

Case report

Successful use of high dose rate brachytherapy for non-malignant bronchial obstruction

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Abstract

High dose rate (HDR) endobronchial brachytherapy is a palliative treatment for symptomatic airway obstruction by malignant tumours. We report a novel use of HDR brachytherapy for treating non-malignant bronchial obstruction. The patient had a metal stent placed in a reconstructed airway after a bronchial tear to ensure patency. Granulation tissue formation in and around the stent caused symptomatic occlusion of the airway, necessitating multiple laser applications. A single treatment of HDR brachytherapy (1000 cGy) was delivered following laser therapy. The patient remains well 15 months after treatment with no evidence of recurrent granulation tissue formation on bronchoscopy. HDR brachytherapy is an effective treatment for non-malignant airway obstruction.

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High dose rate (HDR) endobronchial brachytherapy is considered a palliative technique for alleviating dyspnoea resulting from major airway obstruction by primary and secondary malignant tumours.^{1 2} It has the advantage of delivering a high dose of radiation over a short period of time to the obstructed area without significantly affecting the adjacent lung parenchyma.

Radiation therapy, including brachytherapy, is also used to treat a wide range of non-malignant conditions such as pterygium, exophthalmus, plantar warts, and parotitis, as well as benign tumours.^{3–5} Recently, brachytherapy was shown to reduce intimal hyperplasia and prevent restenosis following angioplasty and stenting of the coronary arteries.⁶ Like coronary artery stents, bronchial stents can cause a proliferative reaction leading to the formation of granulation tissue and obstruction of the stented airway. The use of radiation therapy for this condition was recently reported by Kennedy *et al* in two patients with lung transplantation who developed bronchial obstruction in the area of the anastomosis.⁷

We present the successful use of HDR brachytherapy in a patient with non-malignant airway obstruction caused by granulation tissue formation around a bronchial stent.

Case report

A 19 year old man was involved in a motor vehicle accident and suffered multiple injuries including brain contusion and coma, multiple fractures in both legs, and chest contusion. He was initially admitted to the intensive care unit in another hospital and placed on mechanical ventilation for 4 weeks. Three months later he was referred to our pulmonary department with atelectasis of the right lung. Bronchoscopic examination revealed complete obstruction of the right main bronchus by membranous fibrotic tissue, thought to be secondary to a bronchial tear. The tear was probably just at the area of take off of the right upper lobe bronchus and therefore caused complete atelectasis of the right lung. Nd:Yag laser treatment was applied and the bronchus was completely reopened. Tissue obtained from the area of obstruction showed hyperplastic mucosa with granulation tissue. Subsequent bronchoscopies, however, revealed recurrent obstruction of the bronchus with partial collapse of the airway. A metal Wall-stent (20/10 mm) was inserted and patency of the airway was restored. Several weeks later, however, the patient again presented with dyspnoea and bronchoscopic examination again showed granulation tissue formation around the stent with occlusion of the airway. Multiple laser applications (eight sessions) were required over a 3 month period with alternating improvement and worsening of the clinical condition. Pulmonary function tests showed mixed obstruction and restriction varying from vital capacity of 50–60% predicted. At this point the therapeutic options available were either surgical bronchoplasty or removal and exchange of the stent; both were considered unsatisfactory by us and by the patient who had just recovered from prolonged hospitalisation and refused major surgery.

With the approval of the local Helsinki Committee we decided to treat the patient with HDR brachytherapy in an attempt to prevent regrowth of the granulation tissue obstructing the airway. The procedure was fully explained to the patient who then signed a detailed consent form.

The procedure was performed under sedation in the ambulatory bronchoscopy unit according to a modification of the protocol in use for malignant disease. An Olympus P30 bronchoscope (Olympus, Japan), positioned just above the stent, was used to visualise the airway.

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Figure 1 Simulation radiograph showing HDR catheter with a dummy source to simulate iridium-192 source positions.

Nd:Yag laser was applied (total energy 2300 joules) to clear the granulation tissue, which involved mainly the distal portion of the stent. Under direct fluoroscopic guidance an HDR brachytherapy catheter (4.7 Fr) was passed through the metal stent and secured externally to the patient's nose (fig 1). The bronchoscope was removed and the patient was transferred to the radiation therapy unit. At simulation a single dose of 1000 cGy was prescribed to a distance of 1 cm from the centre of the source with a margin of 1.5 cm from the proximal and distal ends of the stent. Treatment planning was performed with the CadPlan BT brachytherapy planning system (Varian Medical Systems, Palo Alto, CA, USA). The treatment was delivered with the Varisource HDR brachytherapy remote afterloader with an iridium-192 source (10 Ci nominal activity).

Repeated bronchoscopies were performed 3, 6 and 12 months after the procedure. The airway was found to be patent, with relatively smooth mucosa in and around the stent. Clinically, the patient is asymptomatic except for a mild occasional cough. Recent pulmonary function tests showed mild restriction with forced vital capacity (FVC) 83% predicted, forced expiratory volume in one second (FEV₁) 77% predicted, total lung capacity (TLC) 88% predicted, and normal transfer factor. The chest radiograph showed well inflated lung fields bilaterally with a metal stent in the right main bronchus.

Discussion

Radiation therapy is used primarily for the treatment of malignant tumours. It is also an acceptable therapeutic option for benign disease, although there is serious concern about the potential risks of ionising radiation such as carcinogenesis and genetic damage.⁸

Benign disease characterised by excessive proliferation of normal tissue—that is, keloids, heterotopic bone formation, and gynaecomastia—is especially amenable to

treatment with radiation. Cardiologists and radiation oncologists have recently successfully used endovascular HDR brachytherapy to prevent restenosis of coronary arteries following stenting or angioplastic balloon dilatation.⁹ Animal and human models indicate that radiation therapy prevents the neointimal proliferation which occurs in response to injury to the arterial wall.¹⁰

Based on this experience we suspected that a similar mechanism of response to injury may play a role in the proliferation of the granulation tissue around the bronchial stent in our patient and that it would therefore be treatable by radiation therapy.

HDR brachytherapy is a very suitable technique for treating benign diseases for two main reasons. Firstly, the volume treated and dose received outside this area is accurately defined in three dimensions by the computer planning system. Secondly, the treatment can be delivered in a single application over a few minutes with minimal toxicity. After performing the procedure we found the report by Kennedy *et al*⁷ which described a similar approach in two patients with lung transplants who developed hyperplastic bronchial obstruction at the site of the anastomosis in whom balloon dilatation, laser application, and stent placement had been unsuccessful. They used a lower dose (3 Gy) than us although in one patient two sessions were required. One patient had died from an unrelated cause but the airways remained patent in both patients 7 and 9 months after the procedure.

This case demonstrates the successful use of endobronchial HDR brachytherapy in preventing formation of granulation tissue in reaction to a bronchial stent. If our assumption is confirmed, this treatment modality could be applied to other malignant conditions as well as non-malignant airway obstruction, as suggested by Phillips.¹¹ It may also be useful in patients with subglottic stenosis resulting from granulation tissue regrowth following laser therapy.

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