

**PARTIAL LARYNGECTOMY: A DISCUSSION OF SURGICAL TECHNIQUES****Dr. Jaspreet Singh Badwal\***

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**ABSTRACT**

Partial laryngectomies are prevalent in many centres of Europe. The following discussion will describe the techniques as per European standards. The numerous conservative surgical laryngeal procedures have evolved over time with many modifications. The intent of this manuscript is to provide an overview of the available procedures, their indications, contraindications, oncologic results and functional outcomes. Procedures will be presented based on the site and extent of the tumour.

**KEYWORDS:** Partial laryngectomy, organ preservation surgery of larynx, conservative laryngeal surgery.**INTRODUCTION**

Partial laryngectomy began more than two centuries ago, when a French surgeon, Pelletan,<sup>[1]</sup> used median thyrotomy to remove an impacted piece of meat. Billroth performed the first hemilaryngectomy for malignancy in 1874.<sup>[2]</sup> Over the ensuing decades numerous procedures evolved to afford patients the maintenance of speech and swallowing without permanent tracheostomy. In 1947, Alonso<sup>[3,4]</sup> first described the open supraglottic laryngectomy to spare the true vocal cords and arytenoids by resecting the upper portion of the thyroid cartilage with the supraglottic structures. The procedure was popularized in Europe by Bocca and in the United States by Ogura, Som, and Kirchner.<sup>[5]</sup> The boundaries of resection were pushed further by Majer and Reider<sup>[6]</sup> in 1959 with the introduction of the supracricoid partial laryngectomy, which provided an alternative to total laryngectomy for patients with selected glottic and supraglottic cancers. Critical review has provided refinements in these procedures. Specific indications have been established based on an improved understanding of surgical anatomy and patterns of tumour spread that have allowed for selected ablation of laryngeal components without the need for total laryngectomy and its associated morbidity.

Thomas et al.<sup>[7]</sup> (2011) have presented an excellent systematic review on the results of partial laryngectomy for laryngeal cancer. A total of 53 articles satisfied inclusion criteria and were included in the review. The pooled local control rate at 24 months from 5061 patients was 89.8% (95% CI 88.3–91.2), pooled overall survival was 79.7% (n = 3967; 95% CI 76.5–782.8) and pooled mean disease free survival was 84.8% (n = 2344; 95% CI 80.6–88.7). The pooled mean operative mortality,

laryngectomy for function, tracheostomy decannulation and permanent gastrostomy rates were 0.7%, 1.7%, 96.3%, and 2.0%, respectively. The authors concluded that open conservation laryngectomy is a good option in selected primary laryngeal cancers with excellent oncological outcomes.

**Surgical Procedures**

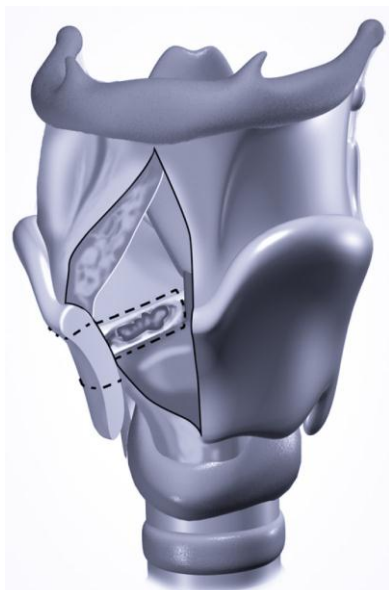
Partial laryngectomies are prevalent in many centres of Europe. The following discussion will describe the techniques as per European standards. The numerous conservative surgical laryngeal procedures have evolved over time with many modifications. It is not the intent of this manuscript to convey the nuances of surgical technique necessary for the extirpation of these tumours, but instead to provide an overview of the available procedures, their indications, contraindications, oncologic results and functional outcomes. Procedures will be presented based on the site and extent of the tumour.

**Glottic Carcinoma**

Early glottic carcinoma may be surgically treated with vertical partial laryngectomies which are open procedures approached transcutaneously and employed for the removal of glottic cancers. This category involves a vertical transection through the thyroid cartilage and paraglottic space. The point of transection is based on the extent of tumour, which has been both preoperatively and intraoperatively determined. The disadvantage of this approach is a “blind” entry into the larynx through a narrow exposure.<sup>[8]</sup>

### ***Cordectomy***

Within the category of vertical partial laryngectomies with open approaches is the minimal surgical resection termed laryngofissure with cordectomy. This procedure allows for removal of the vocal cord after visualization of the cancer through a midline thyrotomy incision. It is indicated for early lesions that do not extend to the anterior commissure or involve the arytenoid cartilage region. Tracheotomies may be performed for postoperative airway management. The procedure has excellent oncologic results, particularly for midcord lesions of the mobile true vocal cord. In a study of 182 patients, Neel et al.<sup>[9]</sup> reported a 2.3% local recurrence rate for lesions limited to the true vocal cords, which was consistent with reports by other authors.<sup>[10,11]</sup> Patients generally have good functional outcomes. Swallowing is adequate, with persistent dysphagia rarely extending beyond the acute postoperative period.<sup>[5]</sup> If the overlying thyroid cartilage is resected (Fig. 1), the remaining cartilage is pulled together or “imbricated” to shorten the vertical height of the hemilarynx. The false vocal cords can be elevated as a flap and sewn inferiorly to reconstruct the glottis. Speech results with this reconstruction strategy have been studied. Brasnu et al.<sup>[12]</sup> found that only 18% of patients with reconstructed larynges had voice alteration.



**Fig. 1: Laryngofissure with cordectomy and resection of overlying thyroid cartilage.**

### ***Vertical Hemilaryngectomy***

For larger glottic carcinomas with extension to the vocal process or involvement of the ventricle, or for transglottic lesions without cord fixation, a vertical hemilaryngectomy is used (Fig. 2). In standard hemilaryngectomies, the thyroid cartilage is cut in the center to allow entry into the laryngeal lumen at the anterior commissure. The resection specimen includes most of the true vocal cord, the overlying thyroid cartilage, and the involved false vocal cord. Subglottic extension of more than 10 mm anteriorly or 5 mm

posteriorly is a contraindication for vertical partial laryngectomy. In addition, lesions with invasion of the cricoarytenoid joint, interarytenoid region, thyroid cartilage, or both arytenoids should not be removed via this method. Vocal cord fixation is a relative contraindication, depending on the cause of the fixation and tumor size. Extended procedures to the vertical hemilaryngectomy include the frontolateral, posterolateral, and extended vertical hemilaryngectomies. In cases of bilateral lesions in which the tumour involves the anterior commissure, the frontolateral vertical partial laryngectomy can provide an increased extent of resection by moving the vertical thyrotomy from the midline toward the less involved side. In the posterolateral vertical hemilaryngectomy, all the endolaryngeal circumference except for one arytenoid region and the posterior commissure can be removed. The extended vertical hemilaryngectomy removes the superior aspect of the cricoid cartilage.<sup>[13]</sup>



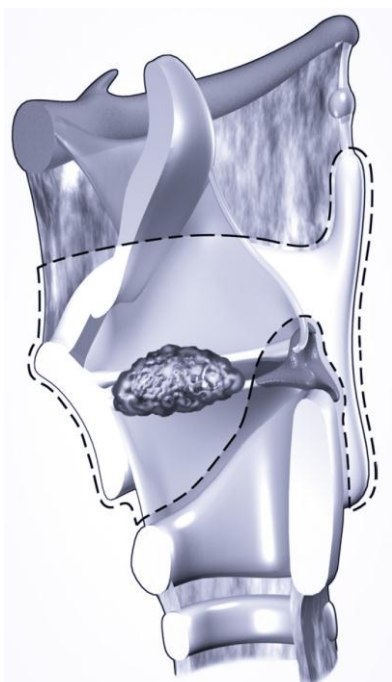
**Fig. 2: Vertical hemilaryngectomy.**

A variety of reconstructions have been proposed. Common to all reconstructions is the reapproximation of overlying thyroid perichondrium. Many surgeons prefer to include some muscle in the repair to increase the bulk of the neocord. A popular strategy is the utilization of bilateral bipedicle strap muscle flaps to reconstruct the defect. Reconstruction can also be undertaken with the preserved epiglottis. Epiglottic laryngoplasty is performed by advancing the epiglottis inferiorly and laterally to reconstruct the larynx after vertical hemilaryngectomy or anteroinferiorly to reconstruct after a frontolateral vertical laryngectomy.<sup>[5]</sup> Many authors have reported excellent survival results with their vertical partial laryngectomy experiences. Olsen and DeSanto report that their use of vertical partial laryngectomies produces better patient survival and fewer total laryngectomies for salvage in comparison with radiation therapy.<sup>[14]</sup> Several series have reported local control rates for T1 lesions of greater than 90%. More recently

Nie et al.<sup>[15]</sup> (2014) presented results of vertical partial laryngectomy for T1 and T2 lesions of the glottic carcinoma with anterior commissure involvement. Local control rate of 94% was achievable. Mantsopoulos et al.<sup>[16]</sup> (2012) have shown commendable results for T3 lesions of glottic carcinoma treated with partial laryngectomy. The 5-year disease specific survival was 78.3% while organ preservation was achieved in 90.1% of patients. Bakhos et al.<sup>[17]</sup> (2008) recommend that lesions which show contralateral vocal fold spread should be managed with SCPL-CHEP rather than anterior frontal laryngectomy.

### **Supracricoid Laryngectomy With Cricohyoidoepiglottopexy**

Supracricoid partial laryngectomy with cricohyoidoepiglottopexy (SCPL-CHEP) is a horizontal partial laryngectomy operation for glottic cancer management in selected patients. It provides an alternative to total laryngectomy, while offering better local control for selected lesions than extended partial laryngectomies. There is preservation of speech and swallowing without a permanent stoma. The operation encompasses removal of both the true and false vocal cords, both paraglottic spaces, the petiole of the epiglottis, and the thyroid cartilage (Fig. 3). The cricohyoidoepiglottopexy refers to the reconstruction that is performed by suturing the cricoid to the hyoid and the remnant of epiglottis (Fig. 4). In contrast to other partial laryngectomies that require variable types of reconstruction, the supracricoid partial laryngectomy with cricohyoidoepiglottopexy has a single method of reconstruction, thus ensuring reliable functional outcomes.<sup>[18]</sup>



**Fig. 3: Supracricoid laryngectomy with cricohyoidoepiglottopexy (SCPL-CHEP).**



**Fig. 4: Cricohyoidoepiglottopexy reconstruction after SCPL.**

The indications for the SCPL-CHEP are bilateral true vocal cord involvement, T3 glottic lesions with true vocal cord fixation but mobile arytenoid motion, impaired true vocal cord mobility with limited subglottic extension, and unilateral true vocal cord mobility with anterior commissure involvement.<sup>[19]</sup> Patients must have adequate pulmonary reserve to withstand anticipated postoperative aspiration. Furthermore, there are oncologic contraindications that would preclude this procedure. Glottic tumors that cause arytenoid fixation or invade the posterior commissure are not amenable to SCPL-CHEP. Extensive preepiglottic space invasion and subglottic extension of more than 1 cm anteriorly or 5 mm posteriorly are contraindications to this approach.<sup>[18]</sup> Thyroid cartilage invasion is a relative contraindication depending on the presence of extralaryngeal spread. Postoperative rehabilitation regimens vary from institution to institution. Dysphagia is expected postoperatively, but it is rare to have long-term dysphagia. It is better to perform a cricopharyngeal myotomy at the time of surgery, which assists postoperative swallowing. Patients work with the speech pathology team as outpatients to improve and “relearn” speech and swallowing techniques. Patients will often go home with a tracheostomy, which is removed in the outpatient setting after the edema from surgery has resolved.

Oncologic outcomes are acceptable. Piquet et al.<sup>[20]</sup> reported results of 104 patients with stage T2 and T3 lesions of the glottis, treated with SCPL-CHEP. 86% of the patients survived 3 years and 75% survived 5 years. There were only 5 instances (5%) of local recurrences. 7 patients had neck recurrence and 8 developed a second primary tumour. 13 patients developed intercurrent disease or were lost to follow-up. Normal deglutition was achieved in all patients, except 2 who aspirated occasionally. 85 patients (81.5%) were decannulated before the 28<sup>th</sup> day. 3 patients developed stenosis,

requiring surgical reconstruction. The voice, produced by vibration of the arytenoid mucosa against the epiglottis, was satisfactory in all the patients. Laccourreye et al.<sup>21</sup> reported a 3 year actuarial survival of 86.5% in 36 patients. In 2 cases (5.6%), there was a local recurrence of tumour. All 36 patients were decannulated between 3 and 57 days postoperatively. All patients recovered normal deglutition, 35 of the 36 patients achieved deglutition within the first postoperative month. Physiologic phonation was achieved by all patients. Vocal quality allowed for normal social interaction. SCPL-CHEP thus achieves local control rates comparable to those of total laryngectomy for selected laryngeal cancers while still preserving the functions of deglutition and speech.

More recently, Leone et al.<sup>[22]</sup> (2014) evaluated the oncological and functional outcomes in patients who underwent supracricoid laryngectomies with a crico-hyoidopexy (SCL-CHP) or a crico-hyoido-epiglottopexy (SCL-CHEP) for the treatment of primary and recurrent laryngeal cancer. A retrospective study was conducted on 152 consecutive patients seen from January 1996 to December 2006. Overall survival (OS) and disease-free survival (DFS) were analysed using the Kaplan-Meier method and were compared according to the type of surgery and clinical stage of the tumour. The mean period before decannulation, nasogastric tube (NGT) removal and recovery of a normal diet and speech were evaluated and statistical analyses were performed regarding the association with the type of surgery and arytenoidectomy. The median follow-up period was 49.9 months (range: 10–110 months). The 3- and 5-year OS were 87.5 and 83.5%, respectively, and 3- and 5-year DFS were 78.3 and 73.7%, respectively. For patients with early stages tumours, the 5-year OS and DFS were 92.3 and 84.6% respectively, whereas for patients with locally advanced stage tumours, the OS and DFS were 74.3 and 62.2%, respectively. Significant differences in OS and DFS for patients who had early or locally advanced cancers were found ( $p = 0.0004$  and  $p = 0.0032$ , respectively). The rate of overall local control was 92.1%, while the mean period until decannulation or NGT removal was 25.1 and 16.6 days, respectively. The mean period until NGT removal was significantly different according to the type of surgery ( $p = 0.0001$ ) and whether arytenoidectomy was performed ( $p = 0.0001$ ). The reliable oncological and functional results of SCL for early and locally advanced laryngeal cancers are confirmed by this series of patients. In a similar study, Bron et al.<sup>[23]</sup> presented a review of patients operated in their department with supracricoid partial laryngectomy with either cricohyoidoepiglottopexy (CHEP) (59 cases) or cricohyoidopexy (CHP) (10 cases) technique, for primary or recurrent glottosupraglottic squamous cell carcinoma. Thirteen percent of the patients received adjuvant radiotherapy. Minimum follow-up was 2 years or until death. Five-year actuarial survival (Kaplan-Meier method) was 68%. Global local control was achieved in 84% of cases. Among previously

untreated patients ( $n = 54$ ), local control rate was 94.5%. The authors concluded that this technique is a valuable alternative to radiotherapy for T2–T4 glottosupraglottic carcinomas, particularly those with extension and invasion of the anterior commissure. It allows for preservation of a good laryngeal function without altering the long-term survival, keeping total laryngectomy as a salvage procedure.

### Supraglottic Carcinoma

Supraglottic cancers behave in a different fashion than primary glottic tumours. Because the supraglottis has a distinctly different embryologic origin from the glottis, it was a widely held belief for many years that supraglottic cancers remain confined to the supraglottis. This has proved not to be the case. Supraglottic cancers do tend to remain supraglottic until late in their course when paraglottic spread or ventricular mucosa provide a route for extension out of the supraglottis with subsequent cord fixation. Most cancers of the epiglottis tend to have pushing rather than infiltrating borders, and this characteristic allows for narrow resection margins.

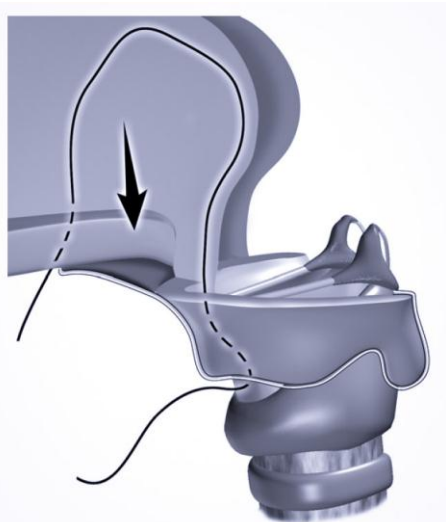
### Supraglottic Laryngectomy

The standard open supraglottic laryngectomy is designed for ablation of tumours confined to the supraglottis. In this procedure, there is sparing of both true vocal cords, both arytenoids, and the tongue base (Fig. 5). T1 or T2 lesions of the epiglottis, false vocal cords, aryepiglottic folds and T3 lesions owing to preepiglottic space involvement are well addressed by this approach. It is not used to address lesions that extend to the glottic level, an important contraindication. Lesions within 5 mm of the anterior commissure are contraindications to supraglottic laryngectomies. Supraglottic laryngectomies must be avoided when there is decreased vocal cord mobility or ventricle involvement.



Fig. 5: Supraglottic laryngectomy.

A supracricoid partial laryngectomy with cricothyroidopexy (SCPL-CHP) as described next would be a viable alternative for such lesions. Other contraindications to the supraglottic laryngectomy are tongue base involvement causing impairment of mobility or tumour that approaches within 1 cm of the circumvallate papilla and thyroid cartilage invasion. Reconstruction is accomplished via a laryngoplasty that brings the inferior half of the thyroid cartilage in contact with the tongue (Fig. 6). The external thyroid cartilage perichondrium is sutured up to the tongue base; mucosa-to-mucosa closure is not attempted. The procedure has excellent results in regard to oncologic control; the main caveat is proper patient selection, a recurring theme in all conservative laryngeal procedures. T1 and T2 local control rates range from 85 to 100%.<sup>[24,25]</sup> The local control of T3 and T4 lesions with supraglottic laryngectomy alone has been reported at 70 to 85%.<sup>[26]</sup>



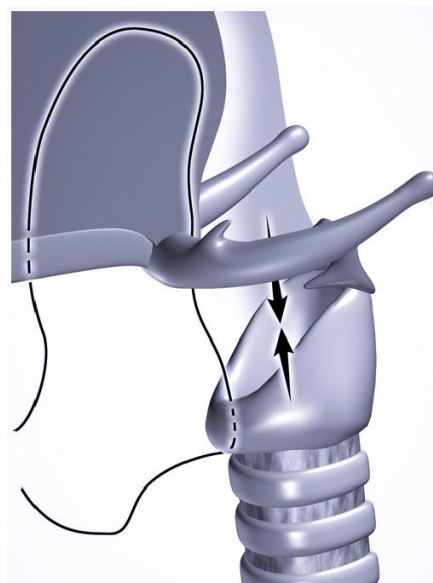
**Fig. 6: Reconstruction after a supraglottic laryngectomy.**

After supraglottic laryngectomy, many surgeons advocate the use of a percutaneous gastrostomy tube to allow for outpatient swallowing rehabilitation with removal after nutritional demands are met via an oral diet, which may be delayed if postoperative radiation is required. Thick liquid purées are first introduced followed by solids and then thin liquids. The patient must adapt to the altered anatomy to expedite swallowing and this may be accelerated by early removal of the tracheostomy tube once the operative edema has resolved. The need for postoperative radiation therapy will result in a higher incidence of tracheostomy and gastrostomy dependence. The reported complication of tracheostomy dependence ranges from 2.1 to 29%.<sup>[27,28]</sup> Other complications include pneumonia from aspiration. This incidence ranges from 2.1 to 19.5% and recurrent episodes may necessitate a secondary conversion to a total laryngectomy. However, Pauloski.<sup>[29]</sup> (2008) states that these complications can be avoided by preserving at least one arytenoid cartilage, preserving the hyoid bone if possible and excluding lesions with major tongue base

involvement. For lesions with major tongue base or aryepiglottic fold involvement, near total laryngectomy is the preferred modality. More recent studies<sup>[30-33]</sup> have shown that functional results with supraglottic laryngectomy are good, such that over 90% of patients can be decannulated and take food orally.

#### **Supracricoid Laryngectomy With Cricothyroidopexy**

As previously mentioned, glottic extension of supraglottic carcinoma precludes a supraglottic laryngectomy. The other open partial surgical alternative is SCPL-CHP. It is similar to cricothyroidopexy, but it is a more extensive resection that additionally removes the whole epiglottis and preepiglottic space. Preservation of the cricoid cartilage and hyoid bone are necessary for the reconstruction, which places these structures in apposition to one another through suturing techniques (Fig. 7). Therefore, compromise of these two structures by subglottic extension, arytenoid fixation, massive preepiglottic extension or extension to the pharyngeal wall, vallecula, base of tongue, postcricoid area or interarytenoid region would serve as contraindications and necessitate a different strategy.<sup>[27]</sup>



**Fig. 7: Cricothyroidopexy reconstruction after SCPL.**

Tumour control rates with SCPL-CHP have been reported by Laccourreye et al.<sup>[28]</sup> who found no local recurrences in 68 patients; most of the carefully selected patients were staged T2 and T3. Further reporting by Laccourreye et al.<sup>[28]</sup> on patients with preepiglottic invasion displayed a 94% local control rate in 19 patients. Chevalier et al.<sup>[34]</sup> have reported similar excellent results for local control (3.3% recurrence) of supraglottic cancer managed with supracricoid laryngectomy with cricothyroidopexy. The procedure achieves successful results in selected patients because it addresses potential pathways of tumour spread such as the paraglottic spaces, which may harbour occult disease. In regard to functional outcome, many patients will experience temporary dysphagia and a tracheostomy.

Long-term dysphagia is rare, but patients will most commonly experience hoarseness as a long-term functional sequela.

### **Near Total Laryngectomy**

An uncommon procedure that has proven oncologic efficacy for supraglottic cancer with a fixed cord or glottic cancer with significant subglottic extension is the near total laryngectomy, which was introduced by Pearson.<sup>[35]</sup> It can be used for lesions presenting as transglottic cancer, supraglottic lesions spreading to pharynx and lesions involving tongue base. This is a clear advantage over supraglottic laryngectomy. The procedure entails the preservation of the posterior half of the uninvolved hemilarynx and is dependent on a long-term tracheotomy. Using the preserved tissue, an internal shunt is created with a superiorly based pharyngeal flap. This allows for an adequate voice by leaving an innervated arytenoid that will permit the air to pass into the pharynx and guard against aspiration. It resects a much larger specimen and is indicated when the aforementioned conservation operations are inadequate.

The main advantages of the procedure are the persistence of voice without the replacement of synthetic prostheses<sup>[36]</sup> and the fact that air enters the pharynx around the tracheotomy directly rather than starting as a bolus in the esophagus. The latter advantage is important because cricopharyngeal dysfunction can have an adverse impact on the voice.<sup>[37]</sup> In regard to oncologic results, the local recurrence rate was 7% in a series of 225 patients undergoing near total laryngectomies for intermediate and advanced cancer of the larynx or pharynx.<sup>[38]</sup> Near total laryngectomy for supraglottic or pyriform carcinoma after failed radiotherapy was associated with a shunt recurrence rate of 20%, and surgical salvage was 0%. Therefore it is not used as a salvage procedure after radiation failure. Speech acquisition rate was 85% overall.

### **Hypopharyngeal Cancer**

Vandenbrouck et al.<sup>[39]</sup> presented a landmark randomized controlled trial which compared the results of preoperative versus postoperative radiotherapy for management of hypopharyngeal cancer in a prospective manner. A statistically significant difference ( $p < 1\%$ ) existed in favour of postoperative radiotherapy relative to survival rates, complications, and quality of survival. The postoperative radiotherapy group showed a 56% 5-year survival rate compared to 20% in the preoperative radiotherapy group. Eisbach and Krause<sup>[40]</sup> reported a slightly lower cure rate with preoperative radiotherapy when compared with surgery alone. Similarly, Donald et al.<sup>[41]</sup> found a greater than twofold improvement in survival when postoperative radiotherapy was compared to preoperative radiotherapy group. Donald<sup>[42]</sup> reported another study which revealed that complication rate is much lower when the irradiation is used postoperatively. More recently Harris et al.<sup>[43]</sup> (2015) presented the survival outcomes for patients with advanced-stage

hypopharyngeal SCC treated at a single institution with either primary surgery plus RT or CRT or definitive CRT. Five-year OS (overall survival) and RFS (recurrence free survival) for patients treated surgically were 66.3% and 53.6%, respectively; for patients treated with definitive CRT, OS and RFS were 41.3% and 34.5%, respectively.

### **Partial pharyngectomy**

Because of the anatomic proximity of the pharynx to the larynx, situations arise in which a tumour will involve the medial wall of the pyriform sinus. These lesions may be amenable to conservative surgery via a partial laryngopharyngectomy, as described initially by Ogura et al.<sup>[44]</sup> An important characteristic of the medial wall lesions is their propensity for laryngeal infiltration and contralateral lymphatic spread, as high as 64%.<sup>[45]</sup> Partial laryngopharyngectomy for tumours of the medial pyriform sinus is contraindicated when there is involvement towards the apex of the pyriform sinus, extensive submucosal spread and deep invasion of the lateral pyriform sinus wall. Ipsilateral arytenoidectomy is often necessary when tumour involves the pyriform sinus. Reconstruction requires that the vocal ligament be sutured directly to the cricoid cartilage.

The use of the supracricoid hemilaryngopharyngectomy<sup>[46]</sup> was popularized in the mid 1960s and this procedure is indicated for carcinoma of the supracricoid upper part of the pyriform sinus and carcinoma of the lateral laryngeal wall with normal mobile vocal cord. The use of near total laryngectomy<sup>[47]</sup> has been advocated for more advanced cancer of the pyriform fossa, which includes both the lateral and medial wall sites, with or without a fixed vocal cord. This resulted in preservation of speech and aspiration-free swallowing in the majority of patients.

### **CONCLUSION**

In conclusion, total laryngectomy continues to maintain an important role in the treatment of head and neck cancer patients, but the introduction and development of conservation laryngeal procedures has augmented the quality of life for appropriately selected candidates. It is paramount that patients be accurately examined to determine their candidacy for these procedures. Partial laryngeal surgery provides important options for consideration in the context of a multidisciplinary approach to the treatment of head and neck cancer patients.

### **CONFLICT OF INTERESTS**

The author declares that there is no conflict of interests that could influence this work.

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