Hepatoblastoma is the most common malignant hepatic tumor in children, with an annual rate of 1.3 cases per million. It is usually found during the first 3 years of life, and most patients are younger than 2 years. The term "hepatoblastoma" indicates a group of tumors of embryonal origin, histologically distinct from hepatocellular carcinoma of childhood [1]. The clinical presentation of hepatoblastoma is usually characterized by an abdominal mass and an elevated level of serum α-fetoprotein. Prognosis is poor when the tumor is unresectable; however, complete resection is possible in about 50% of cases [2]. Chemotherapy may produce response in a significant number of patients, and preoperative chemotherapy has been used with some success in converting unresectable tumors to resectable. In children with an unresectable mass that is not responsive to chemotherapy, orthotopic liver transplantation should be considered [2]. Morphologic imaging techniques such as CT, sonography, and MRI may locate a neoplastic liver mass; but negative findings on conventional imaging studies do not always exclude the presence of disease [3–8].

Because, to our knowledge, the potential role of FDG positron emission tomography (PET) in children with hepatoblastoma has not been previously investigated, we report a case of a 4-year-old boy with orthotopic liver transplantation as a result of hepatoblastoma, in whom tumor recurrence was assessed with FDG PET.

Case Report

A 4-year-old boy with a history of fever, abdominal pain, and hepatosplenomegaly underwent abdominal sonographic and liver CT examinations that revealed multiple liver lesions with a maximum diameter of 4.5–5.5 cm (Fig. 1A). His serum α-fetoprotein level was 2,333 ng/mL. Hepatic biopsy was performed under sonographic guidance, and the diagnosis of hepatoblastoma was made. At histologic examination, the tumor was classified as the mixed (mesenchymal–epithelial) type: 25% embryonal, 25% fetal, and 50% trabecular hepatocellular carcinoma cells. Chemotherapy treatment was started (four cycles of cisplatin, vincristine), but the tumor did not respond. This fact, along with the absence of distant metastases on whole-body CT, suggested liver transplantation as a possible therapeutic option.

The patient underwent surgical resection en bloc of the native liver and received a segmental liver transplant (lateral segment of the left lobe). The serum α-fetoprotein level after transplantation was 188 ng/mL; however, 3 months later the serum α-fetoprotein level increased to 1,248 ng/mL. Contrast-enhanced CT of the transplanted liver was performed: no lesion was seen in the liver parenchyma, but an irregular area of hypodensity was noted along the posterior edge of the liver (Fig. 1B). These findings were confirmed on MRI performed with unenhanced and gadolinium-enhanced sequences.

PET was performed to better assess the possible presence of liver tumor. After the patient fasted, whole-body PET was performed 50 min after the IV administration of 147 MBq of FDG using an integrated PET–CT device (Discovery LS, General Electric Med-
FDG PET of Hepatoblastoma in Transplanted Liver

ical Systems). PET data sets were reconstructed iteratively with segmented correction for attenuation using the CT data. CT images with integrated PET–CT were not evaluated for diagnostic purposes because they were without contrast enhancement. CT images were used only for conventional visual correlation with PET images. Coregistered images were displayed using eNTEGRA software (General Electric Medical Systems). The reconstructed transverse, coronal, and sagittal images were analyzed visually; radiotracer uptake—the standardized uptake value—was measured quantitatively by normalizing the amount of radiotracer uptake in the lesion detected to the injected dose and patient body weight. Standardized uptake values were calculated in the largest tumor deposits to minimize partial volume effects.

Analysis of PET images showed an area of high radiotracer uptake along the posterior edge of the transplanted liver that corresponded to the hypoattenuating region depicted on contrast-enhanced CT (Fig. 1C). Analysis also revealed multiple areas of focal radiotracer accumulation in the liver that had no corresponding finding on contrast-enhanced CT (Figs. 1D and 1E). Moreover, two other nodules showing abnormally high radiotracer uptake were found in the peritoneum; these two lesions were not identified on contrast-enhanced CT (Fig. 1F). Additional liver lesions and peritoneal implants were also not detectable on MRI performed before PET. PET findings were interpreted as consistent with multiple neoplastic lesions in the liver and peritoneum. Lung metastases, which are common in these cases, were not seen on either FDG PET or contrast-enhanced CT.

Discussion

Imaging evaluation of primary liver tumors in children has been conducted using a wide variety of techniques, including sonography, CT, and MRI [3–8]. Sonography is the screening technique of choice because of its sensitivity, low cost, and general accessibility. However, sonography has relatively low specificity in evaluating liver tumors, and it pro-

![Fig. 1.](image-url)
vides less anatomic detail than CT does. On contrast-enhanced hepatoblastoma, the most common presentation of hepatoblastoma includes large, diffuse, or multifocal lesions predominantly hypodense relative to normal hepatic parenchyma, occasionally characterized by calcifications and septations, which may help differentiate hepatoblastoma from other liver neoplasms in children [3]. CT with contrast enhancement is the technique currently used to diagnose, preoperatively evaluate, and follow up hepatoblastoma in children. However, CT findings are sometimes inaccurate for preoperative staging of liver tumors. King et al. [8] found that CT cannot be used to determine ultimate resectability of hepatoblastoma in children, nor is preoperative scanning always accurate for defining exact lobar and segmental involvement. In another study, Finn et al. [7] reported that the extent of primary malignant liver tumor was underestimated on the basis of CT findings in two of eight children in whom CT and surgical results were correlated. Likewise, postoperative CT has proven to have some limitations in assessing recurrent or residual liver tumor in children [8].

Advances in instrumentation and the development of specific surface coils provide high-quality MRI of primary liver tumors in children. Boechat et al. [6] have assessed the efficacy of this technique, and their results indicate that the accuracy of MRI is comparable with that of CT in the diagnosis and staging of these tumors. Their report also suggests that MRI is more sensitive than CT for detecting recurrent tumor in the postoperative period. Unfortunately, fibrosis with chronic inflammation after surgery was seen to have signal intensity characteristics on MRI similar to those of tumor tissue. More recently, it has been suggested that MRI is a valuable method for assessing resectability of liver tumors in children, but it may have limited value in distinguishing viable from necrotic tumor tissue.

PET using FDG has been shown effective in the identification of malignant tissue in different primary and metastatic tumor types. FDG PET can reveal the biochemical differences between normal and malignant tissues on high-resolution tomographic images, and it has been used as a functional method of determining tumor viability. FDG PET can be useful for assessing the viability of residual disease after chemotherapy, and it can also be used, as in our patient, in the evaluation of recurrent disease. We have found that this technique may provide additional means of evaluating liver parenchyma in a patient with recurrent hepatoblastoma and may help detect metastatic sites not identified by other imaging techniques, thus allowing more precise tumor staging. In our patient, CT and MRI correctly detected the presence of recurrent tumor along the edge of the transplanted liver but did not allow depiction of lesions inside the liver parenchyma and peritoneal metastases: these were detected only with PET.

In agreement with previous reports, our findings confirm that PET, by adding metabolic information to anatomic details provided by other imaging techniques, may help in staging tumors. The ability of PET to differentiate malignant lesions may be excellent, as shown in several studies in which PET identified metabolically active tumor foci with no correlates at morphologic imaging. Also, in our case, a possible explanation for higher sensitivity for tumor tissue shown by PET may be that positive findings on PET were correlated with metabolic rather than morphologic changes in malignant tissue.

In conclusion, our preliminary experience suggests that in children with hepatoblastoma, FDG PET may be a useful adjunct to CT and MRI because the integration of functional and anatomic data may represent the most effective method of evaluating disease status.

References