech facilitates aspiration, which some times is life threatening. Those fistulae, not complicated by this problem, are usually too stenotic to allow adequate speech". Similar has been my experience.

In order to solve the problem of stenosis of Neo-Glottis a modification of the above procedure

Fig.13:

PWT—Posterior wall of trachea. NE—Neo-Epiglottis raised from PWT. TrS—Tracheostome. T—Trachea. TS—Transverse slit in anterior oesophageal wall. ET—Endotracheal tube. F—Fenestra in ET. O—Oesophagus. AT—Anchoring stiches. AWO—Anterior wall of oesophagus.

was introduced (Ghosh, 1984). The anterior tracheal wall was split open by an oblique incision extending from the upper cut margin downwards. This incision with obliquity was thought to prevent development of subsequent stenosis as reported earlier (Ghosh, 1984). The margins were retracted by a self-retaining retractor. Two oblique mucosal flaps, one superiorly based with 'finite' blood supply and the other inferiorly based with 'infinite' blood supply were raised from the posterior tracheal wall after infiltrating submucosally with normal saline and 1 in 100000 epinephrine solution (Fig.12) and introduced into the transverse slit in the anterior oesophageal wall (meant to be the Neo-Glottis) and the silastic sheet was inserted between the two (Fig.12). Then the tracheal wound was closed with extraluminal 3-0 vicryl stitches. The procedure is technically difficult but amply rewarding. This procedure has reduced the incidence of stenosis of the Neo-Glottis to a certain extent.

With a view to minimizing the vexing problem of stenosis, another new operation was developed (Ghosh, 1986). In this operation, after total laryngectomy, preferably supracricoid, when feasible, the trachea was separated from the oesophagus by blunt and sharp dissections upto about 1/2 cm. above the tracheostome. For constructing a Neo-larynx a long supratracheostomal trachea is required (Viz. by performing supracricoid laryngectomy as described by Kitamura, 1970). A slightly curved transverse incision of 4-5 mm (with concavity above) was made in the membranous posterior tracheal wall comprising its whole width without injuring the cartilage bars through its entire thickness about 2.5 cm. below the upper cut margin of the trachea and was extended vertically upwards on either side to raise a superiorly based tongue-shaped flap stopping short at about 1 cm. below the upper cut margin of the trachea (Fig.13). This was meant to be the future Neo-Epiglottis. An anchoring silk stitch is applied to the lower end of the Neo-Epiglottis. The trachea was then retracted anteriorly. An endotracheal

Fig.14:

NG-Neo-Glottis. UCM-Upper cut margin of transverse slit. ET-Endotracheal tube. F-Fenestra. CB-Cartilage bar. St-Stich. NE-Neo Epiglottis. MF-Mucosal flap. AWO-Anterior wall of oesophagus. PWT-Posterior wall of trachea. LM-Lower cut margin in PWT after raising the NE. OM-Oesophageal mucosa. NE (EO)-Extra-oesophageal and NE (IO)-Intra-oesophageal parts of NE.

Fig.15:

AT-Anchoring thread. PWT-Posterior wall of trachea. AWO-Anterior wall of oesophagus. NE-Neo-Epiglottis inserted into the oesophagus. G-Gap left after raising NE. SL-Superior lip of transverse cut in anterior oesophageal wall and IL-Inferior lip. NG-Neo-Glottis. O-Oesophagus. T-Trachea.

tube was fenestrated and passed from above through the crico-pharyngeal ring into the oesophagus with the fenestra looking forward (Fig. 13). A transverse incision of about 4 mm was made through the anterior wall of the oesophagus into its lumen at the level of the base

of the Neo-Epiglottis. The incision is made over the fenestra of the indotracheal tube in order to avoid injury to the posterior oesophageal wall (Fig.13). Two anchoring silk stitches were applied to the anterior oesophageal wall, just lateral to the ends of the transverse incision (Fig.13). A small cartilage bar (4 mm long and 2 mm thick) was cut out from the thyroid ala of the unaffected side or from a preserved nasal septal cartilage and was placed on the anterior oesophageal wall transversely just below the transverse incision (Fig.14). The oesophageal mucosa was everted out from inside the lumen and brought over the cartilage bar (Fig.14) and stitched to the anterior oesophageal wall with 3-0 vicryl (Fig.14), thus

Fig.16:

CDS-Cul-de-sac. St.-stitch. PWT-Posterior wall of trachea. AWO-Anterior wall of oesophagus. NG-Neo-Glottis. NE-Neo-Epiglottis. RS-Raw surface of NE. M-Mucosal surface of NE. G.-Gap in posterior tracheal wall after raising NE. PS-Phonetic stream. LM-Lower cut margin of G. F-Fenestra. T-Trachea. O-Oesophagus. AT-Anchoring thread. TS-Transverse slit in anterior wall of oesophagus. NE-inserted into oesophagus (View from front)

completely submerging the bar under the mucosa. Here I use the operating microscope. This would be the reinforced rigid lower margin of the Neo-Glottis (transverse cut) and was meant to offer a stronger voice. The anchoring thread of the Neo-Epiglottis is now passed through the transverse cut into the oesophageal lumen (Fig.15) and caught with a long artery forceps, passed through the fenestra of the endotracheal

Fig.17:

Enlarged view of NG: T-Trachea. TM-Tracheal mucosa. UCM-Upper cut margin of transverse slit. LCM-Lower cut margin of transverse slit. NE-Neo-Epiglottis. S-Slant of NE. ML-Mucosa-lined anterior surface of NE. St-Stitch. TMF-Tracheal mucosal flap. PWT-Posterior wall of trachea. AOW-Anterior wall of oesophagus. O-Oesophagus. T-Trachea. TT-Tracheostomy tube. CB-Cartilage bar. OM-Oesophageal mucosa (everted out). RS-Raw surface of NE.

tube. The two anchoring threads of the oesophageal wall are passed through the fenestra in the posterior tracheal wall, left after raising the full thickness flap (Neo-Epiglottis), and recovered in the tracheal lumen and brought out and secured with two artery forceps (Fig.13). A gentle downward pressure was applied on the artery forceps, holding the thread of the Neo-Epiglottis, pushing the neo-epiglottis into the oesophageal lumen while simultaneously negotiating the apex of the neo-epiglottis through the transverse cut in the anterior oesophageal wall, from the anterior aspect, into the oesophageal lumen (Fig. 15 & 16) and at the same time of the above manoeuvres the assistant gently pulled the oesophageal anchoring threads upwards and laterally, thus engaging the lower rigid lip of the transverse cut (Fig.16) against the anterior mucosa-lined surface of the Neo-

Fig. 18:

O-Oesophagus. CDS-Cul-de-sac. T-Trachea. S. H-Sternohyoideus. OH-Omo-hyoideus. St. Stitch. An-anastomosis between right and left strap muscles. NG-Neo-Glottis. TrS-Tracheostome.

Epiglottis (Fig. 17). The transverse slit between the mucosa-lined anterior surface of the Neo-Epiglottis above and the lower mucosalined rigid margin of the transverse cut in the anterior oesophageal wall below would form the Rima Neo-Glottidis (Fig. 16 & 17). The gap in the posterior tracheal wall was thus closed by the anterior oesophageal wall (Fig. 16 & 17). In some cases with patent Neo-Glottis, aspiration was a problem. To bring about a statico-dynamic competency of the Neo-Glottis for preventing aspiration of food-stuff and saliva through it into the tracheo-bronchial tree during deglutition the following procedure was performed: The right strap muscles, omo-hyoideus and sternohyoideus, were cut at their lower ends, below the level of the Neo-Glottis, and passed between the trachea and oesophagus across the midline and recovered on the left side, sternohyoideus above and the omohyoideus below the Neo-Glottis and the cut ends of the muscles on the left side were stitched to each other with 3-0 vicryl (Fig. 18). Another stitch was put between the two muscles on the right side adjacent to the Neo-Glottis, so that a transversely disposed and fairly tight fusiform dynamic sphincter was created around the Neo-Glottis (Fig. 18). The left sternohyoideus and

omohyoideus were isolated, superiorly based, and their lower cut ends anastomosed with the left end of the sphincter with 2-0 vicryl (Fig. 18). Thus the sphincter was suspended from above by the left and right strap muscles. The nerve supplies to these muscles were left intact which was ensured by sectioning them below the level of the ansa hypoglossi. When the hyoid bone is to be removed, the periosteum along with the attached strap muscles are elevated from the bone from midline laterally and after excision of the hyoid and the pre-epiglottic space the periosteum with the attached muscles are stitched to the mylohyoid muscle and the surrounding soft tissues in order to stabilize the upper ends of the strap muscles for the sphincter and the neo-elevators (vide infra) of the Neo-Larynx to act effectively. So when the muscular lips of the sphincter contract during deglutition, they swell up and press on the Neo-Glottis from above and below, thus bringing about competency of the Neo-Glottis which would prevent aspiration.

Fig. 19:

O-Oesophagus. CDS-Cul-de-sac. T-Trachea. SCM-Sterno cleido mastoideus. An-Anastomosis between right & left flaps. PF-Pedicled flap. St-Stitch. NG-Neo-Glottis. TrS-Tracheostome. PF raised superiorly and medially.

Moreover, when the muscles on both sides contract together from above, the Neo-Larynx is elevated under the suprahyoid epiglottis and the bulging base of the tongue during swallowing, acquiring further protection from aspiration. So the laryngeal 'depressors' (the strap muscles) have been converted into Neo-Laryngeal 'elevators'. At the same time this conjoint bilateral muscle contraction pulls the lateral ends of the sphincter laterally, thus tensing its lips and brings about an adduction of the lips of the sphincter which presses on the Neo-Vocal folds of the Neo-Glottis from above and below. Thus the Rima Neo-Glottidis is narrowed and aspiration is further prevented. This action is similar to that of cricothyroideus, the external tensor and the 'tuning fork' of the vocal cords. These above actions contribute towards offering a good voice. Besides the above dynamic factors, there is a static factor which protects the Neo-Glottis. The muscle masses in the upper and lower lips of the sphincter produce transverse bulgings in the anterior wall of the lumen of the oesophagus above and below the Neo-Glottis and the upper one mechanically diverts the food stuff over the Neo-Epiglottis posteriorly while gliding over the Neo-Larynx. This prevents aspiration. The Neo-Glottis and the Neo-Epiglottis are actually situated in the transverse gutter between the superior and inferior bulges (Fig.18) and so are virtually hidden and protected from the down flowing food stuff. When the above muscles are not available, pedicled muscle grafts may be raised from the sternocleidomastoideus (Fig.19). The adjacent tracheal and oesophageal walls were now stitched extraluminally through their walls, to each other with 2-0 vicryl so that relative movements between the trachea and the oesophagus did not take place and consequently, the Neo-Larynx, though created from two organs viz. trachea and oesophagus, became a single organ.

Now, as described earlier, a mucosal flap was raised from the posterior tracheal wall on one side of the fenestra (left after raising the Neo-Epiglottis) after infiltrating with normal saline and

1 in 100000 epinephrine solution submucosally and stitched to the lower margin of the everted oesophageal mucosa with 3-0 vicryl (Fig.17). This covered the raw anterior oesophageal wall, peeping through the fenestra, left after raising the Neo-Epiglottis, which is intended to mucosalise in order to minimize the subsequent development of fibrosis and stenosis. Use of operating microscope is helpful at this stage. The anchoring stitches along with the endotracheal tube was removed. A rectangular silastic sheet of the same width as the Neo-Glottis was passed through the Neo-Glottis from the tracheal side into the lumen of the oesophagus (as in Fig.7) and was left there for about five weeks for preventing adhesions and stenosis of the neo-glottis in course of time. The anterior and upper tracheal end of the sheet was anchored with a 1-0 silk thread which was brought out through the tracheostome and fixed

Fig.20:

DUCK-BILL NEO-LARYNX : St-Stitch. C-Cartilage bar. M-Muscle sling. NG-Neo-Glottis. NE-Neo-Epiglottis. PS-Phonetic stream. TT-Tracheostomy tube. T-Trachea. O-Oesophagus. W-Wedge of lateral tracheal wall. Ant-Anterior. Post-posterior.

to the front of the chest with adhesive strap which would be used later for removal of the sheet. Two wedges were removed from the lateral upper cut margins of the trachea on either side (Fig.7B) and the upper end of the trachea closed with 2-0 vicryl stitches (Fig.16). Thus the tracheal lumen ended in a cul-de-sac at its upper end which would stop

the phonetic stream and channelise it through the only available opening viz. Neo-Glottis (Fig.16). The pharynx was repaired in the usual way after inserting a nasogastric feeding tube. The skin wound is finally closed after putting a drainage tube, one on each side. The patient is put on appropriate antibiotics for two weeks and oral feeds started after ten days after a test feed. The silastic sheet was removed after five weeks by pulling on the thread coming out through the tracheostome. A fenestrated tracheostomy tube, preferably one with a speaking valve, was inserted. The patient was asked to expire and phonate after closing the tube with his finger (if it is an ordinary tube) and to his surprise and joy he did it instantaneously without much training. He was advised to keep on talking, talking and talking which would keep the Neo-Glottis patent.

DUCK-BILL NEO-LARYNX

Another simpler procedure is proposed for construction of 'Duck-Bill' Neo-Larynx which would yield better results. The trachea is cut above the cricoid cartilage or the first tracheal arch while removing the cancerous larynx. The cartilage arches of the tracheal walls and cricoid cartilage are removed upto about 1/2 cm. above the tracheostome. Now it is a mucomuscular trachea which is soft. I call it 'surgical tracheomalacia'. A cartilage bar, preferably straight, harvested from the unaffected thyroid ala of about 1 cm length and 3mm breadth or from a preserved septal cartilage, is placed on the anterior tracheal wall about 1.5cm above the tracheostome and the soft walls of the trachea above and below the bar are pulled anteriorly and stitched to each other over the cartilage which consequently sinks posteriorly towards the tracheal lumen producing a transverse ridge in the anterior wall of the tracheal lumen (Fig. 20B & C). Two small wedges are removed from the lateral walls of the upper end of the trachea resulting in an anterior and a posterior tracheal flaps (Fig.20A) and the upper angled corners are rounded and the flaps are tapered towards the free ends thereby narrowing both the flaps. The posterior flap is made shorter by cutting the upper

end. The lateral edges are stitched to each other with 3-0 vicryl making it a narrow and flat mucomuscular tube in which the anteroposterior diameter is smaller than the transverse one. A transverse incision, slightly smaller than the breadth of the tracheal flaps, is made in the anterior wall of the oesophagus as mentioned earlier and the stitched tracheal flaps are introduced through it into the oesophageal lumen which in the profile looks like a 'Duck-Bill' (Fig. 20B) and hence so named. The tracheal flaps are stitched to oesophagus extraluminally through their walls with 2-0 vicryl in order to retain it in the lumen. A sling is made of the available muscle (vide supra) and inserted between the tracheal and oesophagus from one side to the other which had been separated from each other for about 1.5 cm. below the transverse slit in the oesophageal wall (Fig.20B-M). The trachea and the oesophagus are stitched to each other with 2-0 vicryl for preventing relative movements between them. So the upper ends of the trachea and oesophagus with the Neo-Glottis and Neo-Epiglottis work as a unit i.e. Neo-Larynx. The pharyngeal defect and the skin wound closure are done in the usual way. The patient is asked to phonate after gently closing the tracheostomy tube with his finger after two weeks and he would readily do so. The anterior tracheal flap is longer which overhangs and overlaps the posterior one in the oesophageal lumen (Fig.20B) and acts as the Neo-Epiglottis and prevents aspiration as the food and saliva glide down over it. Moreover, the muscular sling (Fig.20B-M) closes the shunt by pressing upwards from below the tracheo-oesophageal fistula and prevents aspiration. There would be no adhesion and stenosis because both the opposing surfaces of the flaps are mucosalined. The ridges, produced by the incorporated cartilage anteriorly (Fig.20B-C) and the muscle sling posteriorly (Fig. 20B-M) act as the Neo-Glottis and the voice would be good. While phonating, the ends of the tracheal flaps presumably vibrate, producing harmonics and there is the usual pseudoglottis formed by the bulge of the cricopharyngeus muscle in the posterior oesophageal wall, both of which

contribute towards enriching phonation. The lumen of the Neo-Larynx becomes slit-like in the coronal plane because when the flabby mucomuscular trachea is folded posteriorly in the coronal plane while introducing its upper end into the oesophagus, it bends with an angle opening posteriorly thereby bringing the anterior and posterior walls nearly in apposition to each other.

OBSERVATION

20 cases underwent surgery for construction of Neo-Larynx; out of these 10 had transverse tracheo-oesophagoplasty (Ghosh, 1977) and 10 had the operation with Neo-Epiglottis constructed from the membranous posterior tracheal wall (Ghosh, 1984).

The lips of the Neo-Glottis in the 1984 operation were mucosa lined, in contradistinction to those in the 1977-operation (Ghosh, 1977) and so subsequent development of adhesions and stenosis in the 1984 operation are significantly less. Both the lips were rigid, the lower one more so, and hence the Neo-Glottis produced a better and stronger voice. The tracheal flap acted as a Neo-Epiglottis (Fig.17) which protected against aspiration of foodstuffs into the trachea during swallowing. Aspiration occurred in 2 cases. Stenosis and aspiration never occurred together in any of our cases as expected. In one case, even during vomiting, there was no aspiration presumably owing to the presence of the competent muscular mechanism in the oesophageal wall as explained earlier (Ghosh, 1984) (Fig.9). Besides, the dynamic circum-neolaryngeal sphincter and the static bulges produced by the muscle masses in the anterior oesophageal wall above and below the Neo-Larynx offered an effective statico-dynamic protection preventing aspiration through the Neo-Glottis into the tracheobronchial tree. So, aspiration was insignificant and it was not incapacitating since the patients could manage to swallow with occasional minor aspirations. In two cases aspiration was profuse and the fistula had to be closed by using pedicled sternomastoid

muscle flap as reported earlier (Arjun Dass et al, 1988). Immediately after removal of the silastic sheet from the Neo-Glottis the patient could phonate without any training and much exertion in contrast to what a patient has to do in course of developing pharyngo-oesophageal speech. The lateral soft tissue neck x-ray, taken five weeks after the operation, showed the enlarged air column in the oesophagus which is continuous with the phonetic stream during phonation (Fig.11). It is heartening to observe that the patients were very happy after they learnt that no extraneous inert synthetic material had been implanted and left in his body and his post-operative voice box had been created from his own tissues.

The latest operation (Duck-Bill Neo-Larynx) is simpler and here the anterior (superior one in the oesophageal lumen) longer lip of the mucomuscular trachea, projecting into the oesophageal lumen and overlapping the posterior one (inferior one in the oesophageal lumen) works as a Neo-Epiglottis, effectively preventing aspiration and the incorporated cartilage, which produces a transverse ridge in the anterior tracheal wall above the tracheostome, alongwith the bulge in the posterior wall of the trachea, produced by the muscle sling, acts as the Neo-Glottis (Fig.20). The walls of the tracheo-oesophageal shunt are mucosa lined and adhesion and stenosis are not likely to occur.

DISCUSSION

These (1986 one and the Duck-Bill Neo-Larynx) are comparatively simpler operations than the previous ones (Ghosh, 1976 and 1977) in which Neo-Epiglottis (hitherto not mentioned in the literature to my knowledge) and a Neo-Glottis are ingeniously constructed. The patient develops 'Tracheo-oesophageal' alaryngeal phonation (c.f. conventional pharyngo-oesophageal one) instantaneously after removal of the silastic sheet from the Neo-Glottis and does not have to undergo any strenuous and grueling training as is necessary for developing pharyngo-oesophageal phonation which often leads to

severe depression and lack of motivation. About 40% to 50% of the laryngectomees fail to develop the latter and the depression is compounded. In this operation, if the Neo-Glottis is patent, 100% of them develop good intelligible speech. Incorporation of a cartilage bar in the lower lip of the Neo-Glottis that works in apposition with the mucosa-lined anterior surface of the Neo-Epiglottis offers a stronger and better voice, akin to normal one, than that without the bar (1977 operation of Ghosh) and pharyngo-oesophageal one. In the latter, whether the bulky cricopharyngeal muscle mass with its blunt edges (c.f. sharp ones of vocal cords) is set at vibration or phonation occurs on the principle of air passing through the narrow aperture of an organ i.e. oesophageal phonetic stream, while passing through the narrow aperture in the cricopharyngeal sphincter, produces the sounds, the voice is quite husky and weak. Female patient with this voice develops an unpleasant complex. In general the laryngectomee is so happy and excited to phonate with the Neo-Larynx without much effort that the factors of depression and lack of motivation are almost completely eliminated. The tracheo-oesophageal phonation is more physiological than the conventional pharyngo-oesophageal one in that the patient uses his normal bellows for producing the phonetic stream, the pressure of which is much higher (15-25 cm. water in normal conversation and about 95 cm water during loud shouting) and is more easily produced than the one produced in the oesophagus which in that case acts as a weak pseudolung. It requires production of a very high positive pressure in the oesophagus to the extent of about 100 cm of water or more to vibrate the cricopharyngeal muscle-mass ring and to overcome the resistance at the cricopharyngeal aperture. I believe, hypothetically it may, though very rarely, lead to spontaneous oesophageal rupture. The voice quality of the Neo-Larynx is akin to the normal laryngeal one and is not monotonous unlike the pharyngo-oesophageal one, presumably because of the presence of incorporated cartilage bar in the lower lip of the

Neo-Glottis and the dynamic sphincter around the Neo-Larynx with its continuously changing tension. The former makes the Neo-Glottis stiffer which offers a stronger voice than pharyngo-oesophageal one. In Duck-Bill Neo-Larynx the tracheal flaps in the oesophagus vibrate during phonation and produce harmonics, enriching the voice. The tracheo-oesophageal speech is more or less continuous, comparable to the normal one, with good inflectional quality unlike the periodically interrupted, monotonous and dead pharyngo-oesophageal one and the laryngectomee gets easily exhausted to produce the latter in contrast to the former. Associated expiratory snort and the gulping noise that are quite often present in pharyngo-oesophageal phonation are conspicuously absent in tracheo-oesophageal speech.

Even some patients can sing to their pleasure. The pseudoglottis at the cricopharyngeal level above the Neo-Glottis, perhaps, also enriches the voice. Phonetic studies would help understand this aspect.

Introduction of mucosa-lined lips in the Neo-Glottis tends to prevent formation of adhesion and stenosis, though I do not dare to claim that

Fig.21:

Oesophagus-Front view: LM-Longitudinal muscles. CM-Circular muscles. NG-Neo-Glottis. O-Oesophagus.—Direction of muscle contraction.

the present procedures are fool proof. Stenosis was a very difficult sequela in a number of cases who underwent transverse tracheo-oesophagoplasty (Ghosh, 1977). But no case with Duck-Bill Neo-Larynx is likely to develop stenosis. Because of the unequal lengths of the tracheal flaps, projecting into the oesophagus, the free cut margins were at different positions viz. the superior (anterior) one i.e. Neo-Epiglottis is situated posterior and superior to that of the lower (posterior) one and therefore the raw margins are not apposed to each other. Hence adhesions and stenosis can not take place. It is heartening that in cases of post-operative stenosis of the Neo-Glottis the subject is still left with the option of practising and developing pharyngo-oesophageal voice or being provided with a voice prosthesis or electrolarynx.

Aspiration problem has been minimized by creating a statico-dynamic mechanism viz. bulges above and below the Neo-Epiglottis and Neo-Glottis, providing the 'static' hindrance, and the dynamic muscle sphincter around the Neo-Larynx, the 'dynamic' hindrance to aspiration of food stuff and saliva through the Neo-Glottis into the tracheo-bronchial tree during deglutition. If the sternohyoid and omohyoid muscles are not available, pedicled flaps from sternocleidomastoideus (Fig.19) can be utilized.

These operations can be performed even after radical neck dissection with some modifications, if necessary, and so the principles of cancer surgery is not compromised (Ghosh, 1977). But the operation is not suitable in cases with subglottic cancer where adequate length of the supratracheostomal trachea is not available after laryngectomy for construction of the Neo-Larynx. No grave complications viz. mediastinitis or cervical fascitis was come across inspite of extensive cervical dissection and separation of the trachea from the oesophagus.

One may ask as to why there are so many procedures and so frequent changes in my techniques of construction of Neo-larynx. This is because the surgeon should have and has to

acquire parallel dynamism consistent with the most dynamic semi-automatic functions of phonation and speech of the human brain. Phonation is a very dynamic function as to loudness, pitch, breathiness, softness/hardness, pleasantness/unpleasantness, continuous/discontinuous voice, sudden outbursts, sudden stops, cadences and nuances and associated unwanted expiratory snorts and gulping noise which is subserved by the most dynamic phonation and speech brain. Dynamism is quintessential. The surgical odyssey continues. Perhaps, one day this surgical dynamism will hopefully cease once the final solution is achieved. It is obvious from the above account that the existing operations are not fully satisfactory and so there are proliferations of surgical techniques. Hence, it is expected that the Duck-Bill Neo-Larynx will eventually survive to the satisfactions of the patient and the surgeon.

The next question is why I changed from the vertical Neo-Glottis to the transverse one? In vertical one the contractions of the circular oesophageal muscle fibres tend to pull the margins of the Neo-Glottis apart (Fig.21) and the longitudinal fibres, lateral to the neoglottis, shorten and relax the Neo-Glottic margins leading to bowing (Fig.21A) and both working synergistically tend to widen the neoglottis, facilitating aspiration during deglutition. In transversely disposed Neo-Glottis, the circular muscle fibres contract and the two lateral ends of the Neo-Glottis are pulled laterally thus tensing and adducting its margins closing the rhima Neo-Glottidis (Fig.21B), comparable to the function of the cricothyroid muscles. The longitudinal muscle fibres, lateral to the Neo-Glottis, pull the margins to each other achieving the same (Fig.21). Thus the overall action i.e. of the muscular sphincter or sling and the intrinsic muscles of the oesophagus is to close the rhima and prevent aspiration. Moreover, the Neo-Glottis is situated and hidden in a transverse gutter between the superior and inferior elevations, produced by the muscles of the sphincter which offers the static protection while the former, the dynamic one.

There is a ray of hope of perfection i.e. providing the laryngectomee with a 'Biologic' Neo-Larynx without the sequelae of aspiration and stenosis with good voice. I may be permitted to quote the words of Craik, "The importance of a theory lies not in the degree of finality attained by definition and analysis, but in the power of grasp of general principles appearing in diverse instances".

Seeman (1926) opined about the use of synthetic (artificial) larynx as follows : "All are merely prostheses, the use of which must serve to remind the patient constantly that he is not well. The wearing of them is embarrassing, often

burdensome and sometimes impractical". This is not true in the patients with biologic Neo-Larynx who feel that he is well and has voice box of his own.

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References

1. Amatsu M, Matsui T, Maki T, Kanagawa K, (1977) : Vocal reconstruction after total laryngectomy : A new one-stage surgical technique. *J. Otolaryngology* 80 : 779.
2. Arslan M, Serafini I (1972) : Restoration of laryngeal function after total laryngectomy, report on first 25 cases. *Laryngoscope* 82:1349.
3. Asai R (1972): Laryngoplasty after total laryngectomy. *Arch. Otolaryngol* 95:114.
4. Bell Laboratories (1959) :New artificial larynx. *Trans Am Acad Ophthalmol Otolaryngol* 63:548.
5. Blom E.D., Singer M.L., Hamaker R.C (1982): Tracheostoma valve for post laryngectomy voice rehabilitation., *Ann Otol Rhinol Laryngol* 91: 576.
6. Calcaterra T.C, Jafek B. W (1971): Tracheo-oesophageal shunt for speech rehabilitation after total laryngectomy. *Arch. Otolaryngol* 94; 124.
7. Conley J. J, De Amesti F, Pierce J. K (1958): A new surgical technique for the vocal rehabilitation of the laryngectomized patient. *Ann Otol Rhinol Laryngol* 67:655.
8. Conley J. J. (1959) :Vocal rehabilitation by autogenous vein graft. *Ann Otol Rhinol Laryngol* 58: 990.
9. Czermak J (1959): Ueber die Sprache bei luftdichter versch liessung des Kehlkopfes. *Sitzungsb K Akad Wissensch Math Natur C1*. 35:65.
10. Czerny V (1870): Versuche Ueber Kehlkopiexstirpation. *Wein Med Wochenschr* 24:557.
11. Deka Ramesh C, Subimal Roy, S. K. Kacker, P. Ghosh, U. Sharma (1974): Evaluation of biological potential of laryngeal carcinoma by whole organ serial section – a preliminary report. *Indian J. Otolaryngol* 26:11.
12. Deka Ramesh C, S. K. Kacker, P. Ghosh (1974): Some inferences from the study of whole organ laryngeal serial section in cancer of larynx and laryngopharynx. *J. Otolaryngological Soc. Australia* 3:633.
13. Deka R.C., Kacker S. K., Roy Subimal, Ghosh P (1976): Glandular theory of cancer spread in the larynx, *Ind. J. Otolaryngol* 28:115.
14. Deka R. C., Ghosh P, Kacker S. K (1977): Supraglottic horizontal partial laryngectomy. *Ind. J. Otolaryngol* 29:58.
15. Deka Rames C, Santosh K. Kacker, Patit P. Ghosh, Subimal Roy (1979): Whole organ sections of the larynx and hypopharynx. *Ear, Nose & Throat Journal* 58:53.
16. Delhaunty J.E, Nassar V. H (1969): Application of total organ laryngeal section. *Arch Otolaryngol* 90:342.

17. Ghosh P (1974): Asai Laryngoplasty. *Indian J. Otolaryng* 26:35.
18. Ghosh P (1976): Vertical tracheo-oesophagoplasty. *Ind. J. Otolaryng* 28:164.
19. Ghosh P (1977): Transverse tracheo-oesophagoplasty. *Journal of Laryngol & Otol* 91:1077
20. Ghosh P (1980): Phonosurgery (Tracheo-oesophagoplasty). *Bihar J. Otolaryngol* 1:29.
21. Ghosh P (1980): Phonosurgery (Combined Approach Palato-pharyngo plasty 'CAP'). *J. Laryngol & Otol*, 94:1165.
22. Ghosh P (1984): Modification of Transverse Tracheo-oeso-phagoplasty (Construction of a Neo-Larynx). *Ind. J. Otolaryngol* 36:103.
23. Ghosh P (1986): A new operation for construction of Neo-Larynx. *Ind. J. Otolaryngol.* 38:64.
24. Goldstein J. C. (1961): Update on voice restoration following total laryngectomy. *Trans Am Laryngol Assoc.* 102:129.
25. Gussenbauer C (1874): Ueber die erste durch Th. Billrotham Menschen ausgefuehrte Kehlkopf-Extirpation und die Anwendung eines Kuentstlichen Kehlkopfes. *Arch K Chri* 17:343.
26. Guttman M.R (1932): Rehabilitation of voice in laryngectomized patients. *Arch. Otolaryngol* 15:478.
27. Kirschner J. A (1969): One hundred laryngeal cancers studied by serial section. *Ann. Otol. Rhinol. Laryngol* 78:689.
28. Kirschner J.A (1977): Two hundred laryngeal cancers : Patterns of growth and spread as seen in serial section. *Laryngoscope* 87:474.29.
29. Kitamura T, Kaneko T, Togawa K, Unno T (1970): Supracricoid Laryngectomy. *Ann Otol Rhinol Laryngol* 79:1027.
30. Mackenty J.E (1926): Cancer of the larynx. *Arch Otolaryngol* 3:205.
31. Mackenty J.E (1929): Laryngeal Cancer, early diagnosis and treatment. *Arch. Otolaryngol* 9:237.
32. Miller A.H (1967): First experience with Asai technique for vocal rehabilitation after total laryngectomy. *Ann. Otol. Rhinol Laryngol.* 76:829.
33. Montgomery W.W, Toohill R. J (1968): Voice rehabilitation after laryngectomy. *AMA Arch. Otolaryngol* 88:499.
34. Norris M, Tucker G (Jr.), Kuo B.F & Pitser W.F (1970): A correlation of clinical staging, pathological findings and five year end results in surgically treated cancer of larynx. *Ann. Otol. Rhinol. Laryngol.* 79:1033.
35. Panje W.R. (1981): Prosthetic vocal rehabilitation following laryngectomy, the voice button. *Ann. Otolaryngol* 90:116.
36. Panje W.R. (1983): Experience with the voice button results presented at the University of Iowa surgical prosthetic voice rehabilitation course, Copper Mountain, Colorado March.
37. Pearson B.W. (1980) Extended hemilaryngectomy for T3 glottic carcinoma with preservation of speech and swallowing. *Laryngoscope* 90:1950.
38. Seeman M (1926): Phoniatische Bemerkungen zur Laryngectomie. *Arch K Chir* 140:285.
39. Shapiro M.J, Ramanathan V.R. (1982): Trachea stomavent voice prosthesis. *Laryngoscope* 92:1126.
40. Singer M.I., Blom E.D (1979): Tracheo-oesophageal puncture : A surgical prosthetic method for postlaryngectomy speech restoration. *Third International Symposium on Plastic and Reconstructive Surgery of the Head and Neck, New Orleans, LA.*
41. Singer M.I, Blom E.D (1981): Selective myotomy for vocie restoration after total laryngectomy. *Arch Otolaryngol* 107:670.
42. Staffieri M (1970): Laryngectomia totalie conreconstruzione di glottide fonatona. *J. Boll Soc Med Chir Brescina* 24:406.

43. Taub S, Spiro R. H (1972): Vocal rehabilitation of laryngectomees : Preliminary report of a new technic. *Am. J. Surg.* 124:87.
44. Tiwari R.M, Snow G.B, Le Cluse FLE et al (1982): Observation on surgical rehabilitation of the voice after laryngectomy with Staffieri's method. *J. Laryngol Otol* 96:24.
45. Vega M.F (1975): Larynx reconstructive surgery – a study of three-year findings a modified surgical technique. *Laryngoscope* 85:866.
46. Wind J (1976): Phylogeny of the human vocal tract. *Annals of the New York Academy of Sciences*, 280:612.

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We are delighted to announce the ENT News Fellowship winner as Mr Abir K Bhattacharyya, MS FRCS (ORL), a Senior Registrar in his final year of training in Otolaryngology at the Royal National, Throat, Nose & Ear Hospital, London.

Mr Bhattacharyya's areas of special interests are phonosurgery and the management of voice disorders, and he is interested in learning new management techniques and investigative methods employed in benign laryngology and related topics.

Mr Bhattacharyya will receive a cash sum of £500 from ENT News and a waiver of registration fees from the Royal Society of Medicine to attend the 2nd USA/UK Joint Otolaryngology Meeting in Boston in July 1997.