

AN INTERDISCIPLINARY APPROACH TO VOICE MANAGEMENT FOLLOWING A TRACHEAL RESECTION: A CASE STUDY¹

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ABSTRACT

A voice management program utilizing a specially constructed methylmethacrylate air shunt and voice therapy is described for a 52 year old male who had undergone a tracheal resection. The patient had a tumor extending from just below the vocal folds to a point 3 cm. above the tracheal bifurcation. Subsequent to the removal of this section of the trachea, the patient's larynx was effectively separated from his lower respiratory system. He was also left with a stoma over the upper mediastinum for breathing and a laryngostoma below the vocal folds for drainage. Reconstruction of the trachea for phonation was deferred for one year to allow for medical observation. In the interim the patient was referred for esophageal speech training. Following a period of unsuccessful esophageal and electrolaryngeal speech training, a management program was cooperatively undertaken by speech pathology and prosthodontology. This program allowed the patient to quickly regain his own voice and to return to his work in a relatively short time.

R.M., a 52 year old salesman was admitted to hospital with symptoms of respiratory insufficiency. Direct laryngoscopy and bronchoscopy revealed a massive adeno-cystic carcinoma on the right posterior wall of the trachea extending from just below the vocal folds to a point 3 cm. above the tracheal bifurcation. Subsequent to surgical removal of this section of the trachea, the patient's larynx was effectively separated from his lower respiratory system. He was left with a stoma over the upper mediastinum for breathing and a laryngostoma below the vocal folds for drainage (Figure 1). Reconstruction of the trachea for phonation and normal respiration was deferred for one year to allow for medical observation.



Figure 1. Post-operative tracheostoma (A) and laryngostoma (B).

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During the initial interview, a routine pure-tone hearing screening was performed. The results revealed normal hearing sensitivity, bilaterally. For the remainder of that first session and three subsequent therapy sessions, all of the traditional esophageal insufflation and sound production techniques were attempted, but without success. At that point consideration was given to the feasibility of fashioning a temporary mechanical air-flow shunt whereby the expiratory air stream would be channeled from the tracheostoma through the larynx *via* the laryngostoma. Voice production by this means seemed to be much more practical than by long-term esophageal speech training. Furthermore, a normal voice production would certainly be qualitatively more effective than either an esophageal sound or one produced by means of an electrolarynx.

In order to investigate this possibility, a crudely designed shunt was constructed. This consisted of a six-inch piece of flexible plastic tubing with a small funnel-shaped cup attached at each end. The purpose of this device was explained to R.M. He was instructed to place one of the cups directly over the laryngostoma. Then, just prior to exhalation, he was to place the second cup over the tracheostoma, thereby directing the air stream upward through the tube and into the larynx. As he did this, he was to attempt to phonate the vowel /a/.

The sound produced on this first attempt was soft, low-pitched, and breathy. When asked to phonate at varying pitch levels, he was minimally successful. A subsequent examination of R.M.'s intra-laryngeal structures by means of indirect laryngoscopy revealed that the vocal folds were sluggish in mobility, due to a general weakness of the larynx associated with the surgical procedures. Much of the voice quality exhibited during these phonatory attempts was largely attributable to this fact.

Although these results were not qualitatively impressive, they did suggest that perhaps with a functionally better designed prosthetic shunt and voice therapy a more improved voice production might be achieved. The Department of Prosthodontology of the University of Manitoba was contacted for advice and assistance.

After an evaluation of R.M.'s anatomical and physiological status, a design was established for a prosthetic shunt. Impressions were taken of the tracheostoma and laryngostoma using modelling plastic and impression wax. The impressions were seated to position and an irreversible hydrocolloid impression was made to obtain the relationship of the components. The resultant impression was poured in artificial stone and a methylmethacrylate prosthetic shunt was fabricated (Figure 2).



Figure 2. The prosthetic tracheo-laryngeal shunt seated in its functional position.

A removable one-way valve was incorporated into the prosthesis allowing R.M. to inhale through the tracheostoma and exhale through the larynx via the prosthesis. This respiratory shunting system was required so that no inhalation would take place through the larynx which, otherwise, could result in aspiration.

In order to help improve the seal around the two stomata, the prosthesis was designed to cover a relatively large area and was held securely in place by straps tied around the neck. However, in spite of these features, the prosthesis still had to be held in place manually by R.M. during phonation because of continued air leakage around the stomata.

After a short period the valve was eliminated because it offered too much resistance to the respiratory air stream, particularly on exertion. This modification enabled R.M. to either inhale and exhale through the resultant tracheal opening in the prosthesis or to redirect the expiratory air stream, as before, by digitally occluding this opening. Once the prosthetic shunt had been modified and R.M. became accustomed to wearing it, a program of voice therapy was initiated.

Because of the general weakness of the larynx, therapeutic attempts were directed at progressively strengthening the vocal mechanism. After a two-week period of intensive therapy, R.M.'s voice became stronger and less breathy in quality and, although still limited in pitch variability, it was functional enough for him to return to his job which requires much use of the telephone.

The prosthesis was used successfully for a period of seven months. At that time a local recurrence of the tumor was diagnosed and resected. In addition, an externally constructed skin tube was created. This tube extended from the laryngostoma to just above the tracheostoma. These surgical procedures made the existing prosthetic shunt non-functional and, therefore, required the fabrication of a new one.

Modelling plastic and wax impressions were made, with particular attention being given to the contour and impression of the opening at the inferior end of the skin tube. It was our intention to gain as much seal as possible around the two openings, i.e., the inferior tubal opening and the tracheostoma. The impression was poured in artificial stone and the new prosthesis fabricated (Figure 3). A one-way valve was not incorporated into this model because of the respiratory difficulties encountered previously. However, a hinged silver flap

was added to this new prosthesis in order to provide a firm base for digital occlusion and, thereby, provide a better seal.



Figure 3. The modified prosthetic shunt with hinged silver flap.

This new shunting system was functionally similar to the previous one, that is, R.M. could inhale and exhale directly through the tracheal opening in the prosthesis or he could divert the expiratory air stream up through the skin tube and into the larynx by digitally occluding this opening. Phonatory results were better than before because of fewer air leakage problems.

To date, there has been no further evidence of tumor recurrence. R.M. is functioning quite effectively with the new prosthesis, his voice has continued to improve, and he is communicating over the telephone without any difficulty whatsoever.

In conclusion, this prosthetic shunt enabled the patient to return to work in a short period of time and continue to provide an income for his family more effectively than would have been possible with esophageal speech training or an electrolarynx. This would seem to indicate that such a voice management program represents a very reasonable and practical way to treat similar types of disorders. This clinical case also demonstrates how speech pathologists can utilize other professional resources in a somewhat uncommon way to the overall benefit of the patient.

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