

A review and meta-analysis of tongue and palatal implants for post carcinoma corrections

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Abstract

Tongue and palatal implants, prosthesis are recently being used for improvising patient's medical condition. This paper reviews recent advances and research to overcome post carcinoma treatments for aiding vital processes such as deglutition, mastication and speech, using palatal augmentation prosthesis, food guiding prosthesis and tongue replacement prosthesis. Silent speech can be overcome by using magnetic implants and sensors. Restoration of voice box post laryngectomy and glossectomy can be achieved by Electrolarynx (EL) and Transoesophageal Voice Prosthesis (TEP). The success of tongue and palatal implants are discussed in the clinical report.

Keywords: Glossectomy; laryngectomy; obturator; palate; tongue; voice prosthesis

1. Introduction

Patients with carcinoma of the base of tongue are treated by total glossectomy, sometimes along with laryngectomy, followed by chemo radiotherapy or intraoperative radiotherapy.[1]

The problems associated with radiotherapies are as follows:

- Constant pain
- Impairment of speech
- Mastication
- Deglutition
- Mandibular deviation
- Facial disfigurement

Palatal augmentation prosthesis, tongue replacement prosthesis, or food-guiding prosthesis is few of the prosthetic approaches which can be used to solve few of the above mentioned problems.

2. Types of tongue and palatal prosthesis

2.1 Palatal Augmentation Prosthesis

The palatal augmentation prosthesis is used to restore impaired speech and swallowing in glossectomy patients. It artificially lowers palatal vault and provides contact between tongue and palatal contours. However, it is very bulky as compared to the living tongue making it impossible to replace the dynamic nature of the living tongue.

2.2 Food guiding prosthesis

The food guiding prosthesis guides food through the oesophagus after complete glossectomy.

But food has to be blended before consuming or a special pusher spoon can be used.

2.3 Tongue replacement prosthesis

Immediate Surgical Obturator: To prevent contamination of wound, matrix is placed over the surgical packing which enables the patient to speak and swallow immediately after surgery.

Definitive Obturator prosthesis: It restores defects of hard palate. Dentures are used to restore speech, swallowing, mastication and facial contour restoration.

Osseointegrated implants are placed during surgery to remove remaining malignant tissues. Such implants are most effective for edentulous patients. Facial prosthesis is used to improve facial disfigurements. Silicone elastomers are used for this purpose. Craniofacial implants made up of titanium are used to increase life span of facial prosthesis and provide patient comfort.

3. Voice Prosthesis

3.1 Tracheoesophageal voice prosthesis (TEP)

Voice prosthesis is an artificial device, usually made of biomaterials and it is used enable speech in laryngectomized patients. During a complete laryngectomy, the trachea and esophagus are separated from each other and the entire larynx is removed. An opening between the esophagus and the

trachea called the tracheo-esophageal puncture (TE puncture) can be created either during the operation (primary puncture) or at a later stage of treatment (secondary puncture) for the placement of the voice prosthesis[2]. When air passes from the lungs into the prosthesis by occluding the stoma, a voice sound is created called tracheo-esophageal speech. A valve like structure is present on the back of the prosthesis to avoid food, water or saliva entering into it.

There are two ways to insert the voice prosthesis:

- 1) **Retrograde manner:** Through the mouth and throat with the help of a guide wire
- 2) **Anterograde method:** Through the tracheostoma directly which is used widely nowadays.

Figure 1: A typical tracheoesophageal voice prosthesis[3]



The advantages of this method are[4]:

- This prosthesis provides stability to the tracheo-esophageal wall.
- The flanges protect the puncture against fluids and stomach acid leakage and other stomach contents.
- There is no irritation or pressure from the placement of this prosthesis.
- Patients quickly adjust with their prosthesis as they receive special instructions.
- No outpatient procedure is needed.
- Patients can learn the use of this prosthesis before starting any post-operative radiation therapy.
- As the wound starts healing, patients can start focusing on voice production.
- It has a longer lifetime and needs no frequent replacement.

This prosthesis has only one disadvantage that is the need to use a feeding tube for few days.

3.2 Isolated word recognition of silent speech using magnetic implants and sensors

Silent speech is a condition in which individuals wish to communicate verbally but are unable to do so. Magnetic implants and sensors can be used to overcome this problem especially in laryngectomized patients. Permanent magnets are placed on the tongue and lips and the changes in magnetic field resulting from movement during speech are monitored using a set of magnetic sensors.[5] The sensor signals are compared to sets of pre-recorded templates using the dynamic time warping (DTW) method. Experimental trials were carried out on some subjects with healthy larynx,

using 500-1000 utterances used for speaker dependant training and testing. It showed that recognition rates of over 90% are achievable for vocabularies of at least 57 isolated words which are sufficient to drive command-and-control applications.

3.3 Electrolarynx (EL)

Figure 2: Electrolarynx[6]



An effective way of voice restoration post laryngectomy is Electrolarynx. The EL is a battery operated, handheld device. The user's neck serves as an electro-acoustic transducer. EL transmits low pulse train to the neck which modulates sound into speech. Basic principle involved in the working of EL is that there is a direct relation between pitch of voice and exertion of muscular force. Firstly, tone is generated with fundamental frequency in speech range and introduced into resonant cavity such as mouth. The user then modulates this tone artificially by varying the shape of the mouth while trying to speak.

Pitch of voice can be controlled with the help of two buttons which are provided for higher and lower pitch. Frequency can be changed by screw top potentiometer. Piston functions as a loudspeaker which is embedded in flexible membrane situated above permanent magnet. The side of the piston closest to the interior of the EL is then wrapped with an insulated copper wire. One end of the wire is grounded, while the other end is connected to the voltage output of the pulse generator. As per the Lorentz force equation that $F=q(v \times B)$, so the changing current in the piston above the constant magnetic field of the permanent magnet causes a changing force on the piston. The piston is below a plastic disk, or diaphragm and strikes the plastic disk when it reaches its peak displacement. Thus, the square wave generated by the internal circuit is transformed into a pulse train in pressure waves outside the device. When the EL is pressed against the neck, the pulse train is transmitted through the neck tissue (transcutaneous EL type) to articulators to be modulated into speech. The only disadvantage may be that the EL results in unnatural and unintelligible speech due to inaccurate frequency variation, irradiated noise and reduced loudness in few patients. Care must be taken so that EL operates in male frequency range of 60 Hz-150 Hz and female frequency range of 200Hz-400Hz to avoid frequency variation. TruTone EL allows finger control of pitch and user can release this button when he wishes to

stop talking. This will reduce the problem of reduced loudness to some extent.[7]

4. Clinical report suggesting improvement of Mastication[8]

This clinical report shows the use of prosthesis on a 66 year old patient at Sheba Medical Centre, Israel. He was referred to maxillofacial prosthesis for which he underwent a total glossectomy followed by a total laryngectomy. He had a history of cancer of right base of tongue. As a part of the treatment he was initially subjected to chemotherapy and radiotherapy after which a total glossectomy followed by total laryngectomy and ipsilateral radial neck dissection was carried out. The patient rejected the use of any voice prosthesis post laryngectomy. After few months of this treatment the patient had to undergo total hemimandibulectomy because of a local recurrence. To restore mandibular continuity, reconstruction using iliac crest microvascular free flap was done and the mandible was restored with complete denture. Two endosseous cylindrical 3.25 mm implants were placed in mandibular canine and second premolar to improve retention. The patient complained of having problems while eating, the facial appearance and the speech was not comprehensive.

Figure3: A, Frontal view shows mandibular deviation and collapsed lower lip. B, Intraoral view. Note glossectomy and floor of mouth slope (arrow indicates the uvula)[8]

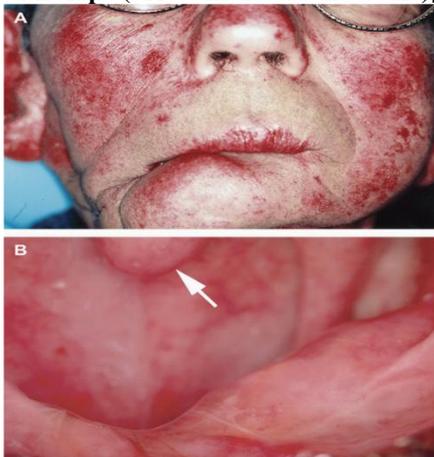
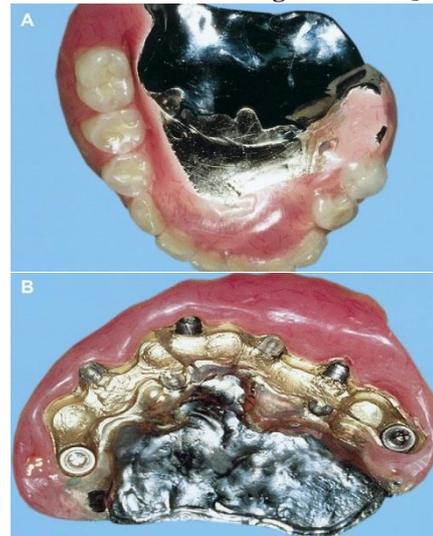


Figure 4: Frontal view 2 years after treatment. Note: improved lip support.[8]



Figure 5: Definitive mandibular prosthesis, A. Polished surface B.Intaglio surface [8]



5. Conclusion

Type of prosthesis	Advantage	Disadvantage
Palatal Augmentation	Improves speech and swallowing	Bulky
Food guiding prosthesis	Improves swallowing	Pusher spoon has to be used
Tongue replacement prosthesis	Improves mastication; facial restoration	Not documented in reference papers
Transoesophageal Voice Prosthesis	Voice restoration	Feeding tube has to be used
Magnetic implants and sensors	Overcome silent speech	Not documented in reference papers
Electrolarynx	Voice restoration	Not documented in reference papers

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