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INTRAOPERATIVE SONOGRAPHY: APPLICATION IN RENAL CELL CARCINOMA

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ABSTRACT

Our ability to detect and potentially to treat renal tumors earlier has increased exponentially during recent years, in part owing to the introduction of more sophisticated imaging modalities. We report 2 cases in which intraoperative sonography was used to localize tumors not palpable at operation. In both cases surgery was performed on solitary kidneys for renal cell carcinoma in otherwise healthy patients. (*J. Urol., 139: 582–584, 1988*)

Renal cell carcinoma in a solitary kidney or the presence of synchronous lesions bilaterally poses a difficult urological dilemma. It is not yet known whether the patient is served best by attempting to conserve functional renal tissue or by being rendered anephric. However, our ability to detect and to treat renal tumors earlier has increased significantly during recent years, primarily because of the increased sophistication of our imaging modalities. The ability to localize these lesions preoperatively and to be able to define their location precisely intraoperatively might significantly improve our ability to conserve renal parenchyma at operation for renal tumors. We report 2 cases in which intraoperative sonography was used to localize tumors not palpable at operation. In both cases surgery was performed for renal cell carcinoma in solitary kidneys of otherwise healthy patients.

CASE REPORTS

Case 1. A 73-year-old man had undergone left nephrectomy 26 years before this hospitalization for renal cell carcinoma. Medical history was significant for a coronary artery bypass graft 8 years previously from which he was now free of symptoms. Followup evaluation with excretory urography (IVP) and a chest x-ray had been negative until 2 years ago when a mass was noted in the solitary right kidney. Renal ultrasound, computerized tomography (CT) and selective right renal angiogram confirmed this mass as solid with neovascularity. A repeat CT scan 3 months later demonstrated an interval increase in size of the initial lesion as well as a second lesion (fig. 1). The larger mass, projecting from the lateral border around the mid portion of the kidney, was approximately 4 × 3 × 2 cm. In addition, a 3 × 2 × 1 cm. mass was noted in the parenchyma, which was surrounded by normal-appearing parenchyma and impinging onto the collecting system. Neovascularity was demonstrated by selective renal arteriography (fig. 2, *A*). Metastatic evaluation with a bone scan and chest x-ray was negative. Admitting laboratory evaluation yielded a blood urea nitrogen (BUN) of 22 mg./dl. (normal 5 to 25) and a creatinine of 1.5 mg./dl. (normal 0.5 to 1.5).

Right renal exploration was planned with the intent of excising both lesions, either in situ or on the bench with subsequent autotransplantation. An 11th rib thoracicoabdominal incision was made for exploration. The kidney was freed from adherent surrounding soft tissues. The renal artery then was exposed and its branches were dissected. The renal artery branched early with the posterior branch beginning at the lateral border of the inferior vena cava. A bowel bag was placed around the kidney and iced slush was applied. With vascular control of the arterial branches the large tumor on the lateral border was excised rapidly and sent for pathological evaluation. Frozen section revealed renal cell carcinoma.

However, careful palpation of the kidney with and without renal artery occlusion failed to disclose the location of the second tumor as delineated clearly by the CT scan. Intraoperative ultrasonography consultation was obtained to assist with localization of this tumor. An Acuson ultrasound with a 5 mHz. linear array transducer was used. The transducer was placed into a sterile cellulose sheath with ultrasound coupling gel against the transducer and sterile saline between the kidney (which itself was in a sterile saline slush) and the cellulose sheath. With this method clear sonographic images were obtained. A 25 gauge needle was used to localize the tumor (fig. 2, *B*). The tumor was identified 0.5 to 1.0 cm. beneath the renal cortical surface. Radial nephrotomy was performed and with blunt dissection a golden yellow, soft tumor was identified and excised. Frozen section again showed adenocarcinoma. A drain was placed in the renal fossa, a chest tube was placed in the 6th intercostal space (mid axillary line) and the incision was closed in standard fashion.

The postoperative course was complicated by a wound infection that required open drainage and secondary closure. Final pathological diagnosis was clear cell renal adenocarcinoma with tumor focally involving the surgical margins of resection. The patient was discharged from the hospital 18 days postoperatively with a serum creatinine of 1.3 mg./dl. He had resumed all normal activities 4 months later.

Case 2. A 73-year-old man had undergone left nephrectomy 43 years before this hospitalization for tuberculosis. Medical history also was significant for mild chronic obstructive pulmonary disease and adult onset diabetes mellitus. Renal sonography, which had been performed as part of a study for recur-

FIG. 1. Case 1. Abdominal CT scan shows large cortical tumor (large arrows) and smaller medullary tumor (small arrows). Note that smaller tumor does not extend to surface of kidney.

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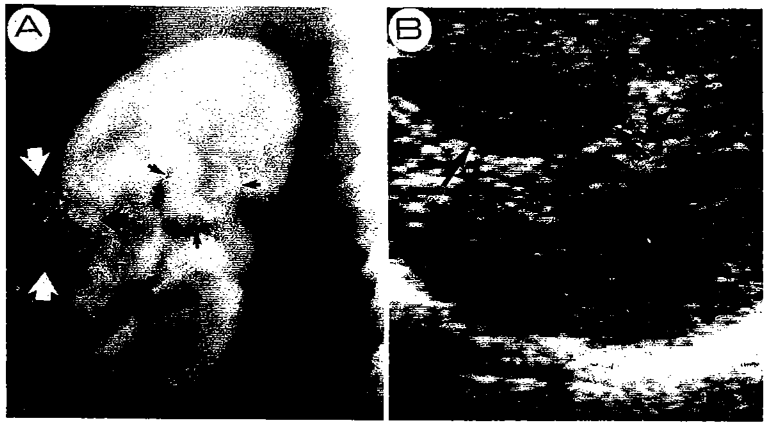

FIG. 2. Case 1. *A*, selective right renal arteriogram shows hypervascular mass (large arrows) bulging off cortical contour at mid pole of kidney. Second renal mass (small arrows) is seen faintly in region of renal hilus. *B*, intraoperative real-time sonogram reveals centrally located renal tumor (arrows).

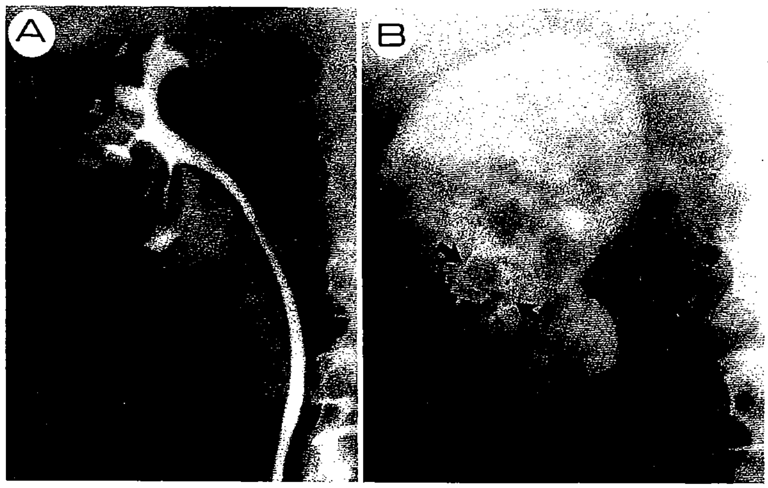

FIG. 3. Case 2. *A*, retrograde pyelogram shows splaying of mid and lower pole collecting systems by lower pole renal mass. *B*, parenchymal phase of selective right renal artery arteriogram demonstrates that tumor is hypervascular, containing irregular tumor vessels (arrows).

rent epididymitis, revealed a right renal mass. An IVP and retrograde pyelography (fig. 3, *A*) showed splaying of the mid and lower pole collecting system. An arteriogram demonstrated tumor hypervascularity (fig. 3, *B*). The preoperative CT scan showed a poorly visualized mass, approximately 3 cm. in diameter, bulging into the renal sinus but not extending to the renal cortex (fig. 4). No lymphadenopathy or metastatic disease was demonstrated by a CT scan, chest x-ray or bone scan. Laboratory values included a BUN of 18 mg./dl. and a creatinine of 1.1 mg./dl.

An 11th rib, extraperitoneal, extrapleural incision was used for right renal exploration. Vascular control of the renal vein and single renal artery was achieved. The tumor could not be located on careful palpation of the kidney despite temporary occlusion of the renal artery. Intraoperative ultrasonography consultation was obtained. The kidney was packed in iced saline slush, the renal artery was clamped and, as described in case 1, an Acuson ultrasound with a 5 mHz. linear array transducer enclosed in a sterile sheath was used to locate the tumor. A 3.0 cm. tumor was localized easily in the mid portion of the kidney slightly towards the lower pole, approximately 1.5 cm. beneath the cortical surface (fig. 5, *A*). In addition, a previously unidentified calculus, measuring 0.5 cm. in diameter, was located in the caliceal system beneath the tumor (fig. 5, *B*). A 25 gauge needle was placed into the tumor under ultrasonic guidance. With this needle guide a longitudinal nephrotomy was made, the capsule of a 3.0 cm. nodule was identified, and with blunt and sharp dissection the nodule was removed. The frozen section report revealed adenocarcinoma. The calix then was opened and the previously visualized calculus was removed. After removal of the tumor several venous channels and the collecting system were identified easily and closed. A piece of perinephric fat was placed in the area of the tumor and the capsule was closed over it. The total cold ischemia time was 55 minutes. After clamp removal the kidney appeared to be well perfused and the incision was closed in standard fashion. Final pathological diagnosis was clear cell renal adenocarcinoma. The margins were not involved.

FIG. 4. Case 2. Abdominal CT scan shows mass (arrows) bulging into renal sinus but not extending to renal cortical surface.

Convalescence was uneventful and the patient was discharged from the hospital 9 days postoperatively with a BUN of 14 mg./dl. and a serum creatinine of 1.4 mg./dl.

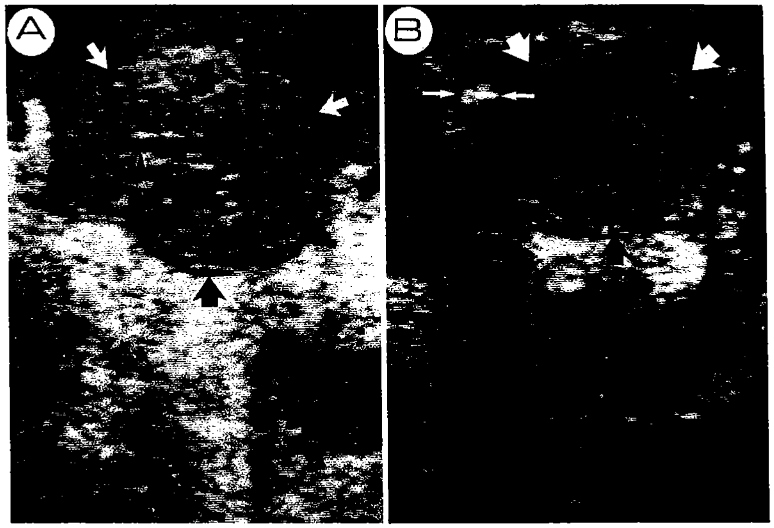

FIG. 5. Case 2. Intraoperative real-time sonogram. *A*, coronal orientation reveals solid renal mass (large arrows) containing focal echo-poor areas (small arrows) probably representing areas of necrosis. *B*, transverse orientation shows calculus (small arrows) alongside tumor (large arrows).

DISCUSSION

These 2 cases provided a unique opportunity to use intraoperative ultrasonography to localize small intrarenal tumors not palpable despite arterial occlusion. The technique of intraoperative ultrasound has been used effectively in pancreatic,[1,2] hepatic,[3] biliary[4] and neurosurgical cases.[5–8] To our knowledge, there are no references in the urological literature on the use of intraoperative ultrasonography for localization of renal tumors, although it has been described for surgery of calculous disease.[9,10]

With the advent of more sophisticated imaging modalities, such as magnetic resonance imaging, CT scan and ultrasonography, our ability to detect and potentially to treat tumors earlier has increased exponentially during recent years. Rinsho and associates reported retrospectively that 30 per cent of the renal cell tumors treated at their institution were found incidentally during studies for other medical problems (70 per cent by ultrasonography).[11] If a lesion is found early enough, one might speculate that enucleation of that lesion alone might be possible. However, much controversy surrounds the use of renal enucleation as treatment for renal cell carcinoma.[12–14] Marshall and associates in a prospective study of 16 patients found that enucleation appears to be a viable alternative for tumors that are well circumscribed and small (less than 8 cm. in diameter), have a low grade histological appearance and have negative lymph nodes.[13] However, as they note tumor heterogeneity, venous invasion and possible multifocality of the tumor contribute to limit the potential usefulness of this operation. Novick and associates followed 33 patients retrospectively who had undergone enucleation of renal cell carcinoma for parenchymal-sparing operations when either bilateral disease was present or when a solitary kidney was involved.[14] They noted that the 3-year actuarial survival was 90 per cent in this group.

Intraoperative sonography is a useful adjuvant, especially when palpation fails to disclose a radiologically demonstrated lesion as depicted in these cases. In partial nephrectomy, after the vessels are isolated, an attempt usually is made to palpate and to localize precisely the lesion. If the lesion cannot be palpated easily the renal artery is clamped in an attempt to soften the surrounding renal parenchyma. Regional hypothermia with ice slush is used routinely. Failing this, radial nephrotomy usually is made in an attempt to find the lesion. Blood[15] and tissue loss[16] occurs frequently (51 and 10 per cent, respectively). It is in this setting, before the radial nephrotomy, that intraoperative sonography would best be used.

In summary, intraoperative sonography has been shown to be useful in localizing lesions that are difficult to palpate at operation. Additionally, the evaluation intraoperatively for multifocality, as well as delineation of the extent of the lesion, might also be reasons to use intraoperative sonography with most surgical procedures on solitary kidneys. In particular, our ability to localize these lesions preoperatively coupled with the ability to define their location precisely intraoperatively with intraoperative ultrasonography might significantly improve the outcome of conservative surgery for renal tumors.

REFERENCES

1. Cherner, J. A., Doppman, J. L., Norton, J. A., Miller, D. L., Krudy, A. G., Raufman, J.-P., Collen, M. J., Maton, P. N., Gardner, J. D. and Jensen, R. T.: Selective venous sampling for gastrin to localize gastrinomas: a prospective assessment. Ann. Intern. Med., **105:** 841, 1986.
2. Vinik, A. I. and Thompson, N.: Controversies in the management of Zollinger-Ellison syndrome. Ann. Intern. Med., **105:** 956, 1986.
3. Castaing, D., Emond, J., Kunstlinger, F. and Bismuth, H.: Utility of operative ultrasound in the surgical management of liver tumors. Ann. Surg., **204:** 600, 1986.
4. Herbst, C. A., Jr.: Letter to the Editor. Ann. Surg., **202:** 790, 1985.
5. Johnston, R. A.: Book review: advanced intraoperative technologies in neurosurgery. J. Neurol. Neurosurg. Psych., **49:** 977, 1986.
6. Sarwar, M., Falkoff, G. and Naseem, M.: Radiologic techniques in the diagnosis of CNS infections. Neurol. Clin., **4:** 41, 1986.
7. Fitz, C. R.: Diagnostic imaging in children with spinal disorders. Ped. Clin. N. Amer., **32:** 1537, 1985.
8. Weiner, R. L. and Eisenberg, H. M.: Advances in pediatric neurosurgery. Ped. Clin. N. Amer., **32:** 1125, 1985.
9. Cook, H. J., III and Lytton, B.: Intraoperative localization of renal calculi during nephrolithotomy by ultrasound scanning. J. Urol., **117:** 543, 1977.
10. Thüroff, J. W., Alken, P., Reidmiller, H. and Hohenfellner, R.: Doppler and real-time ultrasound in renal stone surgery. Eur. Urol., **8:** 298, 1982.
11. Rinsho, K., Ishikawa, S., Uchida, K. and Koiso, K.: The value of ultrasonography in early detection of renal cell carcinoma. Jap. J. Clin. Oncol., **14:** 329, 1984.
12. Graham, S. D., Jr. and Glenn, J. F.: Enucleative surgery for renal malignancy. J. Urol., **122:** 546, 1979.
13. Marshall, F. F., Taxy, J. B., Fishman, E. K. and Chang, R.: The feasibility of surgical enucleation for renal cell carcinoma. J. Urol., **135:** 231, 1986.
14. Novick, A. C., Zincke, H., Neaves, R. J. and Topley, H. M.: Surgical enucleation for renal cell carcinoma. J. Urol., **135:** 235, 1986.
15. Dees, J. E.: Prognosis of the solitary kidney. J. Urol., **83:** 550, 1960.
16. Buttarazzi, P. J., Devine, P. C., Devine, C. J., Jr. and Poutasse, E. F.: The indications, complications and results of partial nephrectomy. J. Urol., **99:** 376, 1968.