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Total pharyngolaryngectomy and voice reconstruction with ileocolon free flap: Functional outcome and quality of life☆

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Summary Total pharyngolaryngectomy (PL) reconstruction with an ileocolon free flap not only restores swallowing but also provides potential for speech.

We report our surgical technique, functional outcome and quality of life (QoL) of 17 (15 males and two females) patients who underwent total PL/voice reconstruction with an ileocolon free flap between 2004 and 2009.

The patients were retrospectively reviewed and swallowing, speech and QoL evaluated. Speech intelligibility was assessed using Hirose and Chen scoring systems, in addition to sound spectrogram analysis. QoL was evaluated using the European Organisation for Research and Treatment of Cancer Core Questionnaire (EORTC QLQ-C30) in conjunction with the disease-specific Head & Neck Cancer Module (QLQ-H&N35).

The mean age of patients was 49 (range 35–69) years and the mean follow-up period was 22 (range 6–72) months. There was one partial flap failure and another flap was successfully salvaged.

Swallowing function was achieved by 16 (94%) patients at 4 weeks, whilst 12 (71%) demonstrated moderate-to-excellent speech intelligibility. There were no cases of aspiration pneumonia.

QLQ-C30 global QoL and functional subscales indicated patients had average-to-good functioning. Comparison of QLQ-H&N35 scores with EORTC reference values indicated our patients had greater difficulty with social contact, mouth opening and weight gain.

☆ This study received Institutional Review Board approval.
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Total PL/voice reconstruction with the ileocolon free flap is a viable option in selected patients, who desire autologous voice reconstruction. A low complication rate and reasonable QoL support this reconstructive method.

Introduction

Total pharyngolaryngectomy (PL) reconstruction can be achieved by different means, notably tubularised fasciocutaneous free flaps, intestinal free flaps and gastric pull-up.

In contrast to the former methods, gastric pull-up tends to be reserved for total pharyngoesophagectomy defects. The associated operative morbidity and mortality preclude its use for lesser defects.

The 'gold standard' reconstruction is controversial, with proponents for each technique. Nevertheless, the ideal reconstruction should be a single-stage procedure, entail minimal donor-site morbidity, promptly restore swallowing, have a low rate of stenosis or fistula, result in short hospitalisation and provide potential for alaryngeal speech.[1]

Regardless of the method of reconstruction, restoration of speech should be considered a key functional outcome. It is already recognised that loss of speech following laryngectomy adversely affects health-related quality of life (QoL).[2]

Patients who desire alaryngeal speech can use an artificial larynx and attempt oesophageal or tracheo-oesophageal (TE) speech. Of these, TE speech has been shown to be a successful option and is widely accepted.[3] This method of voice reconstruction involves the insertion of a voice prosthesis that connects the trachea to the remaining cervical oesophagus. To generate speech, the patients occlude their tracheostomy during expiration. Air is subsequently redirected via the prosthesis into the cervical oesophagus and neo-pharyngoesophageal segment (PES). The resultant vibration in the PES manifests as noise and, coupled with articulation, results in speech. The prosthesis contains a one-way valve mechanism that prevents food and liquid inadvertently passing from the cervical oesophagus into the trachea.

Although TE speech is successful in many, the procedure is not without complications.[4] Izdebski et al. reported 192 complications in their series of 95 patients.[5] Furthermore, the presence of a gap between the tracheal stump and cervical oesophagus following ablative surgery can preclude the use of voice prostheses.

All the early methods of autologous voice reconstruction have involved the creation of a tracheo-pharyngeal shunt, which acts in a manner analogous to voice prosthesis. Such methods included a subcutaneous dermal tube, oesophageal mucosal flap and shunt created from the membranous trachea.[6–8] All these methods, however, were hampered by the absence of a valve mechanism to protect the trachea from food and liquid that pass down the PES.

Total PL reconstruction with an ileocolon free flap is a relatively new technique that simultaneously restores continuity of the aerodigestive tract as well as voice.

In the original description by Kawahara et al., the caecum and ascending colon were used to reconstruct the pharynx, whilst the ileum was anastomosed to the cervical trachea, thereby acting as a tracheo-pharyngeal air-shunt.[9] The ileocaecal (Bauthin's) valve prevented entry of food or liquid into the trachea.

Although the literature has a small number of reports of total PL reconstruction with an ileocolon free flap, these reports only describe functional outcome.[10–12] There has been no previous report that has evaluated QoL.

In this study, we retrospectively evaluated functional outcome and QoL in surviving patients, who had undergone PL and voice reconstruction with an ileocolon free flap.

Patients and methods

All surviving patients who underwent total PL/voice reconstruction between January 2004 and July 2009 at E-Da Hospital, Taiwan, were reviewed.

The study was approved by the hospital review board and informed consent obtained.

Medical records were examined and data extracted according to a predetermined protocol. Patients were recalled to the outpatient clinic between August 2009 and May 2010 and interviewed, specifically with regard to swallowing ability and donor-site complications (e.g., ileus, abdominal pain and change in bowel habit).

Patients also underwent evaluation of speech intelligibility and completed the European Organisation for Research and Treatment of Cancer (EORTC) quality of life questionnaire (QLQ-C30, version 3.0) and supplementary disease-specific head-and-neck module (H&N35 version 1).[13]

Taiwanese language versions of QLQ-C30 and H&N35 were obtained from EORTC with permission. Assistance in completing the questionnaires was provided when requested.

Surgical procedure

A number of points merit reference:

(1) Patients receive bowel preparation prior to surgery.
(2) The preferred recipient vessels are transverse cervical artery and external jugular vein. Outflow from the latter is checked and the artery cut back to a more proximal level, if flow appears inadequate (Figure 1).
(3) The flap is positioned in the neck to act in an isoperistaltic manner (Figure 2).
(4) Following microvascular anastomosis, the caecum is opened and the ileocaecal valve plicated to narrow the opening to 5 mm (Figure 3).
(5) An irrigation catheter is placed near the vascular anastomosis and 1 ml of 2% Xylocaine infused hourly for 24 h postoperatively.

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Figure 1 Ileocolic flap is composed of 10–15 cm ascending colon and 15–20 cm ileum depending on the length of the defect.

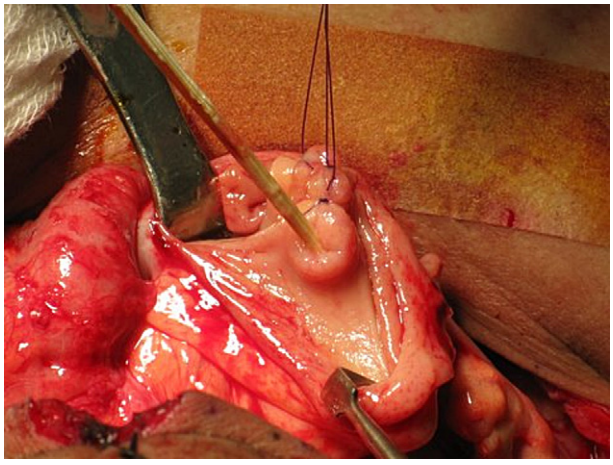

Figure 3 Plication of the ileocaecal valve. Probe has been inserted into the valve.

Speech intelligibility

Speech intelligibility was evaluated using Hirose's scoring system for speech evaluation.[14] We chose this scoring system as it assesses communication from a pragmatic perspective.

Points were awarded on the following basis: 5 if the listener could clearly understand the patient, 4 if the listener could not understand occasionally, 3 if the listener could understand when they knew the subject to be discussed, 2 if the listener could understand on occasions and 1 point if the listener could not understand at all.

A family member and a clinical assistant separately scored each patient. The combined score indicated the degree of intelligibility: 10–8 points = excellent, 7–5 points = moderate and 4–2 points = poor.

A second evaluation of speech intelligibility was also performed using the senior author's (HCC) scoring system. Patients were required to speak five phrases: "What is your name?", "Where do you live?", "I am hungry", "Have you had dinner?" and "Please help me". A family member and a clinical assistant separately counted the number of sentences that were intelligible. The combined total indicated the degree of intelligibility: 10–8 sentences = excellent, 7–5 sentences = moderate and $\leq$4 = poor.

Quantitative analysis of speech was performed using sound spectrogram analysis. Maximum phonation time (MPT) was measured by asking the patient to say 'ah' (i.e., pronounce the vowel 'a') in one breath at a comfortable level of intensity. The best of three attempts was chosen. Mean frequency and dynamic range were also measured.

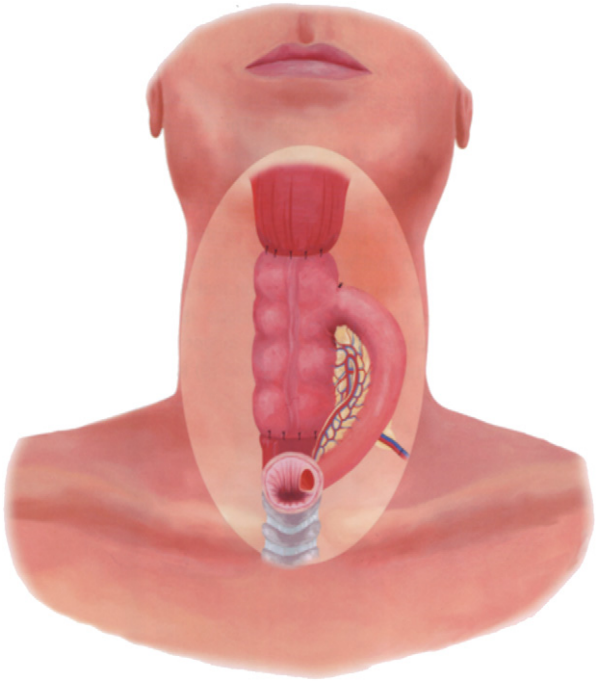

Figure 2 Flap inset. The caecum is opened and anastomosed to the pharynx, ascending colon anastomosed to cervical oesophagus and ileum (voice tube) anastomosed to trachea. When deciding upon the length of the voice tube, it is essential that the ileal-tracheal anastomosis is tension-free. Shortening the voice tube can be performed at a later date if necessary.

QoL instruments

The EORTC QLQ-C30 (version 3.0) is a 30-item self-reporting questionnaire that assesses symptoms commonly experienced by cancer patients. It has been validated in diverse samples of cancer patients in a number of studies in North America, Europe and Taiwan.[15–18]

The questionnaire is composed of five functional subscales (role, physical, cognitive, emotional and social functioning), three symptom subscales (fatigue, pain and nausea/vomiting), a global QoL subscale and six single items (dyspnoea, insomnia, appetite loss, constipation, diarrhoea and financial difficulties). Items 1–28 are scored on a four-point Likert scale (categorical responses include "not at all" = 1, "a little" = 2, "quite a bit" = 3 and "very much" = 4). Items 29 and 30 are scored on a visual analogue scale, ranging from 'very poor' = 1 to 'excellent' = 7. The QLQ-C30 is a core instrument that is intended to be used in conjunction with a disease-specific module.

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Table 1 Details of ablative surgery.

Patient	Category[a]	Tumour location	TNM	Previous treatment	Resection	Co-morbidity
1	2	Larynx	T2N0M0	RT. Subsequent osteoradionecrosis of larynx and pharyngeal wall. Underwent tracheostomy, temporary pharyngostomy and oesophagostomy		
2	1	Hypopharynx	T3N2M0		Total pharyngolaryngectomy, RmRND(II)	
3	3	Hypopharynx	T2N1M0	RT	Total pharyngolaryngectomy, LmRND(III), hemithyroidectomy.	
4	2	Hypopharynx[b]	–	Partial laryngectomy + RT. Gradually unable to speak and stenosis of oesophagus. Suffered oesopheageal tear secondary to bougination		
5	1	Hypopharynx	T4N1M0		Total pharyngolaryngectomy, RmRND(II), LmRND(III), subtotal thyroidectomy	Head injury 2 years after surgery
6	2	Larynx[b]	–	RT		Heroin addict, Hepatitis B & C
7	1	Hypopharynx	T4N1M0		Total pharyngolaryngectomy, RmRND(II), LmRND(III), hemithyroidectomy	Chronic renal failure
8	1	Thyroid	T4N2M0		Total pharyngolaryngectomy, RmRND(III), LmRND(I), total thyroidectomy	
9	2	Larynx[b]	–	Partial laryngectomy + RT. Gradually unable to speak and stenosis of oesophagus		
10	1	Hypopharynx	T3N2M0		Total pharyngolaryngectomy (defect extending to nasopharynx), RmRND(II), LmRND(III)	
11	3	Hypopharynx	T4N2M0	RT + Ch	Total pharyngolaryngectomy, RmRND(I), LmRND(II), subtotal thyroidectomy	Hepatitis B, liver cirrhosis
12	1	Hypopharynx	T3N1M0		Total pharyngolaryngectomy, RmRND(III), hemithyroidectomy.	
13	1	Hypopharynx	T2N0M0		Total pharyngolaryngectomy, RmRND(II), LmRND(II)	
		Oesophagus	T1N0M0		Oesophagus - EMR	
14	1	Hypopharynx	T3N1M0		Total pharyngolaryngectomy, RmRND(II), LmRND(II), hemithyroidectomy	Previous treatment for buccal Ca, suffering from trismus

15	3	Hypopharynx	T4N2M0	RT + Ch	Total pharyngolaryngectomy (defect extending to nasopharynx), LmRND(II), hemithyroidectomy	
		Oesophagus	T1N0M0		Oesophageal Ca - EMR.	
16	2	Thyroid[b]	–	Total thyroidectomy. Postoperative complication of partial ischaemic necrosis of larynx, pharynx and cervical oesophagus. Subsequently underwent pedicled colon interposition		
17	1	Hypopharynx	T3N2M0		Total pharyngolaryngectomy, RmRND(II)	Previous treatment for L tonsil Ca (T2N2bM0), received surgery + RT, oesophageal Ca - EMR

Patients listed in chronological order of surgery.
Patients 13 & 15 had synchronous tumours.
RT = radiotherapy, Ch = chemotherapy, Ca = cancer, EMR = endoscopic mucosal resection, RmRND(II) = right modified radical neck dissection type II.
[a] 1 = cancer resection & immediate reconstruction; 2 = delayed reconstruction; 3 = salvage resection & reconstruction.
[b] TNM stage not known as patient underwent intial treatment elsewhere.

The QLQ-H&N35 module is a 35-item questionnaire that assesses symptoms encountered specifically by head-and-neck cancer patients.[19] There are seven subscales (pain, swallowing, sense problems, speech problems, trouble with social eating and social contact and less sexuality) and 11 single items (teeth, opening mouth, dry mouth, sticky saliva, coughing, felt ill, painkiller use, nutritional supplementation, feeding tube requirement, weight loss and weight gain). All subscales and items relate to symptoms. Items 31–60 are scored on a 4-point Likert scale, with the same categorical responses as in QLQ-C30. Items 61–65 have a "no/yes" response format.

QLQ-H&N35, in conjunction with the QLQ-C30, is reliable, valid and applicable to broad multicultural samples of head-and-neck cancer patients.[20]

Both QLQ-C30 and H&N35 subscales and single items were scored and linearly transformed to scales of 0–100. High scores on the functional subscales and global health status indicate a higher level of functioning, whereas high scores on the symptoms scales and single items indicate a high level of symptoms.

For missing responses, the relevant subscale score was calculated with available responses, that is, the missing response item was disregarded and subscale score calculated with available answers, as suggested by the scoring manual.

Data analysis

With regard to QLQ-C30 data, functional scale and global health QoL scores $\leq$33% and $\geq$66% were taken to indicate problematic and good functioning, respectively. For symptom scales, a score $\leq$33% was considered to reflect low level of symptoms, whereas $\geq$66% was taken to indicate a high level of symptoms. These cut-offs were derived from a general population study.[21]

The H&N35 data were compared with EORTC reference data using Student's *t*-test. Square-root transformation of the H&N35 data was performed prior to statistical analysis. The EORTC reference data were derived from a sample of 436 patients with stage I–IV larynx/hypopharynx cancer.[22]

Data were analysed using Statistical Package for Social Sciences (version 15, SPSS Inc., Chicago, IL, USA).

Results

There were 17 patients available for evaluation, consisting of 15 males and two females, with a mean age of 49 years (range 35–69). The mean follow-up period was 22 months (range 6–72) (Table 1).

Forty (38 males and two females) patients originally underwent total PL/voice reconstruction with an ileocolon free flap between January 2004 and July 2009. However, at the time of review (August 2009), there were 12 (30%) deaths and 11 patients excluded. The reasons for exclusion included: eight (20%) could not be contacted, two (5%) refused to participate in the study and one (2.5%) suffered a cerebrovascular accident and could not communicate.

All deaths were due to disease recurrence and occurred well beyond the 30-day postoperative period.

Patients were categorised into three groups:

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Table 2 Reconstruction details.

Patient No.	Flap modifications[a]	Postop treatment	Complications	Further procedures (months following reconstruction)
1				Release of stricture at colo-oesophageal anastomosis (14), tracheostomy revision (27), shortening of ileal loop (18),
2	Thyrocervical trunk & EJV		Necrosis of anterior wall of ileal loop, reconstruction with DP flap	Tracheostomy revision (14), buccal Ca resection & reconstruction with ALT & reconstruction plate (54)
3	Ascending pharyngeal A & EJV			Revision tracheostomy (4)
4				Release of stricture at colo-oesophageal anastomosis (9)
5	Antiperistaltic	RT + Ch		Tracheostomy revision (13), neck scar contracture release (16)
6	Antiperistaltic	RT + Ch		
7		RT + Ch		Release of stricture at colo-oesophageal anastomosis (12)
8	Ascending pharyngeal A & EJV			Voice hood[b]
9			Wound dehiscence covered with DP flap	
10	Thyrocervical trunk, ileal loop not anastomosed to trachea	RT		Delayed anastomosis of ileal loop to trachea (1), shortening of ileal loop & secondary plication of ileocaecal valve (3), tracheostomy revision and release stricture at colo-oesophageal anastomosis (8)
11		RT + Ch	Stricture at colo-oesophageal anastomosis	Narrowing of tracheostomy (4)
12		RT		
13	Antiperistaltic	RT		
14		RT		
15				
16	Patch, thoracoacromial A&V		Two separate returns to operating room because of pedicle thrombosis	Revision of trachea-voice tube junction, shortening of ileum and dilation of tracheostome (2)
17	STA & IJV			

Some patients refused chemotherapy.
DP = deltopectoral, PL = pharyngolaryngectomy, PLE = pharyngolarynoesophagectomy, CPL = circular pharyngolaryngectomy, EJV = external jugular vein, IJV = internal jugular vein, STA = superior thyroid artery, A = artery, V = vein.
[a] All flaps had an isoperistaltic inset, anastomosed to transverse cervical artery and external jugular vein and ileal loop anastomosed to trachea primarily, unless indicated. Patch refers to de-tubularised ileocolon.
[b] Creation of a skin flap adjacent to tracheostomy, used to occlude the tracheostomy when speech required.

Table 3 Speech assessment results.

Patient no.	Hirose score	Chen score	Maximum phonation time (s)	Mean frequency (Hz)	Dynamic range (dB)	Mean of dynamic range (dB)
1	10	9	15	153.9	21.6–65.7	55.9
2						
3	8	8	28	89.5	59.8–76.3	70.8
4	8	8	3	162	51.3–73.2	69.1
5						
6	7	6	13	177.4	61.5–76.5	70.4
7	5	6	9	107	32.3–71.4	58.4
8						
9	5	5	3	94.8	53.3–83.9	74.2
10	6	6				
11	4	4	4	104.1	33.1–61.8	56
12	6	5				
13	10	9	3	104.6	30.9–70.3	60.1
14						
15	4	4	5	105.4	39.1–64.3	58.5
16	5	4	7	147.5	32.9–63.3	47.8
17						

Shaded rows indicate patients who could not speak.
No. 8 could speak but refused assessment.
Adult norms: maximum phonation time males 20 secs, females 15 secs. Mean frequency males 80–150, females 180–250 Hz. Dynamic range 30–115 dB.

I cancer resection and immediate reconstruction;
II delayed reconstruction (previously underwent surgery ± radiotherapy at another hospital); and
III salvage resection and reconstruction (previously treated with radiotherapy ± chemotherapy).

Group I comprised nine (52.9%) patients, group II had five (29.4%) patients and group III had three (17.6%) patients.

Sixteen (94%) patients commenced soft-diet oral feeding by 4 weeks and one (6%) patient suffered dysphagia as a result of stricture at the colo-oesophageal anastomosis. Following bougination, the patient was able to swallow liquids or pureed food. One (6%) patient (No. 2) subsequently underwent treatment for buccal cancer and abandoned oral feeding.

The average inpatient stay was 23.8 days (range 21–37).

There were no flap failures but there was one partial failure that necessitated a deltopectoral flap, to restore continuity of the voice tube (Table 2; No. 2). There was no obvious explanation for this partial failure. One patient (No. 16) had two separate returns to the

Table 4 QLQ-C30 scores.

Subscale	Mean score	Standard deviation	% scoring $\leq$ 33.3%	% scoring $\geq$ 66.7%
Global QoL/general health	55.9	28.1	23.5	47.1
Functional				
Physical functioning	78.4	25.6	11.8	76.5
Role functioning	59.8	28.9	29.4	58.8
Emotional	70.6	28.4	11.8	76.5
Cognitive	83.3	19.5	5.9	94.1
Social	65.7	30.9	17.6	70.6
Symptom				
Fatigue	38.6	30.7	52.9	23.5
Nausea & vomiting	8.8	17.8	88.2	0.0
Pain	16.7	20.4	88.2	5.9
Dyspnoea	25.5	34.4	82.4	17.6
Insomnia	27.5	31.7	88.2	11.8
Appetite loss	17.6	31.4	82.4	17.6
Constipation	17.6	29.1	88.2	11.8
Diarrhoea	21.6	28.7	88.2	11.8
Financial difficulties	37.3	35.1	64.7	35.3

For functional scales, patients scoring $\leq$ 33.3% have problems; those scoring $\geq$ 66.7% have good functioning.
For symptom scales, patients scoring $\leq$ 33.3% have low symptomology; those scoring $\geq$ 66.7% have problems.

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Table 5 H&N35 scores.

Subscale	Mean	SD	EORTC reference values[c]		p value
			Mean	SD	
Pain	16.2	19.0	35.3	21.0	ns
Swallowing	43.6	29.4	36.7	24.2	ns
Sense problems	43.1	40.4	38.7	33.7	ns
Speech problems	31.4	36.3	50	25.5	ns
Trouble with social eating	41.2	38.2	32.4	24.9	ns
Trouble with social contact	62.7	37.0	28.3	22.1	0.028
Less sexuality	42.2	28.3	46.8	35.2	ns
Teeth	49.0	39.3	36.5	31.4	ns
Opening mouth	69.0	27.1	30.5	28.6	0.033
Dry mouth	33.3	42.5	44.1	33.5	ns
Sticky saliva	48.2	29.2	45	33.9	ns
Coughing	46.6	31.6	54.8	35.3	ns
Felt ill	39.2	35.8	40.9	31.3	ns
Painkillers	29.4	47.0	71.5	45.2	ns
Nutritional supplements	41.2	50.7	61	48.8	ns
Feeding tube[a]	43.8	51.2	58	49.4	ns
Weight loss[a]	56.3	51.2	67.1	47.0	ns
Weight gain[b]	14.3	36.3	58	49.4	0.028

ns = not significant.
[a] 1 missing response.
[b] 3 missing responses.
[c] Reference values from a sample of 436 patients with stage I–IV larynx/hypopharynx cancer.

operating room because of pedicle thrombosis. The flap was successfully salvaged and the patient had an uncomplicated recovery. The overall success rate, defined as complete flap survival and no microvascular revision, was 88% (15 of 17).

There were no cases of aspiration pneumonia. One patient (No. 9) suffered neck-wound dehiscence, which required closure with a deltopectoral flap. This patient had previously received radiotherapy. A few patients experienced intestinal hurry manifesting as frequent and loose stool, which resolved by 4 weeks. There were no bowel anastomotic leaks or problems with laparotomy wound healing.

In one patient (No. 10), the ileal loop was not anastomosed to the trachea at the time of reconstruction, as the resulting tension was considered hazardous to flap survival. The tracheo-ileal anastomosis was performed 1 month later.

Speech intelligibility and sound spectrogram analysis

Thirteen (76%) patients were able to speak but one patient refused speech evaluation (Table 3). Four (24%) patients could not speak (two had difficulty with articulation as a result of buccal cancer treatment, one suffered head injury and one had not commenced voice training). The mean interval between reconstruction and speech analysis was 16.8 (range 1–59) months.

According to Hirose and Chen scoring of speech intelligibility, four patients were excellent and eight moderate.

Ten (59%) patients consented to sound spectrogram analysis, but two (12%) declined. The mean MPT was 9 s (range 3–28) and the mean frequency 124.6 Hz (range 89.5–177.4). The mean of dynamic range was 62.1 dB (range 47.8–74.2).

Quality of life

All 17 patients completed the EORTC QLQ-C30 and H&N35 questionnaires (Tables 4 and 5).

A total of five responses (0.8%) in three separate H&N35 questionnaires was missing. The questions that were not answered included "Have you used a feeding tube?," "Have you lost weight?" and "Have you gained weight?."

With regard to QLQ-C30, the mean score for global QoL/general health (55.9) and five functional subscales (range 59.8–83.3) indicated patients had average-to-good functioning.

'Role functioning' was the most problematic functioning, with 29.4% of patients scoring 33.3% or less. 'Financial difficulties' was the most problematic symptom, with 35.3% scoring 66.7% or more.

Comparing QLQ-H&N35 mean scores with EORTC reference values indicated our patients had more trouble with social contact, mouth opening and weight gain. There were no significant differences with regard to the remaining subscales.

Discussion

The results of this study indicate swallowing was restored in a high proportion of patients (94%). Interestingly, the H&N35 score for swallowing for our patients was not statistically different from that of the pre-treatment

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reference values. One could infer that reconstruction with the ileocolon free flap did not 'worsen' swallowing QoL. We appreciate there are limitations to this interpretation.

Moderate-to-excellent intelligible speech was possible in 12 (71%) of our patients. One advantage of ileocolon free flap reconstruction is that voice training can begin soon after completion of adjuvant radiotherapy. This is in contrast with tracheosophageal puncture and indwelling voice prosthesis, which is often delayed following completion of adjuvant radiotherapy.

Achieving intelligible speech soon after surgery is paramount for these patients, in light of their poor prognosis and short life expectancy.[23]

Ileocolon voice reconstruction tends to produce a lower pitched voice, as evidenced by a mean frequency of 124.6 Hz. A mean dynamic range of 62.1 dB indicates patients could produce a reasonably loud voice.

Although voice quality with an ileocolon free flap is criticised for having a 'wet' and/or coarse quality, we have previously shown patients prefer this voice reconstruction over a pneumatic artificial larynx.[24] In another study, voice was perceived to be superior with the use of ileocolon compared with an electronic larynx.[25]

It is possible that lower tonicity of the voice tube (ileal loop) and the colon are responsible for the characteristic 'wet' voice, compared with a more rigid skin tube reconstruction and indwelling voice prosthesis.

With regard to the general QoL evaluation, the results indicated our patients had an average-to-good level of functioning and low symptom burden.

To our knowledge, there has been no previous study of QoL following PL reconstruction with an ileocolon free flap.

With regard to the head-and-neck-specific QoL evaluation, patients had significant difficulty with speech and social interaction. Although 71% of our patients had moderate-to-excellent speech intelligibility, the low scores for the aforementioned domains is unsurprising. The devastating effect of laryngectomy should not be underestimated.

Ileocolon free flap reconstruction following total PL offers a number of advantages; Regardless of an isoperistaltic or antiperistaltic inset, colon diameter is well-matched to the oropharynx or nasopharynx. Healing between intestinal mucosa and oral mucosa quickly proceeds. Indeed, none of our patients experienced pharyngocutaneous fistula.

Reliability of the ileocaecal valve does not diminish over time, voice training can start soon after completion of adjuvant radiotherapy and anatomy of the flap pedicle is constant.

For patients in whom only primary or secondary 'voice reconstruction' is required, the colon can be de-tubularised to create an ileocaecal 'patch' flap.[26,27] Similar to the findings of others, none of our patients had healing difficulty between the trachea and ileum.[10,11] Although the ileum performs a predominantly absorptive function, there was a small volume of secretion for 2 weeks postoperatively. To prevent secretions entering the tracheostomy, we inset a drainage tube into the ileum via the tracheostomy. We do not know if a histological change to the ileal mucosa is responsible for the eventual decreased secretion.

Optimal flap inset is not known, with both isoperistaltic and antiperistaltic flap inset previously reported with satisfactory results.[11] Our preference is an isoperistaltic inset with the advantage of peristalsis facilitating swallowing. However, the disadvantage is that a longer segment of ileum (voice tube) is required to connect to the trachea. Resultant air trapping within the ileum and greater expiratory pressure required to divert air into the neo-PES, may adversely effect phonation. On the other hand, the high position of the valve in the neopharynx potentially reduces the risk of aspiration.

Succo et al. suggests less pulmonary pressure is required to generate voice when the flap has an antiperistaltic inset. This relates to the shorter segment of ileum between the trachea and colon.

In our series, three patients had antiperistaltic flap insets. Two of these patients demonstrated excellent and moderate speech intelligibility. As colonic peristalsis is not as strong as compared with the jejunum, we do not believe the antiperistaltic flap inset adversely affects swallowing ability.

Stricture at the oesophago-colic junction occurred in four (23.5%) patients, at a minimum of 8 months post-operatively. In some patients, the narrowing was due to oesophageal mucosal hypertrophy.

The size mismatch between the cervical oesophagus and the colon is often significant. When performing the end-to-end anastomosis, we now widen the oesophagus by incising the anterior wall by 1.5 cm, thereby creating a funnel end. This modification has been effective for the majority of our patients.

Although our experience of total PL reconstruction with an ileocolon free flap is increasing, much remains unanswered. As yet, we do not know the optimal length of voice tube, influence of voice tube and colon wall tonicity on speech quality, influence of expiratory pressure and effect of radiotherapy.

The situation is further compounded by the lack of objective evaluation of speech outcomes, making comparison between different surgical voice reconstruction methods difficult.

This study is not without limitations. As the study was restricted to only surviving patients, the data may not accurately represent the original group of 40 patients, who had undergone reconstruction with ileocolon.

Our QoL evaluation was administered as a cross-sectional study. If the evaluation was performed on a longitudinal basis instead, the data would have provided a valuable insight into patient's experience over time. Furthermore, one could also identify changes over time that correlate with high and low QoL. However, a major disadvantage of a longitudinal design is dropout, which is particularly pertinent to this study, given the short survival time.

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Conflict of interest statement

None.

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