

## Current status of near-total laryngectomy: review

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### Abstract

Concurrent chemoradiation is currently the accepted 'standard of care' for locally advanced laryngeal and hypopharyngeal cancers. However, there is a subset of patients not suitable for chemoradiation, in whom primary surgery is the best option. Speech preservation is of prime importance in these patients. Near-total laryngectomy is a voice-preserving procedure which can be considered as an alternative to total laryngectomy for selected patients with lateralised, locally advanced cancers of the larynx and hypopharynx. Although these patients are left with a permanent tracheostomy, lung-powered speech is maintained by way of a dynamic shunt created from the uninvolved tissues of the larynx. Since its first description in the early 1980s, the procedure has been shown by various authors to be oncologically sound, with high success rates. Unfortunately, the procedure has not gained wide acceptance due to perceived fears of surgical complexity. In this review, we discuss the various issues related to the procedure and we review the relevant literature.

**Key words:** Larynx Cancer; Laryngectomy; Speech

### Introduction

There has been a paradigm shift in the management of patients with laryngeal and hypopharyngeal cancers. Concurrent chemoradiation is now the accepted 'standard of care' for these patients.

However, this treatment has its limitations, and benefits a select subset of patients with tumour stage (T) two, three and (in a small number) four cancers. Issues such as toxicity and poor tolerance may further preclude its routine use.

Therefore, there is still a definite group of patients with locally advanced cancer who require total laryngectomy as primary surgery, with ensuing loss of voice.

Following total laryngectomy, the tracheoesophageal puncture prosthesis is the 'gold standard' for speech restoration, with high success rates of up to 90 per cent.<sup>1–3</sup> However, this technique has its limitations, namely complications, recurrent costs, device maintenance and physician dependence.

The near-total laryngectomy procedure is a useful alternative in patients who cannot avoid total laryngectomy. This procedure is as radical as total laryngectomy in terms of disease management, but makes use of the uninvolved contralateral laryngeal mucosa to fashion a dynamic shunt between the trachea and the neopharynx. Speech is lung-powered, and aspiration is avoided as the shunt is dynamic. Most importantly, the procedure has a high success rate (90 per cent),

similar to that for tracheoesophageal puncture prosthesis, and once successful stays so for life, avoiding the recurrent costs associated with device change and maintenance.

Unfortunately, near-total laryngectomy has not gained worldwide acceptance despite numerous publications confirming its oncological safety and functional success. In this review, we discuss the procedure and review the relevant literature.

### Historical background

Near-total laryngectomy was first described by Pearson *et al.* in the early 1980s and is often referred to as the Pearson procedure.<sup>4</sup> Other synonyms for the procedure are extended vertical hemilaryngectomy, subtotal laryngectomy and parsimonious laryngectomy.<sup>4–6</sup> However the most commonly accepted terminology is the near-total laryngectomy.

### Prerequisites

The near-total laryngectomy is ideal for patients who have unilateral laryngeal or pyriform disease limited to one side of the larynx, with sufficient uninvolved contralateral mucosa to be fashioned into a voice shunt.

The essential prerequisites for the procedure are: (1) a contralateral, uninvolved, mobile arytenoid and posterior half of the true vocal fold; and (2) a free interarytenoid and post-cricoid region, to ensure oncological safety of the resection margins.

## Indications

Near-total laryngectomy is suitable for all cases amenable to total laryngectomy, provided the above prerequisites are met. These include: T<sub>3</sub> and T<sub>4</sub> cancers of the larynx and pyriform fossa; patients whose radiotherapy has failed; and cases compatible with resection of the pharynx and limited areas of the tongue base, with or without flap reconstruction.

## Contraindications

There are two main contraindications to near-total laryngectomy.

Involvement of the interarytenoid and postcricoid regions is an absolute contraindication, as this compromises the oncological safety of the resection.

Subglottic disease is not an absolute contraindication to the procedure, as the patient will have a permanent tracheostoma. However, extensive posterior subglottic extension will leave insufficient mucosa to fashion the shunt, and is thus a relative contraindication.

## Types

Near-total laryngectomy is suitable for both laryngeal and hypopharyngeal cancers, and requires the resection of variable amounts of pharyngeal mucosa.

Three types of near-total laryngectomy have been described, based on the amount of pharyngeal resection, as follows: (1) near-total laryngectomy proper, used primarily for pure glottal lesions; (2) near-total laryngopharyngectomy, which involves partial resection of pyriform fossa mucosa with primary closure; and (3) extended near-total laryngopharyngectomy, which involves more extensive hypopharyngeal mucosa resection necessitating a flap repair.

## Technique

A detailed description of the near-total laryngectomy procedure is beyond the scope of this article but has been well presented elsewhere.<sup>4,7</sup>

In terms of disease management, the procedure is as radical as total laryngectomy, with removal of the ipsilateral thyroid cartilage, ipsilateral cricoid cartilage segments and upper tracheal rings, in order to ensure wide excision of the tumour. The pre- and para-glottic spaces are removed along with the ipsilateral strap muscles and thyroid gland. The procedure is compatible with appropriate nodal dissection in the lateral and central compartments.

The success of the procedure is based on the creation of a dynamic myomucosal shunt using a laryngotracheal remnant, the diameter of which should fit a 14 French Foley's catheter. Therefore, the utmost care must be taken to preserve the contralateral recurrent laryngeal nerve and cricoarytenoid joint. The patient will be left with a permanent tracheostoma, as for total laryngectomy, and voicing will require the use of a thumb, as for the tracheoesophageal puncture prosthesis. The neopharynx is created either by primary closure using

uninvolved pyriform fossa mucosa, or by augmented closure using an appropriate flap.

## Outcome measures

The success of near-total laryngectomy is assessed based on its oncological safety, the presence and quality of post-operative speech, and complications.

### *Oncological safety*

Throughout the literature, published cure rates confirm the safety of near-total laryngectomy, with control rates similar to those achieved with total laryngectomy.

In the largest series, 225 cases reported by Pearson *et al.*, five-year local control rates were comparable to those for total laryngectomy.<sup>8</sup>

Aslan *et al.* studied 135 patients undergoing near-total laryngectomy between 1989 and 2000, and analysed survival in 124 patients.<sup>9</sup> Survival rates for T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub> cancers were 50, 64.2 and 73.3 per cent, respectively; these differences were not statistically significant.

The oncological safety of near-total laryngectomy was further demonstrated in a series of 137 patients with laryngeal and pyriform fossa cancer managed at our institution between 1989 and 1999.<sup>7</sup> After a median follow up of 35 months, 70.1 per cent of patients were alive and disease-free. The local and locoregional recurrence rate was 7.3 per cent.

However, in cases with subglottic extension, the oncological safety of near-total laryngectomy is debatable. Aslan *et al.* compared results for supraglottic and transglottic cancers without subglottic extension to those for laryngeal cancer with subglottic extension. The five-year survival rates for transglottic, supraglottic and subglottic cancers were 65.8, 53.8 and 20 per cent, respectively.<sup>10</sup> The presence of subglottic extension increased the risk of local and peristomal recurrence. Thakar *et al.* also found inferior functional outcomes for near-total laryngectomy in cases with subglottic extension.<sup>11</sup> In their 1998 series, Pearson *et al.* did not find any local recurrence in cases with subglottic extension.<sup>8</sup> However, extensive subglottic spread, particularly posteriorly, precludes the use of this procedure and is one of its relative contraindications.

Near-total laryngectomy is possible even in the presence of cervical lymphadenopathy. Aslan *et al.* found survival rates for node stage (N) one and two disease of 84.2 and 66.7 per cent, respectively.<sup>9</sup> All patients with N<sub>3</sub> disease died, which is understandable given the advanced nature of the disease. In our previous series of 137 cases, nodal disease was present in 83 (60.6 per cent) patients, comprising 23 N<sub>1</sub> cases, 46 N<sub>2</sub> cases and 14 N<sub>3</sub> cases. Regional recurrence alone occurred in 11.7 per cent of cases, and locoregional recurrence in 2.2 per cent.<sup>7</sup> Table I summarises the results of literature published to date.<sup>4,7,10–23</sup>

TABLE I  
PUBLISHED NEAR-TOTAL LARYNGECTOMY SURVIVAL RATES

Study	Pts (n)	Site (pts; n)	Time period	Survival rate
Pearson <i>et al.</i> <sup>4</sup>	7	Larynx	3 mth to 5 yr FU	100%
Singh & Hardcastle <sup>12</sup>	4	Larynx (3) Hypopharynx (1)	1.3 yr	100%
Lima <i>et al.</i> <sup>13</sup>	28	Larynx	1990–1994	85% (3-yr disease-free survival)
Andrade <i>et al.</i> <sup>14</sup>	42	Larynx (37) Hypopharynx (5)	1988–1995	81.7% larynx (5-yr overall survival) 66.6% hypopharynx (5-yr overall survival)
Thakar <i>et al.</i> <sup>11</sup>	28	Larynx (16) Hypopharynx (12)	1996–2005	74% (4-yr disease-free survival)
Shenoy <i>et al.</i> <sup>15</sup>	54	Larynx (14) Hypopharynx (40)	1991–1996	74% larynx (3-yr disease-free survival) 66% pyriform fossa, medial wall (5-yr survival) 54% pyriform fossa, lateral wall (5-yr survival)
Maamoun <i>et al.</i> <sup>16</sup>	39	Larynx	1998–2001	76% (2-yr disease-free survival)
Kavabata <i>et al.</i> <sup>17</sup>	15	Larynx (12) Hypopharynx (1) Oropharynx (2)	1993–2002	81.6% (3-yr actuarial survival)
Aslan <i>et al.</i> <sup>10</sup>	74	Larynx	1989–2000	65.8% transglottis (5-yr survival) 53.8% supraglottis (5-yr survival) 20% subglottis (5-yr survival)
Qi J <i>et al.</i> <sup>18</sup>	12	Larynx	1990–1996	75% (3-yr survival) 66.7% (5-yr survival)
Ozüdoğru <i>et al.</i> <sup>19</sup>	20	Larynx (18) Pyriform fossa (2)		81.2% (2-yr survival) 64.2% (3-yr survival)
Tang <i>et al.</i> <sup>20</sup>	14	Larynx (10) Pyriform fossa (3) Oesophagus (1)		78.6% (2-yr survival)
Han <i>et al.</i> <sup>21</sup>	28	Larynx		78.6% (3-yr survival) 68.4% (5-yr survival)
Terris <i>et al.</i> <sup>22</sup>	22	Larynx	1980–1994	90.9% (local control rate)
Bernaldez <i>et al.</i> <sup>23</sup>	87	Larynx (63) Pyriform fossa (22) Tongue base (2)	1991–1998	75.8% (cause-specific survival)
Pradhan <i>et al.</i> <sup>7</sup>	137	Larynx (45) Pyriform fossa (92)	1989–1999	70.1% (alive & disease-free after 12–104 mth FU)

Pts = patients; mth = months; yr = years; FU = follow up

### Presence of speech

The advantages of near-total laryngectomy are its high success rate, lung-powered speech, maintenance-free shunt and excellent speech outcomes. The incidence of successful speech outcomes ranges from 74 to 100 per cent.<sup>4,8,9,11,12,14–18,20,21,23–34</sup> The results of various studies are summarised in Table II.

In the previously published series, we analysed the speech outcomes of 150 patients with carcinoma of the larynx and pyriform fossa who underwent near-total laryngectomy at our institution. Intelligible speech was acquired by 90 per cent of these patients. Similarly extended near-total laryngectomy with or without patch pharyngoplasty also developed successful speech.<sup>34</sup> This speech was maintenance-free. None of the published series reported loss of voice subsequent to its initial establishment.

Satisfactory voice outcomes are generally maintained in patients receiving post-operative radiotherapy.<sup>8,9,17,22</sup> In our previous experience of 94 patients receiving radiotherapy, 88 (93.7 per cent) completed their treatment without any adverse outcome.<sup>7</sup>

### Quality of speech

During our speech analysis of 150 patients treated at our institution, speech quality was subjectively

TABLE II  
PUBLISHED NEAR-TOTAL LARYNGECTOMY SPEECH OUTCOMES

Study	Pts with sat SO (of total pts)	
	n	%
Singh & Hardcastle <sup>12</sup>	4/4	100
Hoasjoe <i>et al.</i> <sup>24</sup>	11/11	100
Desanto <i>et al.</i> <sup>25</sup>	29/39	74
Pearson <i>et al.</i> <sup>4</sup>	7/7	100
Levine <i>et al.</i> <sup>26</sup>	9/11	82
Han <i>et al.</i> <sup>21</sup>	27/28	96.4
Chandrachud <i>et al.</i> <sup>27</sup>	11/11	100
Su & Hwang <sup>28</sup>	18/21	86
Shan <sup>29</sup>	10/10	100
Tang <i>et al.</i> <sup>20</sup>	12/14	85.7
Suits <i>et al.</i> <sup>30</sup>	30/39	76
Shenoy <i>et al.</i> <sup>31</sup>	23/29	79.3
Thakar <i>et al.</i> <sup>11</sup>	23/28	82
Shenoy <i>et al.</i> <sup>15</sup>	44/54	81
Cakli <i>et al.</i> <sup>32</sup>	19/23	82.6
Andrade <i>et al.</i> <sup>14</sup>	35/42	83.3
Maamoun <i>et al.</i> <sup>16</sup>	31/38	81.6
Qi <i>et al.</i> <sup>18</sup>	10/12	83.3
Aslan <i>et al.</i> <sup>9</sup>	90/127	70.8
Pearson <i>et al.</i> <sup>8</sup>	191/225	85
Kavabata <i>et al.</i> <sup>17</sup>	12/15	80
Bernaldez <i>et al.</i> <sup>23</sup>	61/79	77.2
Su <sup>33</sup>	50/66	76
Pradhan <i>et al.</i> <sup>34</sup>	135/150	90

Pts = patients; sat SO = satisfactory speech outcome

divided into three categories depending upon ease and fluency. Speech was graded as excellent when patients were able to speak full sentences effortlessly. A grade of 'fair' was allotted when patients spoke short sentences with some effort. A grade of 'poor' was given when speech was intelligible but consisted of a breathy whisper requiring considerable effort.

Out of a total of 135 patients (90 per cent) developing functional speech, 113 (75.3 per cent) were graded as excellent, 16 (10.6 per cent) as fair and six (4 per cent) as poor (Table III).

We also analysed speech quality objectively using clinical speech voice software. Voice analysis was done three months post-treatment and was compared with matched patients who had undergone total laryngectomy with tracheoesophageal puncture prosthesis. Of the various parameters studied, patients with near-total laryngectomy performed better in terms of fundamental frequency, frequency range and maximum frequency, with results approaching those for the normal voice. This provides strong evidence for the superiority of biological shunting over the tracheoesophageal puncture prosthesis (Table IV).<sup>34</sup>

Similarly, Singh examined eight patients with near-total laryngectomy, using electrolaryngography, and found functional similarities between the neoglottis and the normal glottis.<sup>35</sup> In a subsequent study, this same author used electrolaryngography to compare the fundamental frequencies of 15 near-total laryngectomy patients with those of 17 oesophageal speakers and 11 normal speakers. The mean fundamental frequencies of the neoglottal and male oesophageal speakers were higher than those of the normal group. The fundamental frequency of the single female neoglottal speaker was higher than the normal mean, but all female oesophageal speakers had a lower frequency compared with normal female speakers.<sup>6</sup>

Hoasjoe *et al.* compared near-total laryngectomy voice characteristics to those of normal laryngeal voice.<sup>24</sup> They found that the near-total laryngectomy speakers had a generally restricted fundamental frequency, reduced intensity and limited phonation

duration, compared with the normal laryngeal speakers.<sup>24</sup>

### Complications

The major complications of near-total laryngectomy are shunt stenosis and aspiration. Another complication related to the procedure is pharyngocutaneous fistula. Table V summarises reported complication rates.

*Shunt stenosis.* Shunt stenosis adversely affects voice outcomes. A shunt of adequate diameter is necessary to achieve a satisfactory voice. Stenosis of the shunt can be avoided by taking particular care when creating the shunt. The minimum shunt diameter required to prevent stenosis is said to be 6 mm. We recommend using a 14 French Foley's catheter or a number six red rubber catheter as a guide when fashioning the shunt. If the mucosa is insufficient to create a shunt of adequate diameter, it can be augmented using the mucosa from the adjoining pyriform sinus.<sup>4,7</sup> In cases of stenosis, several dilatations may be attempted. The reported incidence of shunt stenosis varies. Su identified shunt stenosis in 20 per cent of patients, but also reported that 83.3 per cent of stenosed cases could be corrected surgically using a sternohyoid myofacial flap and skin graft.<sup>33</sup> We ourselves have no experience with this technique. Kavabata *et al.* reported shunt stenosis in one of 15 cases who failed to attain speech.<sup>17</sup> In our previous series, the incidence of shunt stenosis was 6.6 per cent.<sup>7</sup>

*Aspiration.* The shunt formed during near-total laryngectomy is a dynamic shunt. This acts as a valve allowing air inflow into the shunt, powered by the lungs, and producing vibration of the neoglottis. Aspiration is prevented by contraction of laryngeal musculature which is vagally innervated. The preservation of the recurrent laryngeal nerve is the most important step to preventing aspiration. Although rates vary in different series, the risk of major aspiration is generally quite low. Aslan *et al.* reported aspiration in 26.7 per cent of cases; however, the incidence of major aspiration was 5.5 per cent, and this could be completely rectified surgically in 57.1 per cent of cases.<sup>9</sup> In our own previous series, minor aspiration developed in 12.4 per cent of cases, while major aspiration requiring completion laryngectomy occurred in only 0.7 per cent.<sup>7</sup> Maamoun *et al.* reported an aspiration rate of 33.3 per cent, but all cases were of a transient nature and resolved spontaneously.<sup>16</sup> Other studies have reported aspiration rates ranging from 10 to 42 per cent.<sup>17,23,30,32,33,36,37</sup>

*Pharyngocutaneous fistula.* Theoretically, one would expect the incidence of pharyngocutaneous fistula to be slightly higher following near-total laryngectomy compared with total laryngectomy, due to the former procedure's uneven suture line caused by the invagination of the voice shunt in the neopharynx. Fortunately, most cases of pharyngocutaneous fistula settle with conservative treatment. Kavabata *et al.* reported a pharyngocutaneous fistula incidence of 53 per cent in their series,

TABLE III  
NEAR-TOTAL LARYNGECTOMY SPEECH OUTCOMES

Outcome	Pts (n)
<i>Success*</i>	
Excellent speech	113
Fair speech	16
Poor speech	6
Total patients	135
<i>Failure†</i>	
Shunt stenosis	9
Shunt breakdown	2
Adynamic shunt	1
Cause unknown	3
Total failed patients	15

\*Found in 90% of patients; †found in 10% of patients. Pts = patients

TABLE IV  
VOICE ANALYSIS: TRACHEOESOPHAGEAL PUNCTURE PROSTHESIS VS NEAR-TOTAL LARYNGECTOMY

Parameter	Procedure	Mean	SD	p*
Fundamental frequency (Hz)	TEP	120.95	41.75	0.000
	NTL	162.32	54.46	
Maximum frequency (Hz)	TEP	159.89	57.63	0.000
	NTL	214.04	73.18	
Minimum frequency (Hz)	TEP	91.60	37.25	0.70
	NTL	108.47	44.38	
Frequency range (Hz)	TEP	68.92	54.13	0.019
	NTL	105.57	80.45	
Maximum intensity (dB)	TEP	70.32	8.79	0.633
	NTL	71.17	6.94	
Minimum intensity (dB)	TEP	38.55	19.66	0.49
	NTL	41.69	20.75	
Maximum phonation time (Seconds)	TEP	4.43	3.75	0.314
	NTL	5.39	4.57	
Jitter	TEP	1.46	0.868	0.738
	NTL	1.36	0.90	
Shimmer	TEP	5.84	2.34	0.843
	NTL	5.67	2.66	
S/Z ratio	TEP	1.11	1.90	0.594
	NTL	1.40	1.92	
Harmonic-to-noise ratio	TEP	14.50	5.32	0.669
	NTL	15.30	5.45	
Sound-to-noise ratio	TEP	31.41	5.00	0.702
	NTL	14.10	5.28	

\*t-test. SD = standard deviation; TEP = tracheoesophageal puncture prosthesis; NTL = near total laryngectomy; S/Z ratio is the ratio of voiceless sound to voiced sound. Normal value is 1.4

but none of these cases required surgical correction.<sup>17</sup> In our previous study, 8.7 per cent of our patients developed a major fistula, and the incidence of leakage requiring surgical intervention was 3.6 per cent.<sup>7</sup>

#### Post-radiation failures

Pearson *et al.* reported a cancer recurrence rate of 20 per cent in their near-total laryngectomy patients who had previously undergone radiotherapy.<sup>8</sup> Thus, they concluded that previous radiotherapy was a relative contraindication to near-total laryngectomy.

In our previous series of 137 patients, 15 had received prior radiotherapy.<sup>7</sup> The local control rate for post-radiotherapy salvage was 93.3 per cent, thus confirming the oncological safety of the procedure in this setting. The complication rate was slightly higher in this group. Two out of 13 patients (15.4 per cent)

developed a major pharyngocutaneous fistula: one of these patients died and the other lost the shunt.

Therefore, in patients who have received previous radiotherapy, judicious selection must be exercised.

#### Current status

Near-total laryngectomy was first described by Pearson *et al.* in 1980, in a small series of seven patients with early glottic cancers. However, the procedure did not gain popularity because of its perceived complexity and unproven oncological safety.

There are now various publications, from many authors around the world, establishing that near-total laryngectomy has acceptable oncological safety, a high rate of successful post-operative speech, and an acceptable complication rate. Therefore, the practising head and neck surgeon should be conversant with the

TABLE V  
PUBLISHED NEAR-TOTAL LARYNGECTOMY COMPLICATION RATES

Study	Shunt stenosis (%)	Aspiration (%)	Pharyngocutaneous fistula (%)
Su <sup>33</sup>	13/66 (20)	4/66 (6)	–
Kavabata <i>et al.</i> <sup>17</sup>		4/15 (26.6)	8/15 (53)
Aslan <i>et al.</i> <sup>9</sup>		34/127 (26.8)	
Maamoun <i>et al.</i> <sup>16</sup>		13/39 (33.3)	9/39 (23.1)
Bernaldez <i>et al.</i> <sup>23</sup>		16/79 (20.2)	40/82 (48)
Gavilán <i>et al.</i> <sup>36</sup>		5/49 (10.2)	23/49 (46.9)
Cakli <i>et al.</i> <sup>32</sup>		(42)	5/23 (21.7)
Prim <i>et al.</i> <sup>37</sup>		(13.9)	(58.9)
Suits <i>et al.</i> <sup>30</sup>		8/39 (21)	
Pradhan <i>et al.</i> <sup>7</sup>	9/137 (6.6)	18/137 (13.1)	12/137 (8.7)

Data represent patient numbers (percentages). – = patients with complications/n. n = no of patients in the series

procedure, given its distinct advantage of avoidance of a tracheoesophageal puncture prosthesis. We estimate that approximately 10 per cent of patients suitable for total laryngectomy are also suitable for near-total laryngectomy. The procedure involves the creation of a shunt from the patient's uninvolved tissues, which has the advantage of being maintenance-free and dynamic.

Near-total laryngectomy should be considered as an alternate to total laryngectomy in selected individuals. Surgeons should train themselves in the procedure, so that it acquires the prominence it deserves.

## Conclusion

Near-total laryngectomy should be considered as an alternative to total laryngectomy in selected patients with well lateralised, advanced laryngeal and hypopharyngeal cancers.

Although patients are left with a permanent tracheostoma, lung-powered speech is made possible by fashioning a voice shunt from the patient's unremoved tissues. This shunt is dynamic, and maintenance-free once established. The incidence of successful post-operative speech is as high for near-total laryngectomy patients as for those using a tracheoesophageal puncture prosthesis. Furthermore, objective speech assessment suggests that the speech outcomes of the former procedure are superior to those of the latter.

Finally, the oncological safety of near-total laryngectomy has been established by various studies worldwide.

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