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Salvage Robot-Assisted Partial Nephrectomy for the Management of Renal Cell Carcinoma Following Failed Stereotactic Radiotherapy

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ABSTRACT

Nephron-sparing surgery is currently the standard of care for the management of small renal masses. While both neoadjuvant and adjuvant conventional external beam radiotherapy have failed to demonstrate an oncologic benefit for the treatment of renal cell carcinoma, more recent work aims to explore the utility of stereotactic radiotherapy. We present the case of a 70-year-old woman who failed primary treatment of a small renal mass with the CyberKnife radiotherapy system and describe her successful salvage treatment with robot-assisted partial nephrectomy. This case demonstrates the safety of robotic surgery for the management of renal tumors following failed stereotactic radiotherapy.

Key Words: CyberKnife, Partial nephrectomy, Salvage treatment, Radiotherapy, Robot-assisted partial nephrectomy.

INTRODUCTION

Guidelines from the American Urological Association favor nephron-sparing surgery (NSS) for the management of small renal masses (SRMs).[1] NSS provides for oncologic outcomes comparable to that of radical surgery while maintaining renal function. Approaches for NSS include open, laparoscopic, and robot-assisted surgery. Alternatively, patients may be treated with a thermoablative technique, such as cryo- or radiofrequency ablation.[2] The choice of treatment is in large part determined by surgeon and patient preference as well as anatomic factors, such as tumor size, location, and adjacent vital structures.

In contrast to these treatment strategies, radiotherapy is not routinely used in the management of SRMs. To date, studies have failed to demonstrate an improvement in oncologic outcomes with neoadjuvant or adjuvant conventional external beam radiotherapy.[3–5] Moreover, no comparative studies have evaluated radiation as primary treatment for localized renal tumors. Recently, however, stereotactic radiotherapy of renal masses has been evaluated in experimental models[6] and the primary setting for patients refusing surgery[7]. Herein, we report our experience performing a robot-assisted partial nephrectomy for the salvage management of a SRM following failed primary treatment with the CyberKnife (Accuray Inc., Sunnyvale, CA) radiotherapy system.

CASE REPORT

A 70-year-old Hispanic female with a past medical history significant for hypertension and depression presented to our care for the management of renal cell carcinoma following failed primary treatment with the CyberKnife robotic stereotactic radiotherapy system. Approximately 1 year prior, the patient was found to have a 2.5-cm enhancing renal mass of the right lower pole. The mass was first identified on a computed tomography (CT) scan performed at an outside facility for workup of abdominal pain. In an attempt to avoid surgery, the patient elected for stereotactic radiotherapy with the CyberKnife system. Prior to radiation, the patient underwent percutaneous biopsy with simultaneous fiducial marker placement. The biopsy confirmed renal cell carcinoma, conventional (clear

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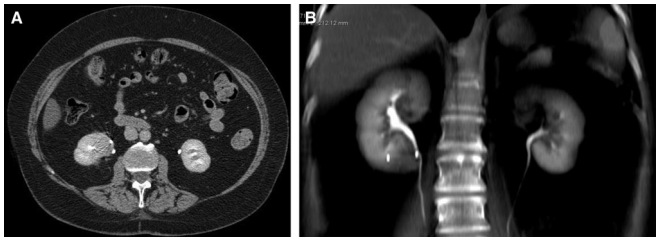

Figure 1. CT-scan 6 months following radio therapy with CyberKnife. (A) Axial and (B) coronal images demonstrate the renal mass between the 2 fiducial markers (arrows).

cell) type. After 30 Gy of radiation divided between 3 fractions, repeat imaging revealed persistent enhancement suspicious for residual tumor **(Figure 1A–B)**. At this point, the patient was referred to our care.

Management options discussed with the patient included active surveillance and salvage treatment with either radiofrequency ablation or NSS. The patient desired treatment, as she did not wish to undergo the frequent imaging recommended with active surveillance. Among the possible treatment options, percutaneous radiofrequency ablation was deemed inappropriate given the location of the tumor in close proximity to the bowel, inferior vena cava, and ureter.

The patient underwent a partial nephrectomy with the da Vinci *S* HD robotic surgical system (Intuitive Surgical, Sunnyvale, CA) performed with the technique previously described by Benway and coworkers.[8] Intraoperatively, we observed a moderate amount of adhesions as well as areas of fibrosis of the lower pole of the kidney. Further, we observed some devascularization of the ureter in the area in close proximity to the tumor. These findings were likely secondary to the effects of radiation.

The mass was clearly identified **(Figure 2A)** both visually and with the aid of a laparoscopic ultrasound. Following mass excision, renorrhaphy was performed with the sliding-clip technique **(Figure 2B)**. Additional hemostasis was achieved by placing Surgifoam as well as a patch of Fibrillar, Nu-Knit, and Evisel fibrin sealant (all from Ethicon Inc., Somerville, NJ) over the repaired tumor bed.

The case was completed without complication. Estimated blood loss was 100mL with a warm ischemia time of 18 minutes. The patient remained free of complications in the perioperative period and was discharged 5 days after surgery. The patient experienced no decline in renal function following the salvage procedure. Both pre- and postoperative serum creatinine levels were 1.0mg/dL. Gross pathologic analysis of the excised mass revealed a well-

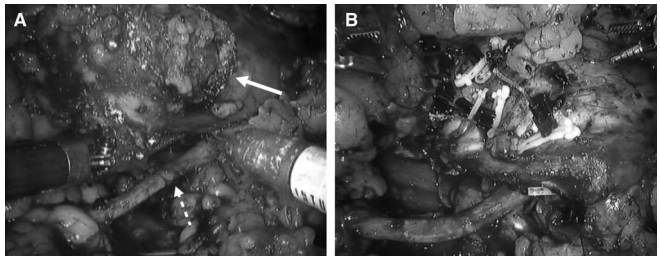

Figure 2. Intraoperative images of (A) the lower pole renal mass (solid arrow) and ureter (dashed arrow) prior to resection and (B) the reconstructed kidney following renorrhaphy with the sliding-clip technique.

circumscribed lesion with areas of hemorrhage measuring 2.2×2×1.8cm **(Figure 3A)**. Contained within the specimen were 2 golden metallic fiducial markers. Microscopic analysis of the mass demonstrated the remaining viable tumor to be Fuhrman nuclear grade 1 conventional (clear cell) type renal cell carcinoma with areas of extensive inflammation and hyalinization **(Figure 3B–D)**.

DISCUSSION

CyberKnife is a state of the art FDA-approved image-guided stereotactic radiotherapy system.[9] This device is composed of a linear accelerator mounted on a highly precise robotic arm. CyberKnife uses an image-to-image correlation algorithm allowing for the irradiation of targets with minimal damage to surrounding tissue. This design makes CyberKnife an ideal platform for the treatment of brain tumors.

Within the context of kidney cancer, stereotactic radiotherapy has been most widely used in the management of brain and spinal metastases.[10–12] CyberKnife has also been evaluated in a porcine model for the primary treatment of renal tumors.[6] In this model, 16 kidneys were treated in vivo with CyberKnife. Gross and histologic evaluation of kidneys was performed at 4, 6, or 8 weeks. The authors found that the degree of radiation-induced changes correlated with treatment intervals. At 8 weeks, tissue showed complete fibrosis with relative sparing of the surrounding tissue.

Following this animal study, Beitler and coworkers[7] reported their clinical experience managing 9 patients with localized renal cell carcinoma using high-dose-per-fraction conformal stereotactic radiotherapy. Radiation was delivered at 40 Gy in 5 fractions with a 1-cm margin around the target masses. Following treatment, only 4 patients were free of clinical evidence of regional or distant disease at a median follow-up of 26.7 months. This

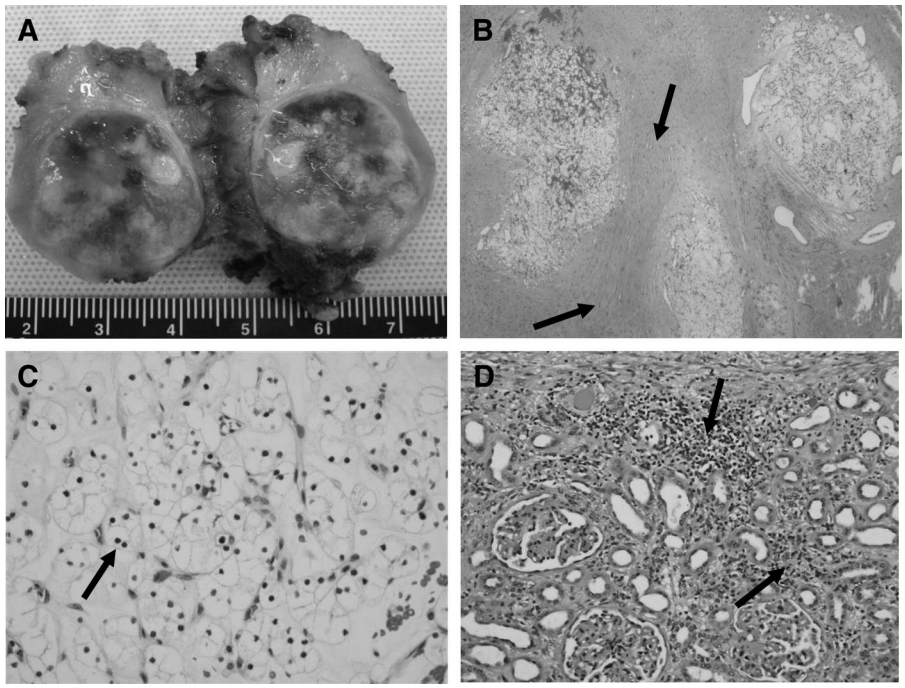

Figure 3. (A) Bisected partial nephrectomy specimen with well-circumscribed, variegated 2.2-cm neoplasm. (B) Renal cell carcinoma with areas of extensive hyalinization (arrows), H&E 4X. (C) Tissue adjacent to fiducial marker showing viable renal cell carcinoma, conventional (clear cell) type, Fuhrman nuclear grade 1 (arrow), H&E, 40X. (D) Renal parenchyma with nonspecific chronic inflammation (arrows), H&E, 20X.

limited experience calls into question the role of this technology outside the setting of a research protocol.

The da Vinci robot has been previously used for the salvage management of failed radiotherapy. While never described for the management of failed primary radiation treatment of kidney masses, its use has been described in several small case series for the salvage surgical management of prostate cancer. Stope et al[13] reported their experience with 6 patients who underwent robot-assisted prostatectomy after primary radiotherapy. Surgery was performed safely with no intraoperative complications. In their larger and more diverse series, Eandi et al[14] reported on patients who underwent primary treatment with brachytherapy (n=8), external beam radiation (n=8), and proton beam therapy (n=2). The authors reported that no patient required conversion to open surgery or had intraoperative complications. A series of 15 patients by Ahallal and coworkers reported similar results.[15] This series, however, is unique in that it included 1 patient who required salvage for failed cryotherapy. Taken together, these series demonstrate that robot-assisted radical prostatectomy can be performed safely and effectively as salvage therapy after failed radiotherapy.

In light of the successful experiences using the robot for salvage prostatectomy, we felt it was reasonable to utilize this tool for salvage management of an SRM incompletely treated by primary radiotherapy. Using the robot, we were able to perform a salvage partial nephrectomy without complications and with minimal blood loss and a warm ischemia time of <20 minutes.

CONCLUSION

While limited in that this is only a single case, our experience suggests that with proper patient selection, the robot-assisted laparoscopic approach may be successfully utilized in the salvage management of renal tumors following failed stereotactic radiotherapy.

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