

# Positron Emission Tomography with Fluorine-18-Fluorodeoxyglucose for the Evaluation of Therapeutic Isolated Regional Limb Perfusion in a Patient with Soft-Tissue Sarcoma

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**Methods:** The treatment of a patient with soft-tissue sarcoma was evaluated with FDG-PET. A limb-saving complete remission of a locally advanced liposarcoma of the left thigh was achieved with isolated regional perfusion of the limb with tumor necrosis factor alpha, interferon gamma and melphalan. **Results:** PET with  $^{18}\text{F}$ -FDG before perfusion showed high glucose consumption in the tumor. After perfusion, glucose metabolism in the tumor was absent. Subsequent excision confirmed complete necrosis of the tumor. **Conclusion:** FDG-PET may be useful in evaluating the results of ipsilateral regional limb perfusion for soft-tissue sarcomas.

**Key Words:** fluorine-18-fluorodeoxyglucose; positron emission tomography; glucose metabolism; isolated limb perfusion; sarcoma

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The potential of positron emission tomography (PET) with  $^{18}\text{F}$ -fluoro-2-deoxy-D-glucose (FDG) to visualize various types of tumors is now well established (1,2). It has been suggested that PET with FDG may be used to evaluate the response of a malignant tumor to chemotherapy and radiotherapy, since a decrease in tissue viability will result in a decrease of FDG accumulation (3-5). This potential application of PET may be of value in the management of patients with soft-tissue sarcoma.

Preoperative chemotherapy in patients with localized soft-tissue sarcoma is the subject of current investigation (6-8). Experience has been gained with hyperthermic iso-

lated regional limb perfusion (HILP) with cytostatic drugs for limb-saving treatment in patients with locally advanced lesions (9). The recent addition of tumor necrosis factor alpha to the HILP regimen offers a new and exciting treatment option (10). We present a case of a locally advanced soft-tissue sarcoma to demonstrate how FDG PET can evaluate the outcome of this treatment modality.

## CASE REPORT

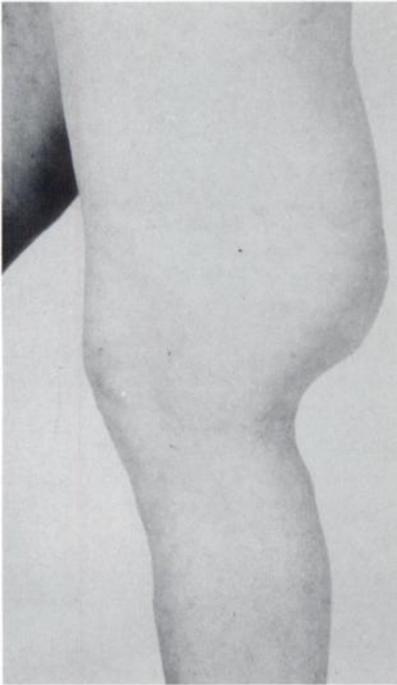
A 50-yr-old woman presented with a high-grade myxoid liposarcoma on the dorsal aspect of the left thigh (Fig. 1). The lesion was 20 cm in diameter. The size and proximity of the tumor to the vessels (Fig. 2A) prevented local excision with an adequate margin. HILP with tumor necrosis factor alpha, interferon gamma and melphalan was performed in an attempt to save the leg.

PET studies were performed before and after HILP in a dynamic and rectilinear fashion. An i.v. dose of 8 mCi (296 MBq) FDG was administered. A Siemens ECAT 951/31 camera was used. The pretreatment PET study showed a high level of glucose consumption in the tumor (Fig. 3A). In all planes, a region of interest was defined around the tumor using a contour analysis technique. The counts within the tumor were averaged per unit of volume for all planes. A Patlak analysis was performed and glucose consumption in the tumor was calculated, assuming a lumped constant of 0.42 (11,12). The glucose consumption was  $41.3 \mu\text{mole}/100 \text{ g}/\text{min}$ .

A rectilinear PET study 11 days after HILP demonstrated a cold spot at the site of the tumor (Fig. 3B). FDG uptake in the rest of the leg was increased, presumably due to the inflammatory response caused by the HILP. A PET study 2 mo after HILP showed the tumor as a similar cold spot. Calculation of tracer uptake demonstrated no glucose consumption in the lesion. In contrast to the PET study, repeat MRI showed only minor changes in comparison to the pretreatment MRI (Fig. 2B). The tumor mass was locally excised the next day (Fig. 4). Pathologic examination of the specimen revealed necrosis; no viable tumor cells were found.

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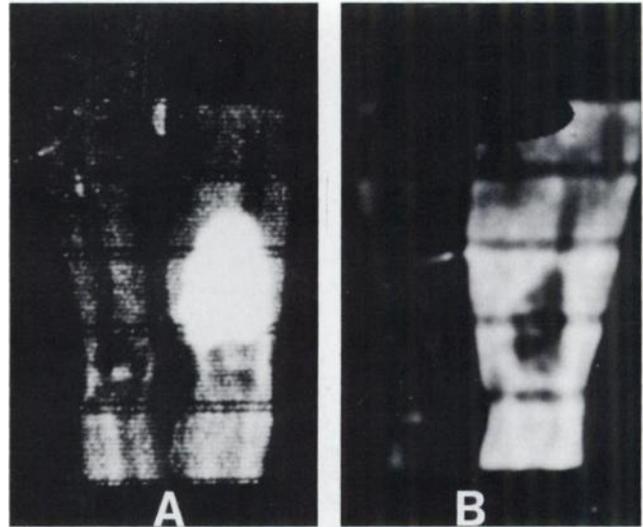
**FIGURE 1.** Lateral view of the left leg with a large liposarcoma on dorsal aspect.

In the ensuing months, the patient developed metastases in the lungs, the left breast, a lymph node in the neck and the 11th thoracic vertebra. She died 9 mo after HILP with widely metastasized disease but without local recurrence of the sarcoma.

**DISCUSSION**

This case illustrates that FDG-PET can suggest complete remission of a soft-tissue sarcoma after HILP. The PET result was confirmed by surgical excision and histologic examination of the tumor.

A few patients with soft-tissue sarcoma have a locally advanced tumor that threatens the limb. HILP with tumor necrosis factor alpha, interferon gamma and melphalan can help to save the extremity in a substantial number of these cases (10). Further studies will be needed to demonstrate whether PET with FDG is indeed able to discriminate between no response to chemotherapy, a partial response and a complete remission. If the present result is confirmed, PET may be able to indicate when amputation is

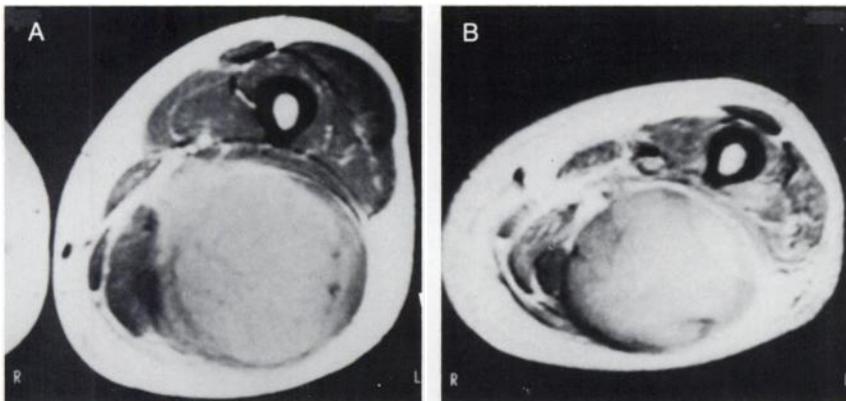


**FIGURE 3.** Rectilinear FDG PET studies, anterior views, before and 11 days after HILP of the left leg. Before treatment, increased glucose consumption in the liposarcoma of the left leg is demonstrated (A). After HILP, glucose metabolism in the tumor is absent (B). The inflammatory response in the treated leg is reflected by a diffuse increase in glucose consumption compared to the other leg.

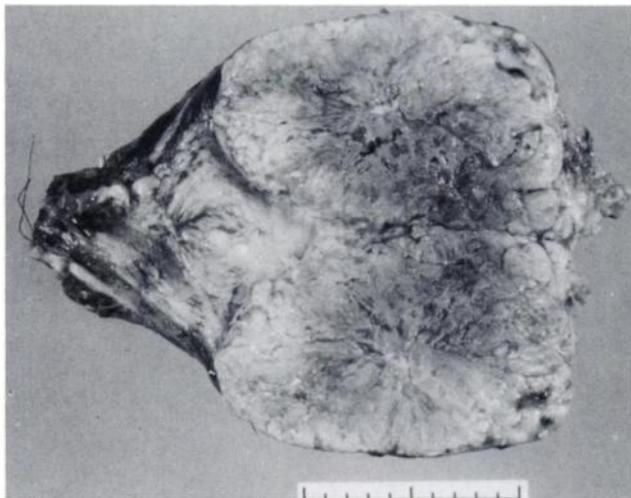
necessary and when local excision with a limited margin—or perhaps even abstaining from excision—is justified. Such studies should take into account the limited spatial resolution of PET as compared to MRI. The partial-volume effect due to this limited spatial resolution may underestimate FDG-uptake, especially in smaller tumors. Consequently, it is possible that FDG-PET overestimates the reduction of glucose consumption as induced by HILP.

Another subject of concern in oncology studies with FDG, is the variability of uptake of FDG with fluctuating blood glucose levels as was recently shown for bronchial carcinomas (13). To overcome this problem, all our patients are studied after 6 hr of fasting. In diabetic patients, a normoglycemic glucose clamp technique is applied. Since effects on dynamic quantification using the Patlak approach are less dependent on the plasma glucose levels, this is the method of choice when reproducibility is needed (13).

Approximately 40% of the patients with soft-tissue sar-



**FIGURE 2.** MRI before HILP illustrates the large size of the lesion and its proximity to the vessels (A). MRI 2 mo after HILP shows a slight decrease in tumor size and vascularity (B).



**FIGURE 4.** Transection of the surgical specimen after limb-saving local excision. Histologic examination confirmed that the entire tumor was necrotic.

coma die with distant metastases. With systemic chemotherapy, remission can be obtained in approximately 40% of these patients (14). A noninvasive technique to predict the outcome of chemotherapy in an early phase will be of value for patient management. In theory, PET has that potential. This study shows that research in this direction may be fruitful.

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