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# Early postoperative brachytherapy following free flap reconstruction

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*SUMMARY.* **Brachytherapy delivered within the early postoperative period has been associated with delayed wound healing and wound breakdown. The objective of this study was to determine whether reconstruction with a microvascular free flap reduced the incidence of wound breakdown in the presence of early postoperative brachytherapy following wide excision of soft tissue sarcomas and head and neck carcinomas.**

**Ten patients with malignant tumours underwent wide excision and free flap reconstruction. Brachytherapy was administered using Iridium-192 wires in the early postoperative period via tubes inserted intra-operatively.**

**In 9 of the 10 patients the wounds healed uneventfully, demonstrating that brachytherapy can be delivered in the early postoperative period following free flap reconstruction without an increase in the frequency of wound breakdown.**

Combined surgery and radiotherapy has been conclusively shown to improve loco-regional control in patients suffering from advanced head and neck malignancy and soft tissue sarcomas. External beam irradiation may be inappropriate when the malignancy has recurred after radiotherapy[1] or where limb oedema might follow radiation to the entire circumference of a limb.[2] In these patients brachytherapy can deliver high dose radiation to the tumour bed without involving the surrounding normal tissue.[3]

Nylon tubes are introduced intra-operatively because postoperative distortion of anatomy may affect

**Table 1**

| | Age | Sex | Clinical diagnosis | Pri/Rec | Previous treatment | Operation | Histology | Interval (days) | Dose | Comp. | Follow-up (months) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | 30 | F | Ca. left ethmoid left orbit | Rec | Ext beam R/T | Exc. of Ca. + free rectus abd. flap | Poorly diff. SCC Deep margin involved | 7 | 50 Gy | Died local rec. | 19 |
| 2. | 53 | M | SCC tongue | Rec | Ext beam R/T | Exc. tumour + ulnar free forearm | SCC tongue | 7 | 60 Gy | Died stomal rec. | 14 |
| 3. | 59 | F | Tumour left parotid | Rec | Superf. parotid ectomy + R/T | Left parotid ectomy + neck dissection rad. forearm flap | Muco epidermoid | 5 | 60 Gy | None | 13 |
| 4. | 59 | F | Tumour left submandibular salivary gland | Rec | Exc. submand. gland + R/T | Exc. submand. gland + neck dissection + rad. osteocut. free flap | Adenoid cystic ca. involving mylohyoid muscle | 20 | 45 Gy | Fracture radius | 10 |
| 5. | 46 | M | SCC right cheek | Rec | Exc. + local flap | Exc. SCC + neck diss. + rad. forearm | SCC margin clear Poor growth pattern (neck clear) | 17 | 45 Gy | Local recurrence | 9 |
| 6. | 44 | M | SCC floor mouth No neck nodes | Prev Ca. Larynx | Ext beam for Ca. Larynx | Exc. SCC + neck dissection + rad. free flap | SCC floor mouth (neck clear) | 28 | 50 Gy | None | 4 |
| 7. | 56 | F | SCC nose | Rec | Ext beam | Exc. of mid face + radial forearm osteo-cutaneous flap | SCC nose | 14 | 50 Gy | In transit metastases | 2 |
| 8. | 84 | F | Sarcoma right popliteal fossa | Rec | Exc. + primary closure + R/T | Wide excision + rad. forearm free flap | High grade sarcoma clear margin | 14 | 50 Gy | None | 11 |
| 9. | 83 | F | Soft tissue tumour left thigh | Incomp. exc. | Exc. + primary closure | Wide exc. + right radial free flap | Sarcoma left thigh clear margin | 14 | 45 Gy | Superf. wound sinus | – |
| 10. | 77 | F | Soft tissue tumour left forearm | Rec | Exc. + primary closure + R/T | Wide excision + free rad. forearm flap | Pleomorphic MFH Margin clear | 19 | 45 Gy | None | – |


Fig. 1

**Figure 1**—(A) Preoperative view of a patient with a recurrent parotid tumour. (B) Intraoperative view following excision of the tumour and insertion of the nylon catheters. (C) Postoperative view following reconstruction with a radial forearm flap demonstrating a well healed wound.

the accurate placement of radioactive implants and are after-loaded with Iridium-192, allowing accurate dosimetry and a reduction in the risk of radiation to the medical and nursing personnel. Previous studies have substantiated the effectiveness of this approach in management of soft tissue sarcomas[4] and inoperable cervical lymph nodes.[5]

Traditionally external beam irradiation has been delayed for 4–6 weeks postoperatively until wound healing has been established. Postoperative brachytherapy administered early after surgery may lead to complications such as delayed wound healing and wound breakdown. Local and pedicled myocutaneous flaps have been used to provide well vascularised tissues to cover the radioactive implants and promote wound healing, although the results reported have been variable.[5,6] Only one study, to our knowledge, has described microvascular free flaps and early postoperative brachytherapy in the management of soft tissue sarcomas.[7] The successful use of free flaps to cover the radioactive implants and early postoperative brachytherapy has not been previously described in advanced head and neck cancer.

In the current study we have performed wide excision of the malignant tumours and free flap reconstruction followed by early postoperative brachytherapy.

## Materials and methods

From November 1990 to October 1992 10 patients underwent excision of malignant tumours, microvascular free flap reconstruction and postoperative brachytherapy. Of these 10 patients 7 had head and neck carcinomas and 3 had soft tissue sarcomas (Table 1). The mean age of the patients was 59.1 years. All patients had a MRI or a CT Scan to evaluate the extent of local spread and presence of enlarged lymph nodes, and a chest X-ray to exclude pulmonary metastases.

Patients with post radiotherapy recurrent head and neck carcinomas and an increased risk of loco-regional spread were selected to have postoperative brachytherapy (Fig. 1A). This risk was assessed by the presence of extensive local spread as determined by the extent of the primary tumour and results of the MRI or CT Scan. The presence of high grade carcinoma, vascular, perineural and sarcolemmal spread histologically, heralded poor prognosis and confirmed the need for postoperative brachytherapy to control loco-regional recurrence.

Two of the patients with soft tissue sarcomas had recurrent tumours following previous excision and one had undergone an incomplete previous excision. Only two patients had received external beam radiotherapy previously (Fig. 2A).

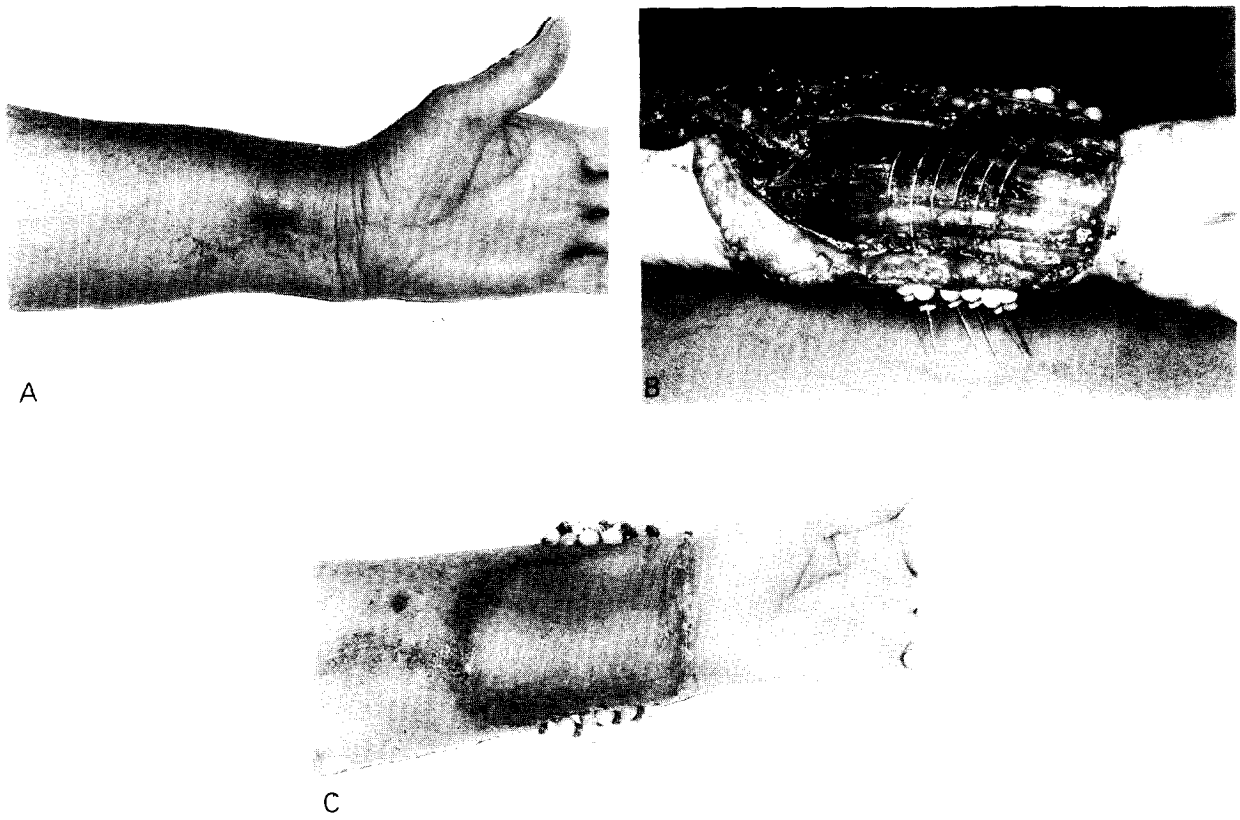


Fig. 2

**Figure 2**—(A) Preoperative view of a patient with a recurrent sarcoma of forearm. (B) Intraoperative view following excision of the tumour and insertion of the nylon catheters. (C) Postoperative view following reconstruction with a radial forearm flap demonstrating a well healed wound.

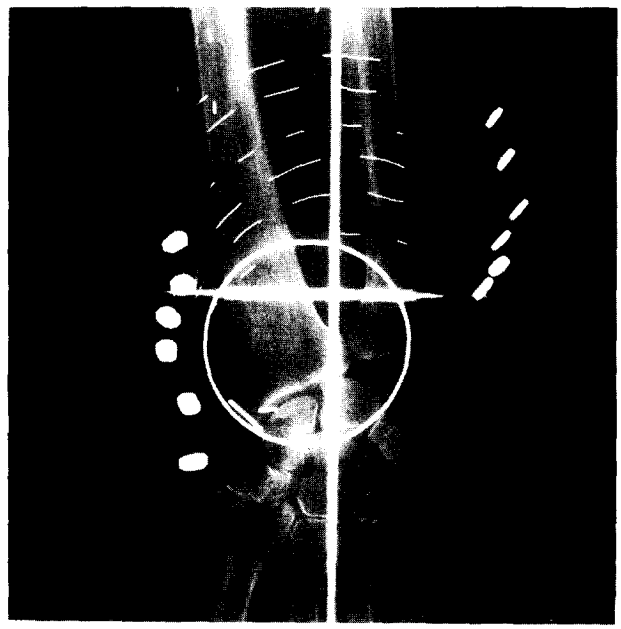

Fig. 3

**Figure 3**—X-ray demonstrating dummy wires within nylon catheters which allow accurate dosimetry before insertion of Iridium-192 wires.

The patients with head and neck malignancies initially had a wide local excision of the tumour and a modified radical neck dissection. Following excision, hollow nylon tubes were introduced into the tumour bed at 1 cm intervals and their ends were left protruding to facilitate afterloading (Figs 1B, 2B). A microvascular free flap was then used to reconstruct the defect. Eight patients had radial forearm flaps and the remaining two had a rectus abdominis free flap and an ulnar forearm free flap each, for reconstruction.

The microvascular anastomoses were performed at least 5 cm away from the site of the tumour, thus lying outside the original treatment fields. Care was taken to prevent contact between the nylon catheters and the vessels on the undersurface of the free flap.

Once the patients were self caring in the postoperative period they were transferred to the Radiotherapy Department for brachytherapy. It was essential for the patients to be self caring to ensure minimal intervention from the nursing personnel, thereby diminishing the risk of radiation to them.

The brachytherapy tubes were afterloaded with Iridium-192 wires between 5 and 28 days postoperatively (mean 14.9 days). The mean dose (calculated at the reference dose rate) delivered was 49.5 Gy over 3–5 days. The dose rate for all patients except patients 4 and 8 was 0.5 Gy per hour. In patients 4 and 8 higher dose rates of 1.5 and 1 Gy per hour were used respectively and the dwell time was adjusted based on the linear quadratic formalism to give a dose rate equivalent to 0.5 Gy (Fig. 3). On conclusion of brachytherapy the Iridium wires and the catheters were withdrawn and the patient discharged from the radiotherapy ward.

## Results

All 10 microvascular free flaps survived and in 9 patients the wounds healed uneventfully (Figs 1C, 2C). One patient who had a sarcoma excised from the thigh developed a discharging sinus. This was treated conservatively and subsequently healed without any surgical intervention after 3 months.

All patients have been followed in the Combined Oncology Clinic, the duration of follow-up ranging from 1 month to 19 months (mean follow-up 9.4 months). None of the wounds developed a breakdown during this follow-up period. Two further patients died from local and tracheostomal recurrence at 19 and 14 months during follow-up. Two patients developed subcutaneous metastases, one during the third postoperative week and another 9 months following operation (Table 2).

One patient was excluded from the study as he died before commencement of brachytherapy. This patient required exploration of the microvascular anastomoses in the postoperative period as he developed spasm of the vessels. This was initially thought to be related to nylon catheters which were lying in close proximity to the vessels but later proved to be caused by exposure to cigarette smoke.

**Table 2**

| *Patient characteristics* | |
|---|---|
| Sex Male/Female | 3:7 |
| Mean age | 59.1 years |
| Previous external radiotherapy | 8 patients |
| Head & neck Ca/sarcoma | 7:3 |
| Type of free flap | |
| Radial forearm flap | 8 |
| Ulnar forearm flap | 1 |
| Rectus abdominis flap | 1 |
| Mean dose of brachytherapy | 49.5 Gy |
| Mean interval | 14.9 days |
| Mean follow-up period | 9.4 months |
| Wound complication rate | 10% |
| Recurrence | |
| stomal recurrence | 1 patient |
| local recurrence | 1 patient |
| subcutaneous metastases | 2 patients |

## Discussion

Combination therapy has been employed frequently in the management of head and neck malignancy and soft tissue sarcomas to reduce locoregional recurrence.[2,4,8–15] This therapeutic modality allows enhanced eradication of tumour cells by allowing surgery to excise the gross disease and radiotherapy to control any residual microscopic disease.[16] A less radical resection of soft tissue sarcomas of the limbs can be performed, thereby allowing preservation of extremity function without compromising on the local recurrence rate.[17]

Postoperative radiotherapy can be administered as external beam megavoltage therapy or as brachytherapy. Unlike external beam treatment, brachytherapy localises the maximum tumouricidal dose to the tumour bed directly, with minimal detrimental effects on the surrounding normal tissues due to the rapid fall off in dose.[3] It also delivers the same dose in a few days while the patient is in hospital and can be used when previous external beam radiotherapy has been unable to control the disease locally.[5]

The timing of radiotherapy is critical. Irradiation will have its maximum effect in the early postoperative period when the tumour cell mass is smaller and the cells are well oxygenated. The presence of scar and fibrous tissue within the wound in the late postoperative period reduces radiosensitivity.[16] An uncontrolled trial of 114 patients with stage 3 and stage 4 squamous cell carcinomas of the head and neck treated with postoperative radiotherapy demonstrated a significant decrease in the locoregional recurrence rate if the radiation was commenced within 6 weeks of the surgery compared with irradiation after 6 weeks.[18]

Brachytherapy when delivered in the immediate postoperative period (within the first 5 postoperative days) however has been associated with significant wound complications. Animal studies have demonstrated that delaying the administration of brachytherapy beyond the first 5 days increases the wound collagen content and the wound-breaking strength.[19] Ormsby *et al.*[20] in a prospective randomised trial at a radiation dose of 45 Gy found a 48% wound complication rate in patients with soft tissue sarcomas who underwent wide local excision, primary closure and postoperative brachytherapy when the tubes were afterloaded within the first 5 days after the operation. This was reduced to 14% when the loading was done after five days. Stafford *et al.*[5] in their treatment of "inoperable" cervical neck nodes using surgical clearance and postoperative brachytherapy (40 Gy) reported the use of large cutaneous or pedicled myocutaneous flaps to close the wound after excision of the previously irradiated area to reduce the risk of soft tissue necrosis. Park *et al.*,[6] in a similar study using

permanent implantation of intraoperative Iodine-125 seeds giving a dose of 82.8 Gy, however demonstrated an increased wound complication rate in the presence of a local flap as compared to primary closure. Each of these wound complications presented with necrosis on the undersurface of the flap where it was in contact with the Iodine-125 seeds which were embedded in gelfoam. They could not establish a correlation between the radiation dose delivered and the rate of wound complications. They attributed the higher incidence of flap necrosis to the greater magnitude of resection and the greater frequency of oropharyngeal contamination occurring in these patients. Though it may seem that the doses given in this study are high, the doses needed for I-125 are often higher as it is administered over a 6–12 month period. Thus the doses delivered in this study are equivalent to about 45 Gy.

Recently, Hidalgo *et al.*[7] reported that brachytherapy (45 Gy) can be administered successfully in the early postoperative period (between 5–8 postoperative days) with free flap reconstruction in a series of three patients with recurrent soft tissue sarcomas of the lower limbs. They concluded that free flaps can be used to reconstruct complex tumour defects of the leg and survive early postoperative brachytherapy without flap loss or increased wound healing complications. Our experience verifies this finding with soft tissue sarcomas.

In our study using microvascular free flaps for reconstruction, brachytherapy was commenced early in the postoperative period (mean 14.9 days) and completed within 3–5 days. Though every effort was made to commence brachytherapy within the fifth to the eighth postoperative days there were delays due to unavailability of beds on the radiotherapy ward and the longer time taken by the patients with oral cavity resections to become self caring. The mean dose of 49.5 Gy delivered was well tolerated and did not adversely affect wound healing.

In conclusion, we strongly advocate combined free flap reconstruction with early postoperative brachytherapy as a modality of adjunctive treatment following wide excision of soft tissue sarcomas and for controlling local recurrence in those patients with head and neck malignancy who have recurrence following external beam radiotherapy.

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