Radiotherapy

Intraoperative radiotherapy of upper abdominal tumours*

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Introduction

Intraoperative radiotherapy (IORT) allows a single high dose of radiation to be delivered to an anatomically defined area during a surgical procedure. It has the advantage that uninvolved structures can be protected by moving them out of the radiation field [1]. The combination of improved accuracy in the selection and identification of the volume to be treated, decreased damage to protected tissues and increased efficacy of the biological effect of radiotherapy, may also increase the therapeutic effect over the conventional combination of surgery and radiotherapy [2].

It has been suggested that the theoretical advantages of IORT are particularly valuable in the treatment of intra-abdominal tumours. Malignant tumours in the upper abdomen are often difficult to remove surgically with adequate margins [3]. Radiotherapy as an alternative radical treatment is limited by the tolerance of normal tissues in the area [4]. IORT is an attractive strategy to intensify treatment for tumours of the upper abdomen [5]. Tumours which have been incompletely removed, or areas in which there is a high risk of tumour recurrence can be treated with an accurate additional dose of radiation while many normal, uninvolved tissues are protected. We report our experience with IORT in miscellaneous different upper abdominal tumours, in an institution in which it has routinely been considered during cancer surgery. Previous publications have described technical aspects and preliminary results of standardised treatment of upper abdominal tumours such as gastric [6] and pancreatic cancers [7]. This study concerns uncommon applications of IORT during cancer surgery: unresectable recurrent or primary tumours and unusual tumour types.

Methods

From September 1984 to December 1989 30 patients with upper abdominal tumours were treated by IORT; the data concerning them have been analysed in May 1991. IORT was indicated because tumour-free margins could not be obtained, because the tumours bed was involved or unresected lesions. IORT was included in the treatment programme of these patients on a case to case basis. The upper abdomen is considered for the purpose of this study to ex-
Fig. 1. Treatment of the lumbar fossa following radical nephrectomy for a hypernephroma. The retractors are exposing the area and the large IORT cone has been located over it.

... tend from the diaphragm to the umbilicus. Gastric and pancreatic carcinomas have been excluded from this analysis because these tumours are included in specific prospective clinical trials of IORT in our institution. Exclusion criteria have been distant metastasis at the time of surgery, unfitness for surgery, and early loss to follow up. Our IORT methods have previously been described in detail [8]. The radiation beam generator is a linear accelerator (Mevatron 77, Siemens, Walnut Creek, California) which produces electron beams of 6, 9, 12, 15, 18 or 20 MeV. IORT cones are circular, ranging from 5 to 15 cm in diameter. The patient is taken from the operating room to the linear accelerator, which approximately 60 meters through hospital corridors and down 2 floors. This usually takes 6–9 minutes each way. The time taken for IORT ranges from 20 to 40 min and includes the preparation of the patient in the linear accelerator room, stabilisation and anaesthetic monitoring, change of clothes and gloves by the surgeon and radiotherapist, selection of the treatment zone and appropriate IORT cone, positioning the cone and mobilisation of uninvolved tissues, proper setting of the television cameras and calculation of treatment time and its conversion into linear accelerator monitor units. The irradiation lasts from 3 to 6 min. The patient is moved and treated under sterile conditions. Each IORT procedure requires the coordinated work of 10–15 health professionals in the hospital. IORT prolongs the total surgical time by 60–90 min. The IORT cone is chosen to include in desired treatment volume plus 1–1.5 cm margin of surrounding normal tissue. The electron beam energy is selected to treat the depth of tumour tissue remaining after surgery plus a 1 cm margin of normal tissue. The isodose to which the radiation dose is calculated is 90%. The total IORT dose given has been 10 Gy for minimal residual disease or areas of high risk of recurrence and 15–20 Gy for macroscopic residue or unresected tumour. As a general rule, the treatment volume is covered by a single cone, but multiple adjacent fields can be also employed. We do not use overlapping fields. Lead shields or bolus materials are employed in such cases to prevent dose contribution from two or more IORT fields.

Fig. 2a–c. IORT of the para-aortic tissues following a retroperitoneal lymphadenectomy for recurrent testicular cancer. a General view of the procedure; b exposure of the area to be treated, with excellent protection of mobile normal abdominal structures using retractors; c detail of the positioning of the IORT cone.

The surgical techniques do not differ greatly from the conventional approach for each site. Skin incisions tend to be larger, to facilitate easy positioning of the cone. Large transverse subcostal skin incision have proved very helpful for combined surgery and IORT of lesions in the anterior or medial upper abdomen. In the lumbar fossa (Fig. 1), retroperitoneum and paraaortic space (Fig. 2), mechanical retractors appear mandatory for safe, adequate safe exposure.