

Introduction

Subtotal, supracricoid surgery started in Austria more than forty years ago¹ and has further been practiced in Italy² and France³ for cancer of the glottic site and then for more extended laryngeal carcinoma, both as first therapy and as salvage treatment upon relapse after a previous operation, provided that arytenoid cartilages are freely mobile. Subtotal, supracricoid surgery is nowadays practiced also in several cases of T1 and T2, i. e. low class laryngeal cancer, where this surgery causes loss of several laryngeal functions sometimes disproportionate to the burden deriving from the tumour class. The inappropriate adoption of this surgery depends on fear not to achieve oncological radicality because of incomplete knowledge of cancer diffusion pathways. Efficient therapy of T1 and T2 laryngeal cancer can be however achieved in many cases with a more conservative, endoscopic or open field surgical approach⁴⁻⁹. These methods risk to be abandoned because of indiscriminate resorting to subtotal surgery. In this text and atlas, the clinical embryology of the larynx, with special attention to the glottic region, helps to identify the anatomical bases for the laryngeal functions and for cancer diffusion pathways and allows to recognize those structures, organized into functional compartments, which can represent an obstacle to, or alternatively a spreading pathway for laryngeal cancer. The analysis of laryngeal structures during ontogenesis poses the premises for correct indication and practicing of compartment surgery of the larynx in T1 and T2 glottic cancer.

Glottic cancer represents about a half of all laryngeal tumours¹ and is frequently treated by conservative treatment^{10,11}. Despite early diagnosis (T1-T2), glottic cancer is still often treated with too aggressive surgery, even if 'conservative', that causes severe functional impairment. The reasons for inadequate treatment are several: fear not to achieve radical therapy, incomplete knowledge of tumour diffusion pathways, debate on the functional role of the anatomical components of subsites, uncertainty about the site and subsite boundaries (also emerging in the TNM classification), and difficulty in defining objectively the degree of deep infiltration by tumour. Comparisons among different centres are made difficult by the limitations in the classification system, which adds to the discrepancy between diagnosis and surgical therapy. All these reasons make the surgical therapy of glottic cancer controversial and may lead to too aggressive surgery.

The study of organogenesis can help the clinics by allowing detailed anatomical analysis of the glottic site and its subsites. Embryological studies help in defining adult functional anatomy by showing, since their early appearance, individual structures and their reciprocal interrelationships¹²⁻¹⁵ which are relevant to oncology and would be ill discernible if looked after only in the adult larynx.

Previous embryological studies have led to identify structures in the anterior commissure which need to be considered in the analysis of the behaviour of ventral glottic cancer and in the classification of these tumours¹⁶⁻¹⁸. In an attempt to indicate more rigorous guidelines for the surgical treatment of glottic T1, T2 cancer, aiming at removing cancer radically without unnecessary damage to laryngeal functions, the development of the whole glottic region and the structures correlated with tumour extension have been analysed. The latter structures may represent either a barrier to or a diffusion pathway for cancer, and their degree of involvement can explain the alterations of laryngeal functions which may occur in each patient.

These structures and their roles need to be taken into consideration when planning surgery for this site.

This text and atlas is designed to show the formation and evolution of glottic structures, as a prerequisite to perform surgery for glottic T1, T2 cancer in such a way as to preserve laryngeal functions. The

material for this book derives from embryonic, foetal and adult larynges, from the VIII week of pregnancy. This material has been analysed in a cranial-caudal sequence at each time point and has been ordered into chapters following the chronology of development.

In the last twenty years the treatment of laryngeal cancer has moved towards conservative methods which spare larynx functions as well as achieve radical therapy of cancer. Hence endoscopic transoral laser surgery, radiotherapy and chemo-radiotherapy are preferred over traditional, partial and subtotal open surgery. The latter has been used as salvage surgery after failure of chemo-radiotherapy or for recurrence upon endoscopic laser surgery, assuming the role previously played by total laryngectomy.

Early laryngeal cancer is confined to the mucosa, down at most to the deep layer of the lamina propria without invading the adjacent muscle and cartilage tissues¹⁹; it comprises the lesions classified as Tis (according to Laryngeal Intraepithelial Neoplasia LIN classification), T1 and T2, with possible inclusion of selected T3 cases²⁰. The lamina propria includes a loose superficial layer (Reinke's space), an elastic middle layer (vocal ligament) and a deep fibrous layer.

The literature provides evidence for the efficacy of laser endoscopic treatment in terms of local control of disease, survival and recovery of speech, deglutition, and respiration. The European Society of Laryngology has classified the different types of cordectomy for early laryngeal cancer in year 2000²¹, and has updated the classification to six types of cordectomy in year 2007²². Upon endoscopic surgery, Chevalier's group²³ has reported an average survival rate without evidence of disease of 75% after five years, with local control of disease in 84% and organ preservation in 90% cases. This group has proposed endoscopic surgery as a valuable alternative to open surgery and radiotherapy for glottic Tis, T1 and T2 cancer. The results of a more recent review show, on the average, local control of disease in 89% cases, survival without evidence of disease in 97.3% cases (range 95-98% for T1 cancer and 90-95% for T2 cancer) and preservation of laryngeal functions in 89% to 96% cases²⁴.

In the case of glottic cancer, the involvement of the anterior commissure (AC) represents a challenge for the surgeon, because it is characterized by high risk both of diffusion outside the larynx or to the crico-thyroid membrane and of pre-operative understaging. The limited diagnostic sensitivity of computerized tomography and nuclear magnetic resonance for glottic tumours involving the AC contributes to errors in staging, which occur in 25% and 50% cases respectively for the two techniques²⁵⁻²⁷. The surgical access to the AC may also be especially difficult in some patients²⁸. A recent review^{29,30} has shown that there is no commonly accepted way of defining the grade of infiltration of the AC in each case and that the prognosis of T1 cancer is worse if the AC is involved, with local control of disease limited between 75% and 98%, independent of the type of treatment, whether surgery (endoscopic or open) or radiotherapy.

The literature does not offer a clear indication of the relative efficacy of partial open surgery and radiotherapy for salvage treatment for early glottic cancer, in terms of local control of disease; surgery appears therefore as a valuable option for salvage in those cases. Indeed, in cases of relapse of laryngeal cancer with involvement of the AC, partial laryngectomy according to Tucker with epiglottoplasty may be a valuable option for salvage³¹. This same operation may be the first choice for selected tumours involving the AC, as alternative to cricohyoidoepiglottopexy.

Good results from the oncological and functional standpoint are offered by endoscopic laser surgery for supraglottic laryngeal cancer. Zeitels³² has reported a local control of disease near 100% and a Mayo Clinic study³³, on transoral laser treatment for supraglottic T1, T2 and selected T3 and T4 cancer, has reported local control of disease in 97% cases, loco-regional control of disease in 94% cases, disease specific survival (selected T3 and T4) in 80% cases and global survival in 85% cases.

The European Society of Laryngology has proposed a classification of partial supraglottic laryngectomy which may be performed by endoscopic laser surgery, which takes into account and hence shows the change occurred in the mini-invasive approach to laryngeal cancer³⁴.

As anticipated, chemotherapy for advanced laryngeal cancer has led to change the indications for open surgery and to propose a role for partial or aggressive surgery for salvage upon failure of non-surgical treatments³⁵. Open surgery of the larynx is the last chance to spare at least some organ functions in case of salvage treatment, with loco-regional control of disease and global survival after five years, respectively, in 75% and 60% cases³⁶⁻³⁸.

In conclusion, the preservation of organ functions has become as important as the achievement of cancer radical treatment and the indications for treatments have changed accordingly. As a consequence, conservative and mini-invasive techniques including endoscopic laser surgery are privileged for early cancer and chemo-radiotherapy for advanced cancer. Partial open surgery gives a second chance to preserve some laryngeal functions in case of failure of the above mentioned treatments and total laryngectomy is the last resource to cure cancer for patient's survival at the expense of all laryngeal functions.