

Cricotracheal resection for laryngeal invasion by thyroid carcinoma: our experience

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Abstract Invasion of the laryngeal framework by thyroid carcinoma requires specific surgical techniques and carries a higher rate of complications that deserve to be highlighted. We reviewed our data from 1995 to 2012 and found six patients with laryngotracheal invasion by thyroid carcinoma. All underwent total thyroidectomy and single-stage cricotracheal resection, plus anterolateral neck dissection. Three had airway obstruction that necessitated prior endoscopic debulking. None of the patients needed a tracheotomy. There were four cases of papillary carcinoma, and two cases of undifferentiated carcinoma. One patient died of complications of the procedure (anastomotic dehiscence and tracheo-innominate artery fistula). Another died 2 months after the procedure from local recurrence and aspiration pneumonia. One case presented recurrence at 15 months, which was managed by re-excision and adjuvant radiotherapy; after 26 months of follow-up, he has no evidence of locoregional recurrence. The three other patients are alive without evidence of disease at 6, 18 and 41 months, respectively. Cricotracheal resection for subglottic invasion by thyroid carcinoma is an effective procedure, but carries significant risks of complications. This could be attributed to the devascularisation of the tracheal wall due to the simultaneous neck dissection, sacrifice of the strap muscles or of a patch of oesophageal muscle layer. We advocate a sternocleidomastoid flap to cover the anastomosis. Cricotracheal resection for subglottic invasion can be curative with good functional outcomes, even

for the advanced stages of thyroid cancer. Endoscopic debulking of the airway prior to the procedure avoids tracheotomy.

Keywords Thyroid carcinoma · Laryngotracheal invasion · Cricotracheal resection

Introduction

Extrathyroidal spread of well differentiated thyroid carcinoma is unusual, and most often due to loss of tumour differentiation, [1, 2]. It has a major impact on survival, which significantly decreases with depth of invasion [3, 4]. Laryngotracheal invasion has been estimated in 5–8 % of patients presenting for thyroid surgery, with endoluminal obstruction being even rarer, (0.5–1.5 % of the cases) [5]. Recurrent laryngeal nerve invasion is encountered in 12 % of patients with locally invasive disease [6]. Surgical management of aerodigestive tract invasion by thyroid carcinoma is still controversial, but incomplete resection has shown poor prognosis and high local recurrence. It is accepted that obvious endoluminal invasion requires radical airway resection, though patients with minimal, non-transmural laryngotracheal invasion undergoing shave excision had similar survival when compared to those undergoing radical surgery [2, 7, 8]. The main problem is that the real depth of laryngotracheal invasion is difficult to analyse and clear margins cannot be assessed. This could lead to a higher risk of local recurrence [9, 10] and poorer prognosis [11]. Tracheal sleeve resections have shown an additional risk of death and major complications even in experienced hands, though with good preservation of voice and swallowing functions [12, 13].

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The same results and controversies can be applied to laryngeal invasion, but literature is scarce on this topic. Most of the cases of laryngeal invasion reported in the literature are mixed with cases of invasion limited to the trachea, without further distinction. Nevertheless, they necessitate different surgical techniques and carry a higher rate of post-operative complications and functional consequences that deserve to be highlighted. Shaving, cricotracheal resection (CTR), partial or total laryngectomies have been recommended depending on the degree of laryngeal invasion. As mentioned earlier, shaving procedures seem to carry the same survival results if no gross tumour is left behind, but they should be restricted to carefully selected cases with superficial invasion [14]. Cricoid infiltration of less than 30–50 % of the total cricoid ring is amenable to partial cricotracheal resection [12, 14]. Partial laryngectomy (mostly vertical hemilaryngectomy) is indicated for unilateral thyroid cartilage invasion, and should be preferred to total laryngectomy if oncologically safe enough. Indications for total laryngectomy are extensive laryngeal framework and endoluminal invasion, airway obstruction, and non-functional larynx [2, 15, 16]. Friedman [17] suggests total laryngectomy if more than 50 % of the laryngeal framework or subglottis is invaded. Total laryngectomy has proven to be safe, and could even be less morbid than other larynx preserving options [18]. To ensure correct staging of a locally advanced thyroid cancer and plan the operative intervention, a complete pre-operative assessment is mandatory in every case, including panendoscopy, and locoregional and distant radiological studies.

Patients and method

We retrospectively reviewed our operative data from 1995 to 2012 and found more than 190 patients that had total thyroidectomy for thyroid cancer. We included only those

patients who had a cricotracheal resection along with total thyroidectomy for transmural laryngeal infiltration, and excluded those with none or minimal laryngeal invasion. This review was approved by our hospital ethics committee. During this period, there were six patients who had cricotracheal resection for subglottis invasion by thyroid carcinoma. One patient had previous hemithyroidectomy for goitre many years ago—exact details were not available. Patients' data are listed in Table 1. There were three men and three women, aged 64–81 years (mean 70 years). All patients were euthyroid and presented with a palpable cervical mass, three patients had hoarseness, two presented with hemoptysis and one patient had dyspnea at rest. On examination, patients with dysphonia showed unilateral vocal fold paralysis (two on the left and one on the right side). Investigations included thyroid function tests, computed tomography of the cervico-thoracic region, cervical ultrasound, magnetic resonance imaging, PET-CT and 16G-FDG scan. All patients showed radiological evidence of anterior cricoid and tracheal infiltration by the tumour and had a pre-operative laryngo-tracheo-bronchoscopy. The posterior cricoid and the thyroid cartilage were free in all patients. Three patients had severe airway obstruction and underwent an endoscopic debulking 7–10 days prior to the definitive treatment. All patients were classified as stage IVa disease (AJCC Cancer Staging Manual, 7th edition 2010). Three patients had positive neck nodes, one presented with lung metastasis and another with clavicular metastasis. Tumour features are summarized in Table 2.

All patients underwent total thyroidectomy and single-stage CTR. Operative data are shown in Table 3. The number of tracheal rings resected ranged between two and six. Four patients had an ipsilateral recurrent laryngeal nerve sacrificed. Three patients had resection of a patch of muscular layer of the oesophagus for superficial invasion by the tumour. Segmental resection of the clavicle was

Table 1 Patients' data

No.	Sex (M/F)	Age	Comorbidities	Symptoms at presentation	Radiologic exams	Vocal cord paralysis	Airway obstruction (%)
1	F	74	Hypertension	Neck mass, Hemoptysis	CT, MRI	None	70
2	M	64	Mental retardation, epilepsy, schizophrenia	Neck mass, Hemoptysis	CT	None	80
3	F	81	Hypertension	Neck mass, Dyspnoea	CT	None	80
4	M	66	Aneurysm of the ascending aorta	Neck mass, Hoarseness	US, CT, MRI, PET-CT	Right	0
5	F	65	None	Neck mass, Hoarseness	US, CT, MRI, PET-CT	Left	0
6	M	72	Hypertension, OSAS, Obesity	Neck mass, Hoarseness	US, CT	Left	0

CT computed tomography, MRI magnetic resonance imaging, US ultrasound, PET-CT positron emission tomography-computed tomography, Osas obstructive sleep apnea syndrome

Table 2 Tumour features

No.	Histology	TNM status ^a	Margins
1	Papillary	pT4a pN1b Mx	R1
2	Papillary	pT4a pN1a Mx	R0
3	Papillary	pT4a pN1a M1	R1
4	Undifferentiated (with focal follicular component)	pT4b pN1b M1	R1
5	Papillary	pT4a pN1b M0	R0
6	Undifferentiated (with focal papillary component)	pT4b pN0 M0	R0

^a TNM status according to AJCC Cancer Staging Manual, 7th edition 2010

performed in one case because of bone metastasis. One patient needed a sternotomy to excise a thymic mass which revealed thymoma on histopathological analysis. All patients had an anterolateral neck dissection (including pre- and para-tracheal nodes). Resection was considered macroscopically optimal in all the patients. There were no intraoperative complications or death, and all patients were extubated in the operating room immediately after the intervention. None of the patients needed a tracheotomy.

Results

Pathological analysis revealed papillary carcinoma in four cases, and undifferentiated carcinoma in two cases (one each with focal follicular and papillary components). Histopathological results are summarized in Table 2. T4 status was confirmed in all the cases. Size of the tumour varied from 1.8 to 5 cm (mean 3.4 cm). A transmural subglottotracheal invasion was confirmed in all patients. Resection status was R0 in three patients, and R1 in the three left. Majority of patients had advanced regional disease (3 pN1b, 2 pN1a).

Operative data and follow-up are summarized in Tables 3 and 4. Two cases (no.2 and 5) had complications directly related to the intervention. Case no.2 had an anterior anastomotic dehiscence on day nine, requiring re-intervention and resection of two additional tracheal rings (five in total). He was a schizophrenic patient with mental retardation and epilepsy. He would move his neck constantly and could not maintain it in constant flexion. On day 16, he presented a massive hemoptysis on a large anterior dehiscence and a tracheo-innominate artery fistula. He had severe endotracheal bleeding and rapidly died. Case no.5 presented with cervical emphysema on day three. Surgical exploration showed a minor anterior tracheal wall dehiscence, which was managed with a lyophilised dura patch and reinforced by interiorly rotating the sternocleidomastoid (SCM) muscle. At 3 months, her

paralysed vocal cord was medialized using autologous fat injection.

Post-operatively, mild to severe dysphagia was seen in four patients of whom two needed a temporary percutaneous gastrostomy. All patients resumed normal feeds within 2 weeks to a few months. Case no.6 needed to be re-intubated few days after the intervention for bronchopneumonia necessitating frequent bronchopulmonary toilet, before he could be extubated 3 weeks later.

Case no.4 died 2 months after the procedure because of local tumour recurrence and severe bronchopneumonia. Three patients with well differentiated cancer were further treated with radioiodine treatment. Two patients had adjuvant radiotherapy (cases no.1 and no.6 because of the R1 status). Case no.1 was lost to follow-up after 18 months, but was free of disease at his last control. Case no.3 is alive and without evidence of disease after 41 months. Fifteen months after the intervention, case no.5 showed local recurrence on PET-CT, which was managed by radical local tumour excision without additional tracheal resection and followed by adjuvant radiotherapy. After 26 months of follow-up, he has no evidence of locoregional recurrence. Six months after the operation, case no.6 is free of disease on PET-CT.

Discussion

Cricotracheal resection for laryngeal invasion by thyroid carcinoma can be curative with good functional outcomes, even for the most advanced stages of the disease. However, it carries along significant risks and complications even in experienced hands [19, 20]. By debulking the obstructed airway before the intervention, a pre-operative tracheotomy has been avoided.

The most frequently observed complications in the immediate post-operative period were anastomotic dehiscence and bronchoaspiration. Dehiscence related problems are probably due to the critical devascularisation of the trachea, mainly by the bilateral anterior compartment and superior mediastinal lymph node dissection. Most of the time, the pre-laryngeal muscles have to be sacrificed for oncological purposes, adding to devascularisation of the anterior tracheal wall. In three of our patients, the tracheo-oesophageal space had to be dissected and extramucosal anterior wall of the oesophagus excised due to superficial tumour invasion, thus severely compromising the vital tracheal vascularity and making the anastomosis vulnerable to breakdown. Thus, care should always be taken to maintain as much blood supply as oncologically feasible. In conventional CTR for laryngotracheal stenosis, resuturing of the isthmus of the thyroid gland over the anastomosis and midline closure of the pre-laryngeal muscles

Table 3 Operative data

No.	Intervention	Neck dissection (levels)	Number of tracheal rings resected	Unilateral RLN resection (Yes/No)	Anastomotic dehiscence (day/location of dehiscence)	Post-operative complications	Revision surgery
1	TT + CTR + sternotomy for removal of mediastinal mass (lymphocytic thymoma)	Bilateral II–IV+VI	6	Y	None	SIADH	None
2	TT + CTR	Bilateral III–IV+VI	3 (during the initial surgery) and 2 (during revision surgery for anastomotic dehiscence)	N	Day 9: anterior, with necrosis of 2 tracheal rings Day 16: massive dehiscence	Day 16: massive dehiscence with severe tracheal bleeding and death due to a tracheo-innominate artery fistula	Day 9: neck exploration and resection of additional 2 tracheal rings
3	TT + CTR	Bilateral III–IV+VI	3	N	None	None	None
4	TT + CTR + patch of muscular layer of the oesophagus + segmental clavicular resection	Bilateral II–V+VI	3	Y	None	None	None
5	TT + CTR + patch of muscular layer of the oesophagus	Bilateral III–VI	2	Y	Day 3: anterior	None	Day 3: Hematoma drainage, tracheal dehiscence covered by lyophilised dura patch and SCM flap
6	TT + CTR + patch of muscular layer of the oesophagus	Bilateral III–IV+VI	3	Y	None	Pneumonia requiring re-intubation at day 9	None

TT total thyroidectomy, CTR cricotracheal resection, RLN recurrent laryngeal nerve, SIADH syndrome of inappropriate antidiuretic hormone secretion

Table 4 Post-operative follow-up

No.	Adjuvant RXT (yes/no)	Iodine therapy (no. of cycles)	Status at last follow-up	Hoarseness	Dysphagia
1	Y	2	AWoD	Mild	Temporary/PEG for a few months
2	NA	NA	DWoD	NA	NA
3	N	3	AWoD	None	Temporary
4	N	None	DwD	Moderate	Temporary/PEG for a few months
5	N	2	AWoD	Moderate	Temporary
6	Y	None	AWoD	Mild	Temporary

RXT radiotherapy, AWoD alive without disease, DWoD dead without disease, DwD dead with disease, NA not applicable, PEG percutaneous endoscopic gastrostomy

reinforce the anastomosis. In CTR combined with thyroidectomy, when the strap muscles have been sacrificed, the anastomosis is essentially covered by the subplatysmal skin flap, which is not adequate to maintain the anastomotic vascularity. Covering the anterior anastomosis with a SCM muscle flap could reinforce the anastomosis and increase the local vascularity. In our series, one patient died of a massive anterior dehiscence with severe haemorrhage due to a tracheo-innominate artery fistula. The anastomotic dehiscence in another patient was closed using a lyophilised dura patch, reinforced further with a sternocleidomastoid (SCM) flap. Post-operative maintenance of the neck in flexion is of utmost importance to reduce tension on the anastomotic sutures. Our case which had a fatal dehiscence occurred in a schizophrenic and mentally retarded patient in whom it was very difficult to maintain the neck in flexion. In such difficult patients, a total laryngectomy or palliative treatment would probably have been a safer option.

Aspiration can be a major post-operative problem, leading to pneumonia with potentially fatal outcome and increased chances of anastomotic dehiscence. Aspiration occurs due to vocal fold paralysis following invasion of the recurrent laryngeal nerve by the tumour. The involved recurrent laryngeal nerve must be sacrificed if there is a vocal fold paralysis during the pre-operative assessment. If the recurrent laryngeal nerve has been sacrificed, vocal fold injection using fat or silicon micro particles (VOX^R implant) must be performed to assist the swallowing rehabilitation. Optimal cicatrisation after CTR takes 8–12 weeks, and medialisation laryngoplasty should be done once complete healing is confirmed. In select cases

though, early medialisation may need to be planned to avoid continued bronchoaspiration. Speech and swallowing therapy must be started as soon as possible, but feeding should be done through a nasogastric tube until optimal airway protection has been achieved. If dysphagia and severe bronchoaspiration persists, a percutaneous endoscopic gastrostomy must be performed to help the speech and swallowing rehabilitation.

The other concern is that of local control; two out of six patients had local recurrence despite having a CTR. Pre-operatively, both of these patients had superficial oesophageal muscle layer invasion and one of them, in addition, had obstruction of the tracheal lumen needing pre-operative debulking. One of these patients is alive without disease after radical local re-excision plus adjuvant external radiotherapy, whereas the other patient died of local disease progression and severe bronchoaspiration. Total laryngectomy could be considered as a salvage procedure in cases of very advanced disease and local recurrence.

Conclusions

Cricotracheal resection for subglottic invasion by thyroid carcinoma is an effective procedure, but carries along high risks of severe complications. In our opinion, this is mainly due to the critical devascularisation of the trachea because of radical tumour removal, sacrifice of the strap muscles and concomitant pre- and para-tracheal lymph node neck dissection. Sternocleidomastoid muscle can be mobilised anteriorly to reinforce the anastomosis. In case of luminal invasion of the subglottis and the trachea, an endoscopic debulking of the airway obstruction prior to the intervention avoids tracheotomy. Post-operative aspiration problems should be anticipated and treated aggressively.

Conflict of interest The authors declare that there are no conflicts of interest.

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