

## Jejunal Grafts for Reconstructing a Phonatory Neoglottis in Laryngectomized Patients

K. Ehrenberger<sup>1</sup>, W. Wicke<sup>1</sup>, H. Piza<sup>2</sup>, R. Roka<sup>2</sup>, M. Grasl<sup>1</sup>, and H. Swoboda<sup>1</sup>

<sup>1</sup>First Department of Otorhinolaryngology and

<sup>2</sup>First Department of Surgery, University of Vienna, A-1090 Vienna, Austria

**Summary.** After laryngopharyngectomy and reconstruction of the upper digestive tract, a free jejunal graft can be anastomosed in an isoperistaltic direction end-to-end to the trachea and the hypopharynx in order to form a shunt for vocal rehabilitation. Following placement of the shunt, no special care is required nor does any patient show any aspiration. Because of a low-flow resistance of the shunt, patients so treated possess long-lasting phonation with loud and modulated voices.

**Key words:** Laryngectomy – Surgical vocal rehabilitation – Free jejunal graft

### Introduction

The goal of operative rehabilitation of the voice after total laryngectomy has been pursued by many surgeons since Billroth performed the first total laryngectomy more than 100 years ago [6].

The fundamental concept behind all procedures used is to create a tracheo-hypopharyngeal or a tracheo-esophageal shunt. This has been done without a voice prosthesis [1, 3, 5, 16] as well as with one [7, 9, 10, 15]. The ideal prosthesis is one that permits the valve-like injection of air into the pharynx in order to produce phonation and yet prevents aspiration. Although the usual contemporary methods of the Staffieri fistula and the silicone prosthesis are largely successful with respect to phonation, they do nevertheless possess numerous disadvantages:

1. In order to produce speech, the patient must manipulate the tracheostoma with his finger.
2. There is a high aspiration rate in patients with Staffieri fistulae.
3. Prosthesis must be cleaned frequently or exchanged periodically, or they must remain permanently inserted to prevent rapid closures of the fistulae.

*Offprint requests to:* Prof. Dr. K. Ehrenberger, 1. HNO-Klinik, Lazarettgasse 14, A-1090 Vienna, Austria

4. The initial placement of a prosthesis requires an additional although minimal surgical procedure, which is performed after primary wound-healing has taken place when patients have attempted to learn esophageal speech but have been unsuccessful.

5. No additional shunt operations are currently possible after extensive laryngopharyngectomies are done, or after complicated reconstructions of the upper digestive tract (with the exception of very special cases) [12]. These patients therefore never have the opportunity to learn esophageal speech and thus remain entirely dependent on the odd monotone of mechanical voice synthesis.

Thus, it was our intention to develop a shunt which would minimize the disadvantages of existing procedures for rehabilitation of the voice. Such a shunt should meet the following requirements:

1. It should involve a single surgical technique, even after complicated reconstructive surgery of the upper digestive tract.

2. It should be capable of producing good phonation with minimal flow resistance and should function failure-free (at least for hours) with an inserted fenestrated tracheostomy tube containing a valve to obviate the need for manual control of the tracheostoma.

3. It should require no care.

4. Patients should experience no aspiration.

Since the publications of Ancona [2], McConnel et al. [8], Roka et al. [11] and Schultz-Coulon [13], the jejunal graft with microsurgical vascular anastomoses is now recognized as being one of the most reliable methods for reconstructing large defects of the upper digestive tract. Additionally, a free jejunal graft can also be used for the construction of a tracheo-esophageal shunt with the qualities listed above.

### Surgical Techniques

After neck dissection, laryngopharyngectomy and reconstruction of the upper digestive tract, a laparotomy is performed and the jejunum is inspected to select a section whose vascular anatomy makes it suitable for use as a graft. A suitable segment about 20 cm in length is isolated and removed. It is then perfused with cold Collins solution and cleaned of its intestinal contents.

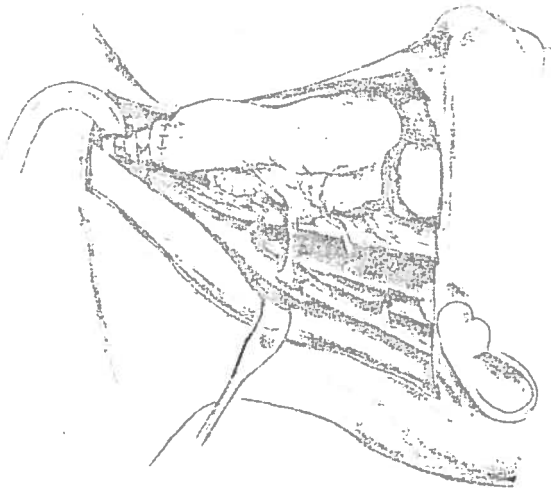
Cervical anastomoses are performed immediately with previously chosen arteries and veins. In certain cases following extremely radical neck dissections, it is possible to use the central stump of the internal jugular vein and the common carotid artery for these anastomoses. The total elapsed ischemic time is about 30–60 min. After circulation is restored, the graft is anastomosed end-to-end to the remaining tracheal stump located above the tracheostoma. It is then pulled up and fixed to the base of the tongue. Following this, it is again drawn downwards and inserted deeply into the reconstructed anterior wall of the hypopharynx to create an open siphon-like tracheo-hypopharyngeal shunt (Figs. 1, 2). Thus, the graft is situated in the direction of peristalsis, making an independent evacuation of the jejunal graft into the hypopharynx possible.



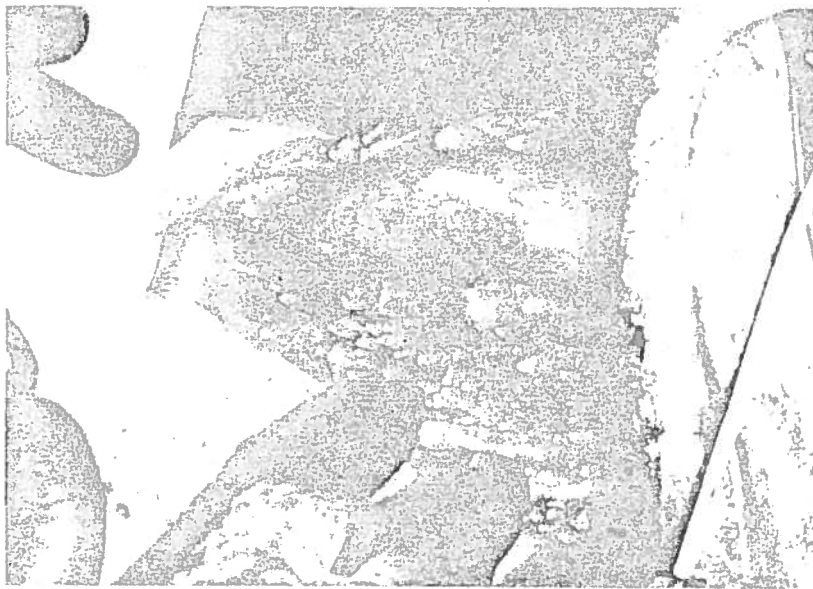
Fig. 2. The intrao

### Results

Free jejunal gr  
patient had va  
4th postoperat  
remaining six  
dwelling nasog



**Fig. 1.** Schematic drawing of the placement of a free jejunal graft between the trachea and hypopharynx. Vascular anastomoses have been effected with the carotid artery and internal jugular vein



**Fig. 2.** The intraoperative graft corresponding to Fig. 1

### Results

Free jejunal grafts have been placed in seven patients at the present time. One patient had vascular insufficiency which produced necrosis of the graft on the 4th postoperative day, necessitating its subsequent removal. However, in the remaining six patients, the graft healed without any complications. An indwelling nasogastric tube was used for feeding after surgery and was removed

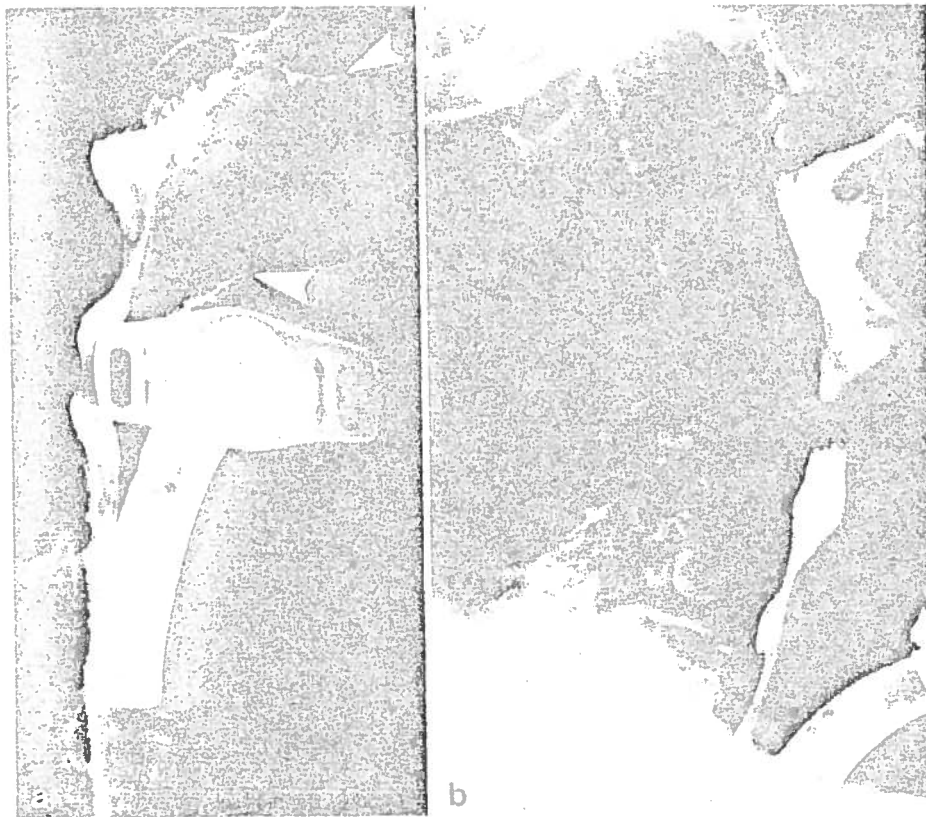


Fig. 3a and b. The self-cleansing effect of the jejunal peristalsis: contrast medium injected into the jejunal graft (arrow in a) disappears after 30 min (b). The hypopharynx and esophagus are simultaneously demonstrated by the contrast medium

in the 3rd postoperative week. At this time, each patient was consistently able to swallow without aspiration.

Six months postoperatively, one of these patients experienced aspiration while eating too hastily. Endoscopic inspection revealed scar tissue at the distal end of the reconstructed hypopharynx, which gradually but increasingly impeded swallowing. This patient, however, quickly learned to avoid aspiration and was shown that after swallowing several mouthfuls of food, brief phonation would then discharge the contents of the jejunal prosthesis into the hypopharynx. When radio-opaque substances are injected into the jejunal voice prosthesis, they are not definable after 30 min. This is due to the self-cleansing mechanism of the natural peristalsis of the shunt, even when patients do not phonate (Fig. 3). In order to have each patient begin phonation we inserted a fenestrated tracheostomy tube during the 2nd postoperative week. The jejunal graft inflates with air and subsequently acts as an air chamber to produce sustained continuous phonation. Because of low-flow resistance, the total phonation pressure averages only 50–60 cm H<sub>2</sub>O and allows a long-lasting phonation to occur (Fig. 4). After only a few weeks of practice, each patient has been

Pressure during

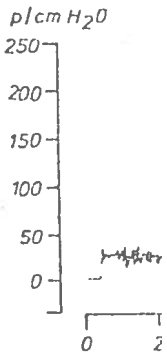


Fig. 4. The time-cumulation of an air

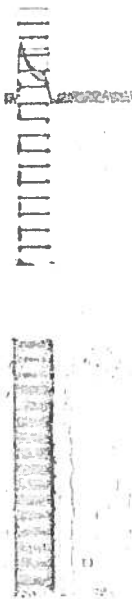


Fig. 5. Sonogram formants with

found to have formants in fenestrated indication of able to cough lems. Two p

Pressure during Phonation of "a"

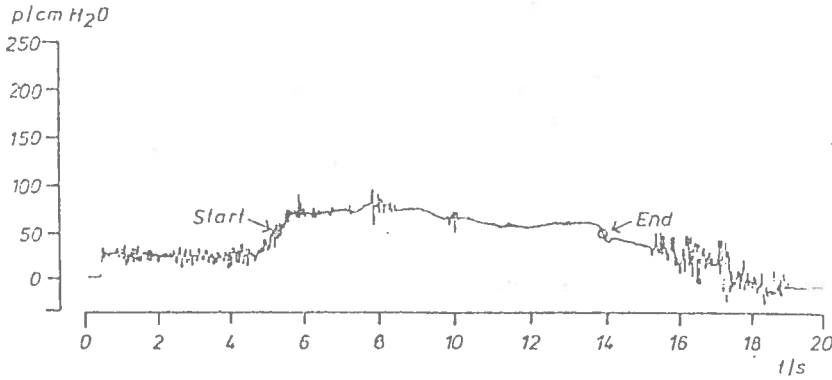


Fig. 4. The time course of the phonation pressure in patient H.A. is characteristic for the evacuation of an air-chamber

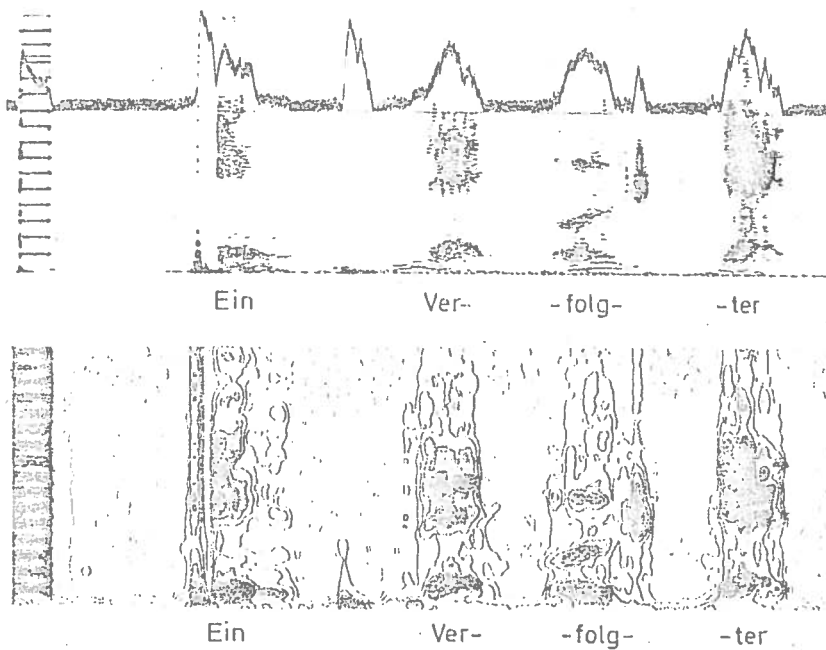


Fig. 5. Sonogram recorded in patient S.M. 12 weeks after operation. Note the distinctive formants with several isolated frequencies

found to have a loud fundamentally modulated voice with clearly defined formants in a sonogram (Fig. 5). One of the patients has retained a valved-fenestrated tacheostomy tube since the 3rd postoperative week without any indication of hindered expiration. His blood gas values are normal and he is also able to cough out small amounts of phlegm through his shunt without any problems. Two patients have been able to tolerate the same type of tube for limited

periods of several hours. One patient has absolutely rejected any tube, and thus must finger-manipulate his tracheostoma to elicit active phonation.

### Discussion

As we have demonstrated, the jejunal shunt largely fulfils our previously stated requirements for creating a phonatory neoglottis.

1. Since our experience with jejunum for constructing the upper digestive tract after extensive laryngo-pharyngectomies is progressively increasing, we can now do surgery in one stage to avoid the need for additional surgery.

2. The shunt requires no maintenance. This factor distinguishes it substantially from shunts which require a plastic prosthesis.

3. In principle there has been no aspiration with the shunt. Even when bolus congestion has occurred, the jejunal graft cleanses itself by means of its autonomic peristalsis. Coughed-up phlegm is also cleared in the same way. We believe that this self-cleansing action of the graft can be further improved by active phonation. This is a decisive advantage when compared to the Staffieri fistulae, which are rarely aspiration-free.

4. Because the shunt's diameter offers less flow resistance, the resulting phonation pressure of 50–60 cm H<sub>2</sub>O is significantly lower than that of other shunts. In the current literature, the pressure necessary for phonation in shunts with plastic prostheses is cited as being up to 200 cm H<sub>2</sub>O [4]; for Staffieri fistulae the values given are 60–145 cm H<sub>2</sub>O [14]. Acting together with the air chamber effect of the jejunal graft, the low phonation pressure produces a corresponding long-lasting phonation.

Our attempts to combine the jejunal voice prosthesis with a valved fenestrated tracheostomy tube have only been partially realized. Because the tolerance of this tube is dependent on phonation and thus expirational flow resistance, we will attempt to modify the surgical procedure in the future in such a manner that even lower values of flow resistance during phonation can be obtained while still maintaining freedom from aspiration.

The placement of the jejunal shunt, however, requires a disproportionately greater expenditure in surgical time and effort. Thus, the indication for this surgery remains limited only to those patients who require reconstruction of the hypopharynx after extensive resections, and thus justify use of a free jejunal graft. In such cases, an additional section of jejunum can be removed for the shunt during the same operation. It should be noted, however, that the additional removal of a small section of intestine by a proficient abdominal surgeon is the lesser procedure when compared to a total laryngectomy. Only lasting successes with our shunt in the future will give us any indication as to whether or not the jejunal shunts can also be justified when simple laryngectomies are done. Ancona [2] and McConnel et al. [8] have already indicated the risks of necrosis when intestinal grafts are used in pharyngeal reconstructions. In the construction of the shunt in seven patients, we also experienced necrosis of the graft in one case. This problem will hopefully be avoided by further perfection of our surgical techniques.

### References

1. Amatsu M (1972) Otorhinolaryngol. 10: 100
2. Ancona E (1972) cervical esophagus. 10: 100
3. Asai R (1972) 10: 100
4. Breuninger H (1972) 267–271
5. Conley JJ (1972) De- 10: 100
6. Gussenbauer (1972) 343–356
7. Herrmann H (1972) laryngol [Suppl.] 10: 100
8. McConnel M (1972) 10: 100
9. Nijdam HF (1972) 10: 100
10. Panje WR (1972) 10: 100
11. Roka R, Nica (1972) 492
12. Saito H, Sato (1972) 10: 100
13. Schultz-Coule (1972) 10: 100
14. Schultz-Coule (1972) 10: 100
15. Singer MI, Blum (1972) 10: 100
16. Staffieri M, P (1972) 57: 477–488

Received March 7

## References

1. Amatsu M (1978) A new one-stage surgical technique for postlaryngectomy speech. *Arch Otorhinolaryngol* 220:149-152
2. Ancona E (1981) Gastrointestinal microsurgery: colonic and jejunal autotransplants for cervical esophagoplasty. *Int Surg* 66:39-40
3. Asai R (1972) Laryngoplasty after total laryngectomy. *Arch Otolaryngol* 95:114-119
4. Breuninger H (1982) Zur Rehabilitation nach Laryngektomie. *Laryngol Rhinol Otol* 61:267-271
5. Conley IJ, De Amesti E, Pierce MK (1958) A new surgical technique for a vocal rehabilitation of the laryngectomized patient. *Ann Otol Rhinol* 76:655-664
6. Gussenbauer C (1874) Über die erste durch Th. Billroth am Menschen ausgeführte Kehlkopf-Extirpation und die Anwendung eines künstlichen Kehlkopfes. *Arch Klin Chir* 17:343-356
7. Herrmann H (1983) Die Technik der chirurgischen Stimmrehabilitation. *Arch Otorhinolaryngol [Suppl]* 1983/11:205-208
8. McConnel MS, Hester TR, Nahai F, Jurkiewicz MJ (1981) Free jejunal grafts for reconstruction of pharynx and cervical esophagus. *Arch Otolaryngol* 107:476-481
9. Nijdam HF, Annys AA, Schutte HK, Leever H (1982) A new prosthesis for voice rehabilitation after laryngectomy. *Arch Otorhinolaryngol* 237:27-33
10. Panje WR (1981) Prosthetic vocal rehabilitation following laryngectomy—the voice button. *Ann Otol Rhinol Laryngol* 90:116-120
11. Roka R, Niederle B, Piza F (1982) Die freie Transplantation von Darmsegmenten zum Oesophagusersatz: Indikation, Technik und Ergebnisse. *Wien Klin Wochenschr* 94:488-492
12. Saito H, Sato F, Saito A, Takenaka H, Mizukoshi O, Kodama M, Shibata J (1984) Vocal rehabilitation by tracheogastric shunt method after pharyngo-laryngoesophagectomy for malignancy. *Arch Otorhinolaryngol* 240:35-41
13. Schultz-Coulon HJ (1983) Möglichkeiten der Hypopharynxrekonstruktion und ihre Indikationen. *Arch Otorhinolaryngol [Suppl]* 1983/11:202-205
14. Schultz-Coulon HJ, Sybrecht GW, Pivalski P (1980) Die kardiorespiratorische Belastung beim tracheo-ösophagealen Shunt nach Staffieri. *Arch Otorhinolaryngol* 227:467-469
15. Singer MI, Blom ED (1980) An endoscopic technique for restoration of voice after laryngectomy. *Ann Otol Rhinol Laryngol* 89:529-533
16. Staffieri M, Procaccini A, Steiner W, Staffieri A (1978) Chirurgische Rehabilitation der Stimme nach Laryngektomie. Operationsmethoden nach Staffieri. *Laryngol Rhinol* 57:477-488

Received March 7, 1985 / Accepted April 9, 1985