Radiofrequency resection of bronchial tumours in combination with cryotherapy: evaluation of a new technique

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Abstract

Background – A number of treatments, including Nd-YAG laser therapy, brachytherapy, cryotherapy, electrocautery, and photodynamic therapy, can re-open the obstructed bronchial lumen in patients with inoperable obstructive bronchial tumours. None of these is considered to be a “gold standard”.

Methods – The results of a retrospective study of 98 patients treated by radiofrequency tissue ablation and subsequent cryotherapy between January 1994 and June 1995 are reported. The patients were divided in two groups according to whether they were treated either after (group 1, n = 50) or before (group 2, n = 48) radiotherapy and/or chemotherapy. Bronchoscopic follow up was performed. The intervention was considered successful if the lumen was opened by >80% and partially successful if it was opened by >50%.

Results – In group 1 treatment was successful in 60%, partially successful in 32%, and unsuccessful in 8%. The median survival time was five months from the time of bronchoscopic surgery. In group 2 treatment was successful in 66%, partially successful in 21.5%, and unsuccessful in 12.5%, with a median survival time of 14 months from the time of bronchoscopic treatment. Forty patients (24 in group 1 and 16 in group 2) received a Dumon stent.

Conclusions – Radiofrequency bronchoscopic surgery with cryotherapy appears to be a useful technique in the treatment of tracheobronchial obstruction.

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Keywords: radiofrequency, cryotherapy, Nd-YAG laser, bronchoscopy, lung cancer.

The aim of endoscopic surgery in patients with malignancies of the tracheobronchial tree is to restore the airway patency in a palliative fashion. Tracheobronchial debulking is known to improve quality of life^{1,2} and may be considered part of first line treatment or even the therapy of choice in patients with medically unresectable early bronchial carcinoma, tumours characterised by a low metastatic potential, or local invasiveness such as carcinoids, adenoid cystic carcinomas and endoluminal benign neoplasms.

Many devices provide effective coagulation and vaporisation, allowing the removal of tumoral masses. The Nd-YAG laser is com-

monly used in bronchoscopic surgery, and most interventional bronchoscopists^{1,2} consider it as the standard device. Other types of laser (argon dye, krypton ion, helium-cadmium laser) are used in association with chromogens for photodynamic therapy³ and for early detection of bronchial cancer.⁴ In contrast, electrocautery⁵ is not widely used in bronchology.

We have used two alternative techniques – radiosurgery and cryotherapy – to treat our patients. Radiosurgery is a new technology which has not previously been used in bronchology. Radiofrequency tissue ablation is a technique for making thermal lesions around the tip of an electrode as a result of tissue coagulation caused by resistive heating. The electrode can be applied directly onto superficial structures surgically, endoscopically, laparoscopically, or via a catheter; the latter technique has become a well established treatment for many symptomatic cardiac arrhythmias.⁶ Thermal methods such as the use of radiofrequency induced tissue coagulation were used in early clinical trials for treating osteoid osteomas,⁷ hepatic tumours,⁸ and lung tissue.⁹ When attached to the appropriate generator, radiofrequency energy is emitted from the exposed uninsulated portion of the electrode. This energy translates into ion agitation which is converted into heat and induces cellular death via coagulation necrosis. In theory, radiofrequency can be used to sculpt precisely the volume of necrosis to match the extent of the tumour. Cryosurgery is safe and inexpensive and acts by immediate protein coagulation and cellular rupture by ice crystals and by ischaemic necrosis as a result of microthrombosis in the tumour vessels in the delayed phase.¹⁰⁻¹²

We report our experience with the combined use of radiosurgery and cryosurgery in operative bronchoscopy for treatment of tracheobronchial tumours. The use of stents¹³ can help to maintain the benefits of debulking treatments and these were used when appropriate.

Methods

PATIENTS

The records of 98 patients treated endoscopically for unresectable tracheobronchial malignancy between January 1994 and June 1995 were reviewed retrospectively. In 80 patients the malignancy was a primary carcinoma with endobronchial involvement, 14 were bronchial recurrences of a previously resected non-small cell lung cancer (NSCLC), and four cases were endobronchial metastases

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Table 1 Summary of patient data

	Group 1 (n = 50)	Group 2 (n = 48)
Patients		
M:F	46:4	44:4
Mean age (years)	66	64
Age range (years)	45–82	46–74
Obstruction site		
Trachea	16% (8)	12.5% (6)
Right main bronchus	56% (28)	62.5% (30)
Left main bronchus	32% (16)	21% (10)
Left lower bronchus		
Lobar bronchus		4% (2)
Pathology		
NSCLC	92% (46)	83.3% (40)
SCLC	8% (4)	8.3% (4)
Metastases		8.3% (4)
Treatment		
RS + cryo + RT		87.5% (42)
RS + cryo + CT		12.5% (6)
RS + cryo	100% (50)	
Stent	48% (24)	33.3% (16)

NSCLC = non-small cell lung cancer; SCLC = small cell lung cancer; RS = radiosurgery; cryo = cryosurgery; RT = radiotherapy; CT = chemotherapy.

of an extrathoracic malignancy. The patients were divided into two groups according to the time of radiotherapy/chemotherapy; 50 patients were treated after receiving radiotherapy/chemotherapy (group 1) and 48 patients were treated before radiotherapy/chemotherapy (group 2). Details of the patients are given in table 1.

TECHNIQUE

Bronchoscopy was performed via a rigid bronchoscope (Storz, Germany or Efer, France) using neuroleptoanalgesia (diazepam 5–10 mg + fentanyl 3–5 µg/kg + propofol 1 mg/kg) to maintain spontaneous ventilation. Blood pressure, electrocardiographic parameters, heart rate, and oxygen saturation were monitored.

The radiofrequency generator used operates at 1750 kHz, maximum power 99W, in continuous, single, repeated pulse and superpulse emission and with the functions of cut, coagulation, cut/coagulation, and superficial coagulation. A Huzly thermic loop⁵ and/or coagulator probe (both Storz, Germany; fig 1)

Figure 1 Instruments used for treatment: Huzly diathermy loop (left), coagulator (centre), cryoprobe (right).

were used to resect the endophytic portion of the tumour, operating with the first tool in “cut/coagulation” mode and the second in “coagulation” mode, both in superpulsed emission, power 60–70 W, six impulses per second of 10/100 seconds each.

Tumours only partially obstructing the tracheal or the bronchial lumen were resected with the Huzly loop under straightforward telescopic control while tumours that completely obstructed the lumen were mechanically avulsed by coring them out¹⁴ with the tip of the bronchoscope, after a punctiform coagulation was performed with the coagulation probe initially applied on the mass surface and then driven into the mass itself. Tumour pieces were removed by suction, forceps or cryoprobe, by cryoadhesion. The residual tumour infiltrating the bronchial wall was then cryotreated with repeated applications of 1–2' to obtain a cytotoxic effect deep in the wall (fig 2) and to sensitise the tumour to chemotherapy/radiotherapy in non pre-treated patients (group 1). Antibiotic coverage was routinely performed after the intervention. One week after cryotherapy bronchial debridement was performed using a rigid bronchoscope and a stent was inserted when indicated using a Herrel-Dumon (Efer, France) bronchoscopic introducer. Stent insertion was restricted to cases where rapid re-stenosis was likely – for example, cases of extrinsic compression. In the other cases we avoided or delayed stent insertion, particularly if we thought that further re-opening of the bronchial lumen could be expected from the chemotherapy/radiotherapy.

The patients were discharged on the same evening whenever possible. Repeat bronchoscopy to assess for re-stenosis was performed at one week and then two monthly thereafter.

Figure 2 Schematic representation of areas treated with radiofrequency ablation surgery and cryosurgery.

Figure 3 Example of bronchoscopic appearance of patient before (right) and after (left) treatment with radiosurgery and cryotherapy.

MEASUREMENTS

Bronchoscopic follow up assess for re-stenosis was performed at one week and then two monthly thereafter; the intervention was considered successful when the lumen was re-opened >80% and partially successful if >50%. Survival from the time of bronchoscopic treatment was also evaluated.

Results

GROUP 1

Debulking was successful in 30 patients (60%), partially successful in 16 (32%), and unsuccessful in four (8%); 24 patients (16 with bronchial cancer and eight with tracheal cancer) received a Dumon stent. Median survival was five months from surgery (range 0–14).

GROUP 2

Debulking was successful in 32 patients (66%), partially successful in 10 (21.5%), and unsuccessful in six (12.5%); 16 patients (10 with bronchial cancer and six with tracheal cancer) received a Dumon stent. Radiotherapy was performed in 42 patients (87.5%) within two weeks of cryotherapy at a mean dose of 50 Gy (range 30–60) and six (12.5%) received six cycles of chemotherapy (cyclophosphamide 100 mg/m² + etoposide 80 mg/m²), two for small cell lung cancer (SCLC) and four for NSCLC. Twenty eight died from disease progression with no local recurrence at the radiographic and bronchoscopic follow up. The median survival time was 14 months (range 2–18). At March 1996 20 patients were still alive with no local recurrence, four of whom (two with NSCLC treated with radiotherapy and two with NSCLC treated with chemotherapy) were disease free after >24 months of follow up. The bronchoscopic appearance of a patient before and after treatment with radiosurgery and cryotherapy is shown in fig 3.

No major complications related to the intervention or anaesthesia were observed. Only minor complications occurred in two patients. In one case in group 1 the stent was obstructed

by the tumour regrowth and it was replaced with a longer one after further radiofrequency treatment. In another case in group 2 the stent migrated from the right main bronchus toward the tracheal lumen during radiotherapy, probably because of further bronchial reopening, and it was replaced with a larger one.

Discussion

The main purpose of interventional bronchoscopy in malignancy is to restore the patency of the airways. This treatment may improve respiratory function, reduce the likelihood of obstructive pneumonia or empyema and, in cases of severe tracheal stenosis, may be life saving. While the treatment may be only symptomatic in patients who have already failed with radiotherapy/chemotherapy, it may allow others to receive this treatment which would otherwise have been contraindicated by severe respiratory failure and/or pleuropulmonary infection. From our experience of bronchoscopic cryosurgery¹¹ in more than 600 patients treated since 1976 we consider it to be a safe procedure for the treatment of tumours infiltrating the bronchial wall as perforations do not occur even with repeated and prolonged applications.

There are, however, several shortcomings. These include (1) a delayed mechanism of action – cytonecrosis is only complete about eight days after surgery so it is not indicated in the treatment of an emergency such as critical tracheal obstruction; and (2) because the tissue response to cryosurgery is proportional to the tissue water and cell content, it is not indicated in the treatment of some benign neoplasms or those of fibrous tissues. For these reasons, in 1992 we tested several contact and non-contact lasers and found that the high level of cutting precision produced by laser systems in other branches of surgery was not required in bronchology where effective coagulation is the main requirement. Moreover, the costs and hazards of lasers – including those for the staff – do not seem justified for a simple mechanical task such as tracheobronchial debulking.

Radiofrequency treatment has several advantages. It provides more precision in the control of heat emission to the healthy surrounding tissues than traditional electrocautery, and energy absorption is not dependent on the tissue colour (clear tissues refract laser light). The hazard of bronchial wall perforation is thus reduced. Furthermore, radiofrequency does not produce retracting scars on bronchoscopic follow up in cases of benign neoplasms. Our experience therefore suggests that radiosurgery is effective in operative bronchoscopy.

Moreover, cryotherapy seems to enhance the responsiveness of bronchogenic tumours to radiotherapy and chemotherapy^{15,16} by increasing the mitotic index and the neo-vascularisation of the tumour. The costs of purchasing and maintaining the instruments for radiofrequency ablation and cryosurgery are much lower than those of lasers (about £6000 for cryosurgery and £5000 for the radiofrequency generator and bronchoscopic tools

compared with about £40 000 for a Nd-YAG laser). The difference in cost could encourage more widespread use of this technique.

Our retrospective study seems to indicate prolonged survival, but the heterogeneity of the patients with regard to histology, site of obstruction, disease stage, complications, and associated oncological treatment, the retrospective nature of the data, and the lack of a comparative group do not allow a statistical evaluation. It would be of considerable clinical interest to investigate the results of tracheo-bronchial bronchoscopic treatments in terms of survival in a prospective controlled study.

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