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Tracheo-oesophageal 'Puncture Speech'

An assessment technique for failed oesophageal speakers

by

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Abstract

We describe the assessment procedures used at Charing-Cross Hospital to investigate laryngectomees who failed to develop oesophageal voice and give the results of assessment in 50 patients. Anatomical or physiological abnormalities in the reconstructed pharynx were found in all patients, and we feel these significantly contributed to the failure of achieving an oesophageal voice. The four cases of failure were due to hypotonicity of the pharyngo-oesophageal muscles, hypertonicity, frank spasm and stricture. This distinction can be used as a functional classification of failure as treatment for each group has to be different if successful surgical voice restoration is to be achieved. Patients with hypotonicity need to use external pressure; those with mild hypertonicity are able to use a low pressure tracheo-oesophageal voice prosthesis; those with spasm need a pharyngo-oesophageal myotomy prior to "puncture", while those with stricture need surgical correction.

Introduction

Although surgical voice restoration after laryngectomy is not a new concept, it is only during the last five years, with improved surgical techniques and the development of new bio-materials for voice prostheses, that success rates have increased to an acceptable level where there is now an alternative to oesophageal voice and/or communication via an artificial larynx. A pilot study was begun in 1982 at Charing Cross Hospital to assess the feasibility of using surgical voice restoration, tracheo-oesophageal or fistula speech as described by Blom and Singer (1980) and Panje (1981) on a British laryngectomy population.

Successful oesophageal voice depends on the ability to inject air into an oesophageal reservoir and then controlling its release through a vibrating segment within the reconstructed pharyngo-oesophageal area. Table I shows the different elements involved in alaryngeal speech (both oesophageal and fistula) compared with laryngeal speech. It will be seen that the pharyngo-oesphageal (P-E) segment or sphincter is the vibrator in both oesophageal and fistula speech, consequently problems in this region will detrimentally affect both oesophageal and fistula speech. Conversely, with good pharyngeal-oesophageal function, the main advantage of fistula speech is the greatly increased air reservoir of the lungs allowing louder and more sustained speech.

Initially, the cine-radiological technique described by Simpson *et al.*, (1972) was used on 8 good oesophageal speakers to evaluate their voicing mechanism. We have now investigated 42 failed speakers who were referred by both ENT surgeons and speech therapists to Charing Cross Hospital for assessment of

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TABLE I
COMPARISON OF LARYNGEAL, OESOPHAGEAL AND TRACHEO-OESOPHAGEAL VOICE PRODUCTION

Physical Requirements	Laryngeal voice	Oesophageal voice	Tracheo-oesophageal (Fistula) voice
1. Initiator	Moving column of air from lungs	Moving column of air from oesophagus.	Moving column of air from lungs.
2. Vibrator	Vocal cords.	Pharyngo-oesophageal (P-E) segment.	Pharyngo-oesophageal (P-E) segment.
3. Resonator	Vocal tract i.e. pharynx nose, mouth.	Vocal tract i.e. pharynx nose, mouth.	Vocal tract i.e. pharynx nose, mouth.
4. Articulators	Tongue, teeth, lips, soft palate.	Tongue, teeth, lips, soft palate.	Tongue, teeth, lips, soft palate.

Adapted from Edels, (1983)

potential for surgical voice restoration in each patient. The assessment technique has been refined during this study and now all results are recorded on videotape rather than cine X-ray as this allows simultaneous sound recording. This method is much less expensive and the tapes can be more easily reviewed. We would like to emphasise that this procedure requires a team approach.

Material and Methods

Currently, the assessment procedure consists of the following stages:
1. Questionnaire
2. Videofluoroscopy
3. Videotaped interview
4. ENT examination

1. Questionnaire

Access to medical notes is not always available in view of the broad-base of our referrals. Each patient referred therefore completes a case history questionnaire with the assistance of a speech therapist or doctor prior to attending a combined clinic for his videofluoroscopic study. The questionnaire includes questions on the extent and type of surgery; length of time hospitalized; extent of speech therapy; present status of voice; extent of radiotherapy (if any) as well as any problems in swallowing, smelling, tasting or eating food. In addition, patients are asked to rate their own communication skills on a Wepman Scale (Wepman *et al.*, 1982) (Table II).

2. Videofluoroscopy

The team met once monthly and consisted of an ENT surgeon, radiologist speech therapist and an audiovisual recording technician, who can evaluate between six and eight 'new' patients in a session.

The examinations were undertaken with standard screening equipment which should be available in the X-ray department of any general hospital, with two simple additions to the X-ray equipment: Firstly, the normal rectangular field was altered by placing a strip of lead rubber over the front of the image intensifier and positioning it in such a way that it cut out non-attenuated radiation which had passed in front of the patient's neck and would have 'flooded' the intensifier. Secondly, a bolus bag containing polyvinyl acetate beads and powdered cellulose was attached to the front of the intensifier at the level of the lower part of the patient's neck. This had the effect of increasing the radiodensity of the lower part of the neck to that of the pharynx.

These small modifications made it possible to obtain diagnostic radiographs of the pharynx and upper oesophagus in a series of patients in whom the soft tissues of the neck had been substantially reduced by laryngectomy surgery.

The dose of radiation was calculated as 5–10 cGy. for videorecording plus spot films for record keeping and publication purposes. This seemed an acceptable dose in view of the potential therapeutic benefit and should be considered in the context that most patients

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had already received therapeutic doses of radiation exceeding 4,000 cGy. All patients gave their informed consent to the procedure.

The position of the tracheostoma was marked by attaching a metallic letter 'S' to the para-stomal skin. The radiological appearances of the reconstructed pharynx and upper oesophagus were recorded in three stages—viz: during the events of swallowing attempted oesophageal phonation and phonation during air insufflation. Ordinary soft tissue X-rays and xeroradiography although showing anatomy, do not demonstrate the physiology of the neo-pharynx. It is only by viewing the dynamic aspect of the whole tract, that problems can be defined and categorized. Barium sulphate (Baritop) was used for the swallow which coated the mucosa during both phonation and attempted phonation with air insufflation testing.

a. Barium Swallow. This should detect any anatomical abnormality within the oral/pharyngeal/oesophageal area which may affect the patients' ability to acquire oesophageal voice eg. stricture.

b. Attempted Phonation. This consists of asking the patient to count from one to ten and noting any oral injection of air into the pharynx or oesophagus as the patient attempts to voice. The features noted were the air charging of the oesophagus and the position and function of a vibrating (pharyngo-oesphageal or P-E) segment, if one is present.

c. Air Insufflation Test. This was described by Taub and Bugner (1973) and consists of inserting a 14 French gauge red rubber catheter trans-nasally into the top of the oesophagus. The examiner blows air passively into the oesophagus via the catheter thus eliminating any problems the patient may have with air injection into the oesophagus. If the patient opens his mouth as the catheter is gently manipulated up and down the tract, oesophageal voice may be heard. This allows the examiner to assess the presence or absence of a vibrating segment, the air pressure required to produce voice and the resistance to air flow through the oesophagus.

3. Videotaped Interview

This provided a base line for comparison after appropriate treatment had been given and included attempts at phonation, reading aloud and a short section of general conversation. From this, the patient's voice was assessed and independently rated by two speech therapists using the Wepman Scale (Table II).

4. ENT Consultation.

This took place after the combined clinic and enabled the surgeon to discuss with the patient the reasons for his failure to acquire pseudo-voice and to advise on the corrective treatment needed. At this interview, a full ENT examination is made. The patient's neck is examined, particularly with regard to the size and contours of the tracheostoma as this may need surgical correction prior to fitting the patient with a tracheo-oesophageal voice prosthesis. An assessment is also made of the patient's intelligence, motivation and any other relevant problems e.g. alcoholism, visual difficulty and adverse social conditions.

Results

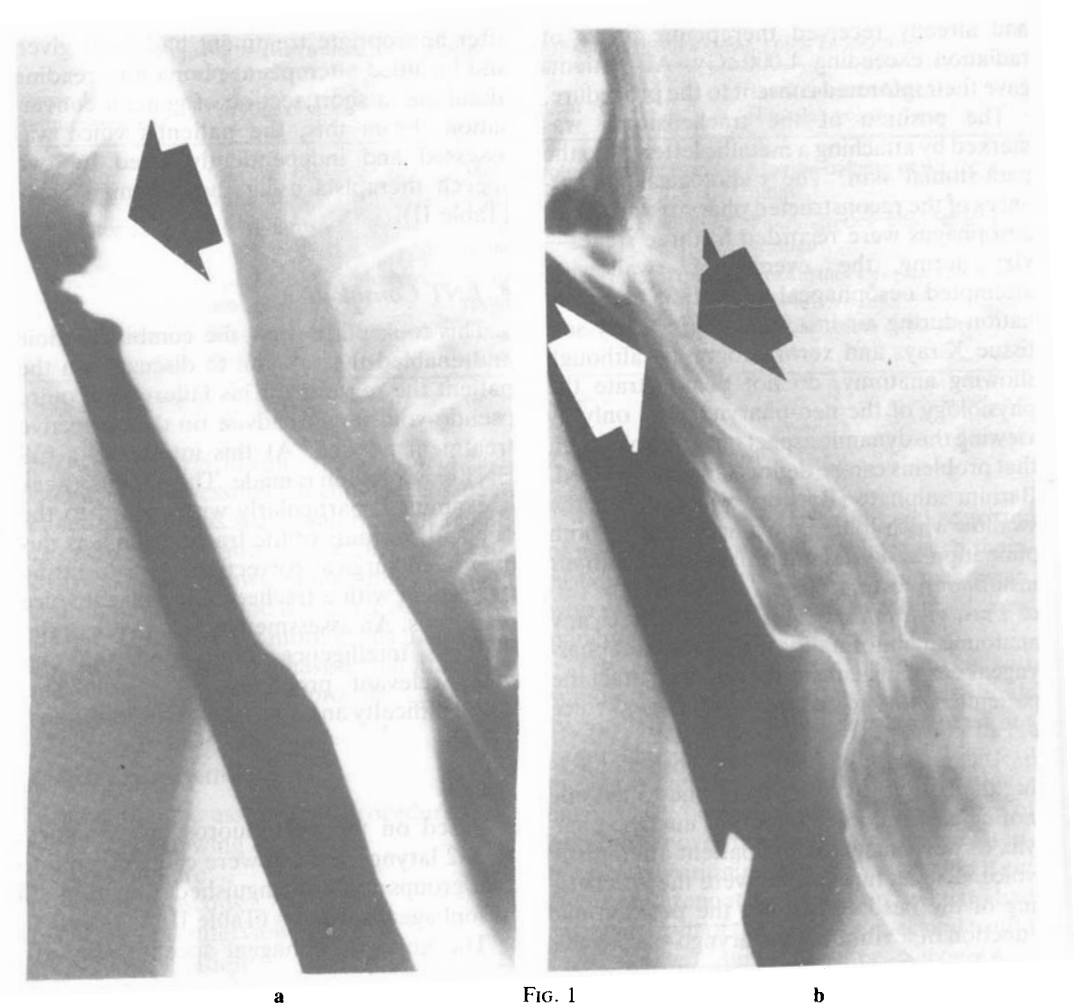
Based on the videofluoroscopic findings, the 42 laryngectomees were categorized into four groups easily distinguished from the good oesophageal speakers (Table III).

The good oesophageal speaker (Fig 1b) demonstrates well the anatomy of the pharynx and upper oesophagus required for good oesophageal voice production (Edels, 1983). There is an adequate amount of air injected into the oesophageal reservoir and a single narrow P-E segment develops to vibrate and produce voice. On swallowing, this segment dilates easily and there is no hold-up to the passage of the barium (1a). The picture on air insufflation is very similar to that on phonation and the voice produced sounds the same. Table III shows the results in each pathological group for the different parts of the videofluoroscopic examination.

1. Barium Swallow

In hypotonic patients the pharynx and oesophagus dilate on swallowing and there is

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a FIG. 1 b

Good oesophageal speaker.

(a) The barium swallow shows slight narrowing and irregularity anteriorly at the pharyngo-oesophageal ana stomosis (arrowed) but there was no hold up to the passage of barium on screening.

(b) A single vibrating segment is present during phonation (arrowed). There is slight narrowing of a shor segment of the lower cervical oesophagus which is not a vibrating segment as the walls are not in apposition.

rapid passage of barium. There is little or no residual barium in the pharynx after swallowing.

In patients with hypertonic pharyngeal muscles (Fig. 3a) or in those with spasm (Fig. 4a), some narrowing of the pharynx may be seen at rest, but this opens on swallowing a large gulp of barium (Fig. 3a) then closes again, often leaving a small amount of residual barium above the segment with an air-fluid level. An alternative picture, when the hypertonicity is not so severe, is to see two pharyngo-oesophageal (P-E) segments with a more dilated area between them.

In patients with a stricture there is narrow ing of the pharynx which does not dilate or swallowing. There is a definite hold-up of bar ium through the neo-pharynx with the patien complaining of dysphagia.

Phonation

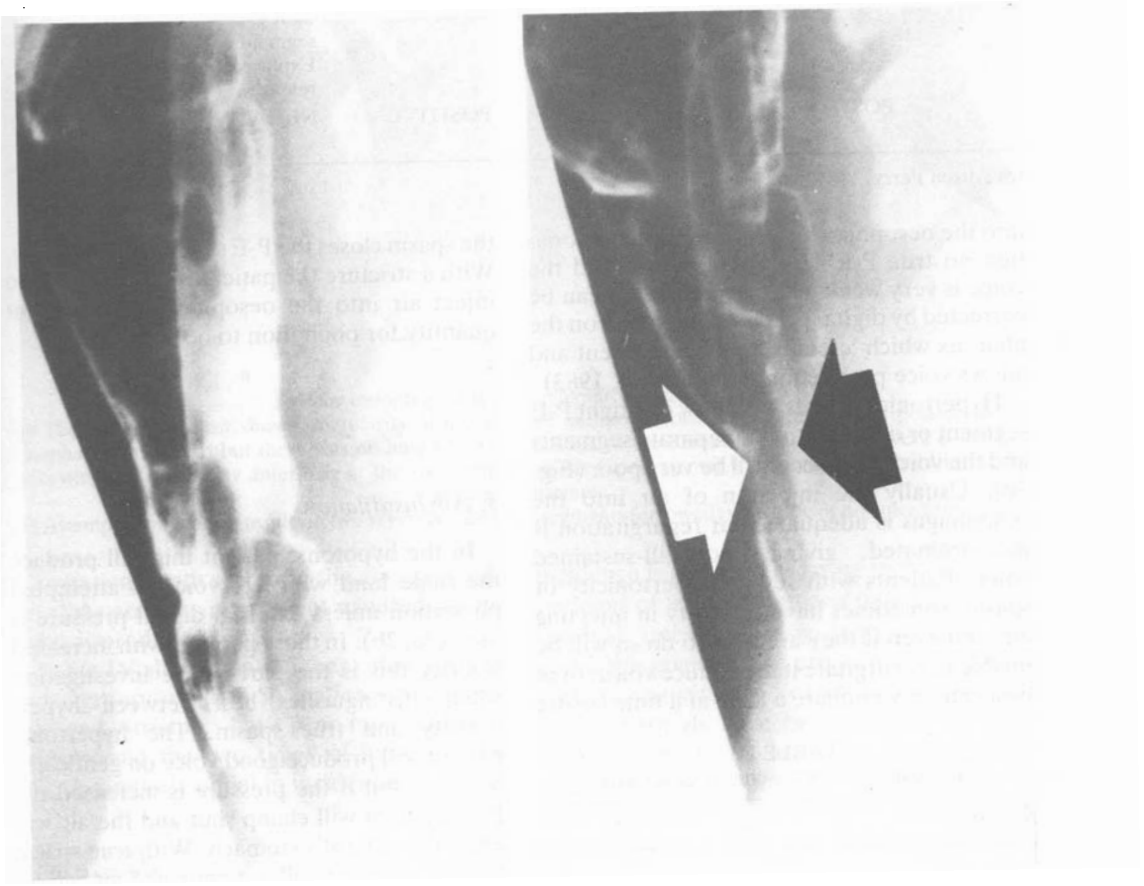
In hypotonic patients air is injected easily

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TABLE II

WEPMAN'S SEVEN-POINT SCALE OF SPEECH PROFICIENCY

Level	Oesophageal sound production	Speech proficiency
7	None	No speech
6	Involuntary only	No speech
5	Voluntary part of the time	No speech
4	Voluntary most of the time	Vowel sound (differentiated). Monosyllabic speech.
3	At will	Single word speech
2	At will with continuity	Word grouping
1	Automatic	Good oesophageal speech.
	Ratings: High = Inferior speech Low = Superior speech	



a FIG. 2 b

Poor oesophageal speaker (hypotonic group).
(a) The pharyngo-oesophageal segment dilates widely when phonation is attempted during air insufflation.
(b) Digital pressure applied to the neck during air insufflation produces a vibrating segment and good oesophageal speech.

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TABLE III
SUMMARY OF ASSESSMENT RESULTS:

	Good oesophageal voice	Hypotonicity	Hypertonicity		
		Hypotonic	Hypertonic	Spasm	Stricture
Barium Swallow	Pharynx-oesophagus opens. Fast motility.	Oesophagus-pharynx dilates. Fast motility.	Slight narrowing in tract visible, but dilates.	Slight narrowing in tract. Dilates.	Hold up to Ba Little/no dilation. Reports dysphagia. Slow motility.
Phonation	One P-E segment visible. Good oesophageal air reservoir	No P-E segment visible.	One tight or 2 P-E segments visible. Poor voice.	Very tight P-E segment. Oesophageal air is good. Very poor/no voice.	Little/no air penetrates oesophagus.
Air Insufflation Test.	Good voice—as own.	Whispery/no phonation	Better voice on *gentle* air-blowing.	No voice achieved. Very tight P-E segments. Explosively releases.	No voice-oesophagus inflates but no P-E opening.
	POSITIVE	SLIGHT POSITIVE	POSITIVE	NEGATIVE	NEGATIVE

(c) Alison Perry, 1984.

into the oesophagus but on attempted phonation no true P-E segment develops and the voice is very weak and whispery. This can be corrected by digital pressure externally on the pharynx which 'creates' the P-E segment and allows voice production. (Logemann, 1983).

Hypertonic patients will show one tight P-E segment or quite often two separate segments and the voice produced will be very poor (Fig. 3b). Usually the injection of air into the oesophagus is adequate, but regurgitation is inco-ordinated, giving poor, ill-sustained voice. Patients with severe hypertonicity or spasm, sometimes have difficulty in injecting air, and even if they are able to do so will be unable to regurgitate it to produce voice; or at best can only phonate a little at a time before the spasm closes the P-E segment completel With a stricture the patient is again unable t inject air into the oesophagus in sufficie quantity for phonation to occur.

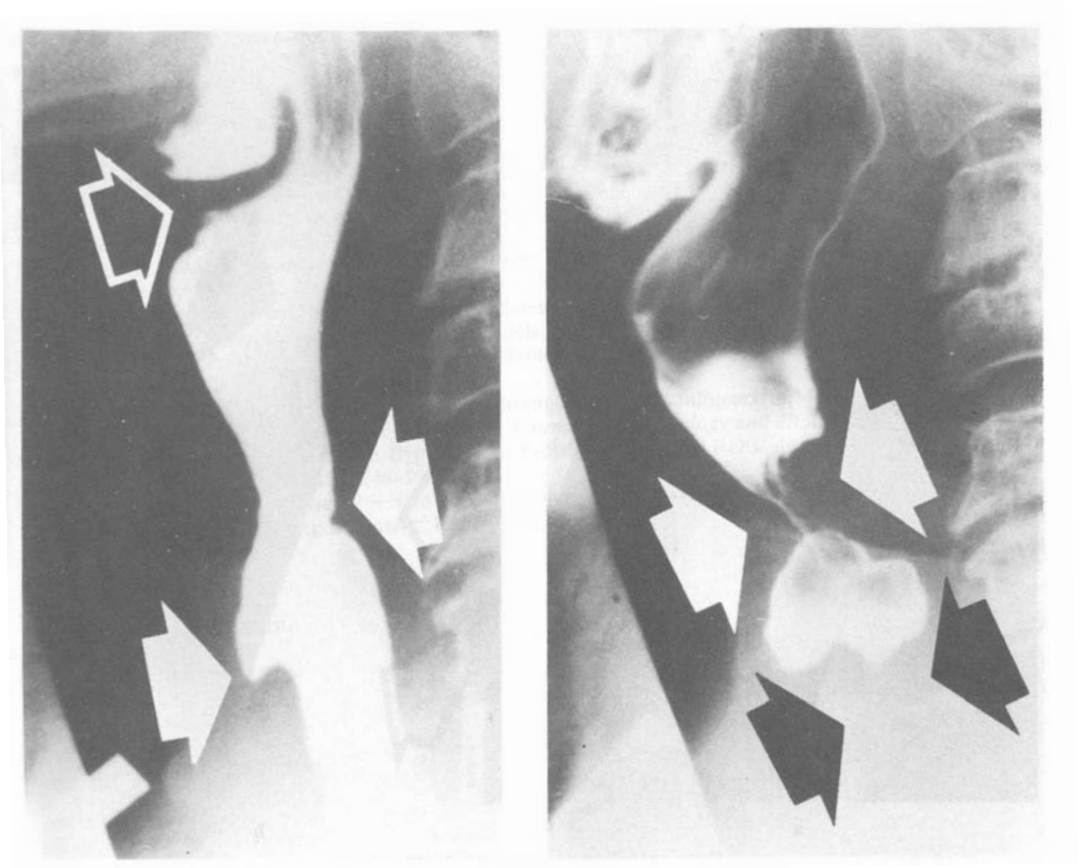
TABLE IV
CATEGORISATION OF 50 PATIENTS EVALUATED

N = 50	
Hypotonic	9
Good Oesophageal Voice	8
Hypertonic	17
Spasm	14
Stricture	2

3. Air Insufflation

In the hypotonic patient this will produ the same faint whispery voice as attempte phonation unless external digital pressure used (2a, 2b). In those patients with increase tonicity this is the part of the investigatic which distinguishes best between hype tonicity and true spasm. The hyperton patient will produce good voice on gentle ai blowing, but if the pressure is increased th P-E segment will clamp shut and the air w enter the patient's stomach. With true spas the P-E segment will not open and air will f the oesophagus and stomach. The examin will feel the resistance to blowing air and th patient will feel bloated and uncomfortab until the air is explosively released (Fig 4b)

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a FIG. 3 b

Poor oesophageal speaker (hypertonic group).
(a) The barium swallow shows irregularity of the anterior and posterior walls of the cervical portion-of the oesophagus (arrowed) but there was no hold up to the passage of the barium on screening. There is marked narrowing and deformity anteriorly at the site of anastomosis (open arrow) which caused no hold up to the passage of barium.
(b) Attempted phonation results in two severely narrowed segments (arrowed) with little or no voice production.

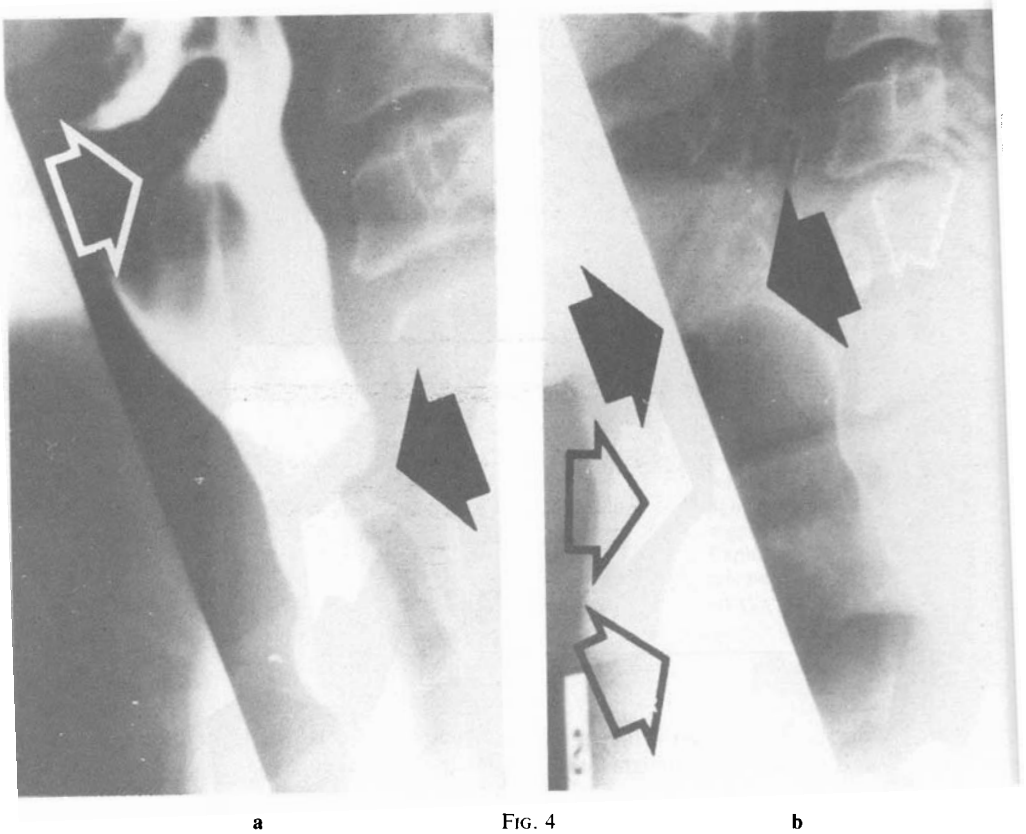
In patients with stricture, the air again inflates the oesophagus but is not released and no voice is produced.

Table IV shows the number of patients in each group of the 50 patients we have assessed. Strictures have been rare but hypotonicity and the two types of hypertonicity have been fairly equal in incidence.

4. Discussion

Failure to develop alaryngeal speech following total laryngectomy is not an uncommon problem. According to Johnson *et al.*, (1979) in their review of the literature the incidence is reported as being between 15–50 per cent of laryngectomized patients. As the survival rates following laryngectomy are good, this gives a large proportion of patients with unsatisfactory oesophageal speech. Many methods have been devised to overcome this problem, including surgically created tracheo-oesophageal fistulas, with or without valves but there is little in the literature describing the investigation of these patients' to identify the causes. It is often assumed that the failure is psychological rather than anatomical or physiological, inadequate or incorrect speech therapy or due to the patients learning difficulties.

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a FIG. 4 b

Poor oesophageal speaker (spasm group).
(a) The barium swallow shows a pouch arising from the posterior wall of the oesophagus at the pharyn oesophageal junction (arrowed) which is typical of crico-pharyngeal spasm. There was no hold up to the pass of barium on swallowing. There is narrowing and irregularity anteriorly at the site of anastomosis (open arr which does not hold up the passage of barium.
(b) Attempted air insufflation test results in complete occlusion of a short segment at the upper end of oesophagus (arrowed) with gross dilation of the lower cervical oesophagus (open arrow).

This study demonstrates that videofluoroscopy can often identify the causes of failed oesophageal voice and, more importantly, offers some indication of the correct form of treatment.

Analysis of the causes of failure show that they are all related to the type of surgery used for the pharyngeal repair. Pharyngeal reconstruction usually involves the suturing of the anterior remnants of the pharyngeal muscles. Although the nerve supply by the pharyngeal plexus and external laryngeal nerve is often disrupted at the time of laryngectomy, videofluoroscopy clearly demonstrates that re-inervation occurs and that the degree of tone in the pharyngo-oesophageal segment is important in the acquisition of alaryng voice. A separate study is being made of various types of pharyngeal closure in attempt to define those techniques benefi for voice production, but it is already cl that if a conventional 2-layer closure mucosa and muscle is performed, a poste pharyngeal myotomy should be performe the same time. Although this may lead hypotonicity, this is much easier to correct digital pressure than hypertonicity wh generally requires further surgery.

The results of treatment of the 50 patie will be presented as a separate paper.

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