Cureus
Open Access Case Report
DOI: 10.7759/cureus.17

CyberKnife Radiosurgery of a Renal Pelvis Tumor to Avoid Renal Dialysis: A Case Report

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Disclosures can be found in Additional Information at the end of the article

Abstract

Transitional cell cancer (TCC) in the renal pelvis is usually treated by nephro-ureterectomy. In functional or anatomical singular renal units, consecutive chronic hemodialysis will be needed. We present a patient treated by image-guided robotic radiosurgery for definitive tumor control of a T2G3 recurrent transitional cell cancer of the renal pelvis in a singular renal unit after nephro-ureterectomy of the contralateral kidney.

Categories: Radiation Oncology, Urology
Keywords: transitional cell cancer, cyberknife, radiosurgery, renal pelvis, singular renal unit, upper urinary tract tumors

Introduction

Transitional cell cancer (TCC) of the renal pelvis and ureters (upper urinary tract) are relatively rare. Tumors of the renal pelvis account for approximately 10% of all renal tumors and approximately 5% of all TCC. Ureteral tumors are even more uncommon, occurring with one-quarter the frequency of renal pelvis tumors. The mean age in patients who develop upper urinary tract tumors is 65 years. The incidence of TCC increases with age. Moreover, TCC tumors are rarely found at autopsy [1]. Nephro-ureterectomy with excision of the bladder cuff is considered the standard therapy in patients with renal pelvis TCC, regionally extensive disease, and high-grade or high-stage lesions. Few therapeutic options exist for bilateral tumors or contralateral recurrent tumor after unilateral nephro-ureterectomy. Surgical removal leads to chronic hemodialysis with impaired quality of live and reduced overall survival. In an effort to avoid hemodialysis, we report on a patient with pT2 G3 TCC of the renal pelvis in a single remaining kidney singular renal unit after contralateral nephro-ureterectomy 30 years ago who was treated with single-session robotic radiosurgery. To our knowledge, this is the first report on radiosurgery for TCC of the renal pelvic system.

Published 11/17/2010

Case Presentation

Radiosurgery system

The CyberKnife robotic radiosurgery system (Accuray Inc., Sunnyvale, CA, USA) consists of a 6-MV compact linear accelerator (LINAC) mounted on a computer-controlled six-axis robotic manipulator. Integral to the system are orthogonally positioned x-ray cameras which acquire

How to cite this article
Staehler M, Kufeld M, Fürweger C, et al. (November 17, 2010) CyberKnife Radiosurgery of a Renal Pelvis Tumor to Avoid Renal Dialysis: A Case Report. Cureus 2(11): e17. DOI 10.7759/cureus.17

images during treatment. The images are processed automatically to identify radiographic features, and are registered to the treatment planning study to measure the position of the treatment site in real time. The system adapts to changes in patient position during treatment by acquiring targeting images repeatedly and adjusting the direction of the treatment beam accordingly. The treatment beam can be directed from hundreds of angles anterior and lateral to the patient.

Respiratory motion compensation

In order to compensate for renal tumor motion, it is necessary to know the internal position of the target throughout treatment. At any given time, the stereo X-ray system can acquire images to establish the tumor position. Conventionally, small gold fiducials implanted in the proximity of the target are identified in both images and used to compute the 3D target position. While this provides accurate information on the tumor location at the instant the X- rays are taken, this is not sufficient to obtain real-time motion information. In the present system, the position of the chest is measured continuously by an external camera array that tracks the position of infrared markers on the patient's chest, and the location of the tumor is detected periodically in the x-ray images. A series of internal and external position measurements taken at the same time is used to establish a correlation model. Throughout treatment, frequent measurements of both positions are used to check and update the model [2].

The 75-year-old male patient underwent left-sided nephro-ureterectomy 30 years prior to radiosurgery treatment due to idiopathic hydronephrosis. Four years ago, he developed recurrent TCC of the renal pelvis which was treated several times by ureterorenoscopic excisions and multiple laser coagulations. Finally, a partial resection of the renal pelvis was performed for pT2 G3 TCC, as the patient refused nephro-ureterectomy and hemodialysis. One year later, recurrent disease was documented by high-resolution CT scan, ureterorenoscopic biopsy (>pT1G3), and positive cytology. Again, nephro-ureterectomy was offered but refused by the patient. In an effort to avoid hemodialysis, the patient urged us to consider any therapeutic alternative, and single-session radiosurgery was offered. Informed consent was obtained based on no clinical experience existing at this time for these sorts of tumors. Baseline serum creatinine was 2.1 ng/ml. Two gold fiducials were implanted percutaneously into the renal parenchyma by ultrasound guidance on the right side. A third fiducial was fixed to the tip of a JJ catheter and placed at the upper renal pelvis to increase tracking accuracy of the tumor located in the renal pelvis. Treatment planning was performed based on helical 1-mm CT images done one day after fiducial implantation (Figure *1*). The treatment volume was defined by the attending urologist taking into account the anatomical location of the tumors in the renal pelvis as the results of diagnostic ureterorenoscopy performed the day before radiosurgery (Figure *2*). In a single-session procedure, 25 Gy was delivered to the 70% isodose. Figure *3* shows the DVH of the renal parenchyma. Fifty percent of the renal parenchyma received 8 Gy or less and only 25 % of the parenchyma received 12 Gy or more, even though the treatment volume in the renal pelvis was relatively large and maximum dose was above 30 Gy. The radiosurgical procedure was completely uneventful, and the patient was followed by routine video ureterorenoscopy, cystoscopy and photodynamic diagnostic as well as CT scans every three months. On last follow-up 30 months after treatment, renal function was still unchanged (serum creatinine 2.0 ng/ml) and no recurrent tumor could be detected (Figure *4*).

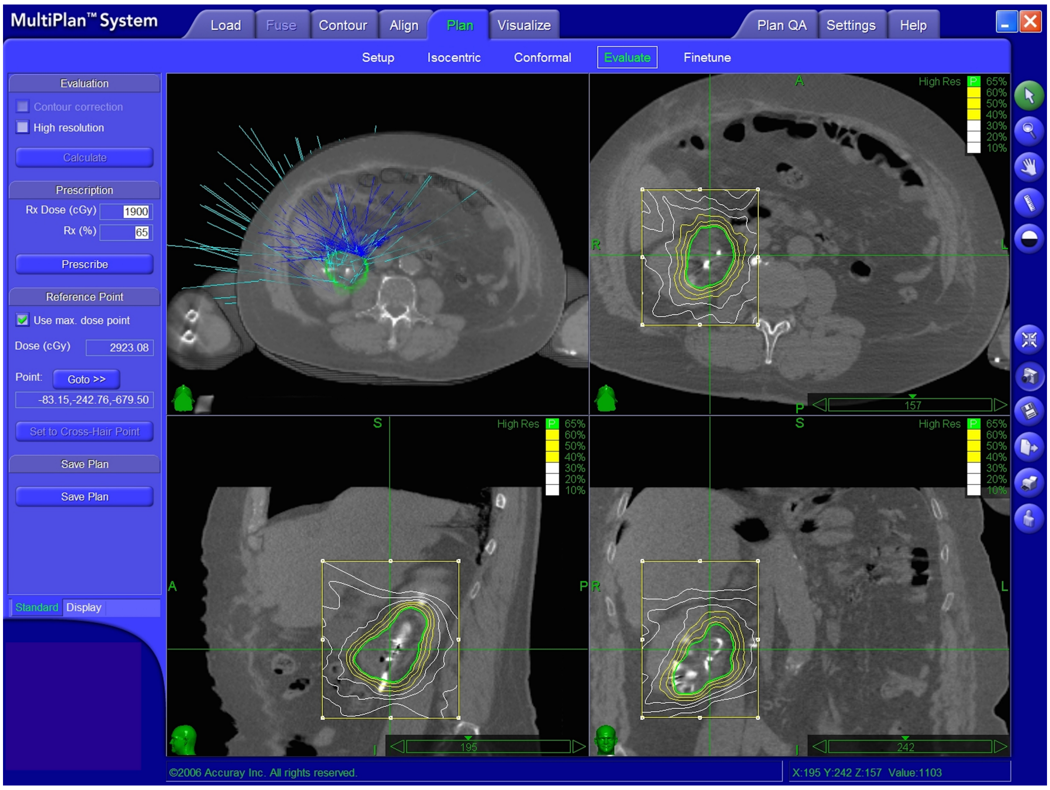

FIGURE 1: Screenshot with triplanar representation of the isodose configuration and the JJ catheter in the renal pelvis

Screenshot with triplanar representation of the isodose configuration and the JJ catheter in the renal pelvis.

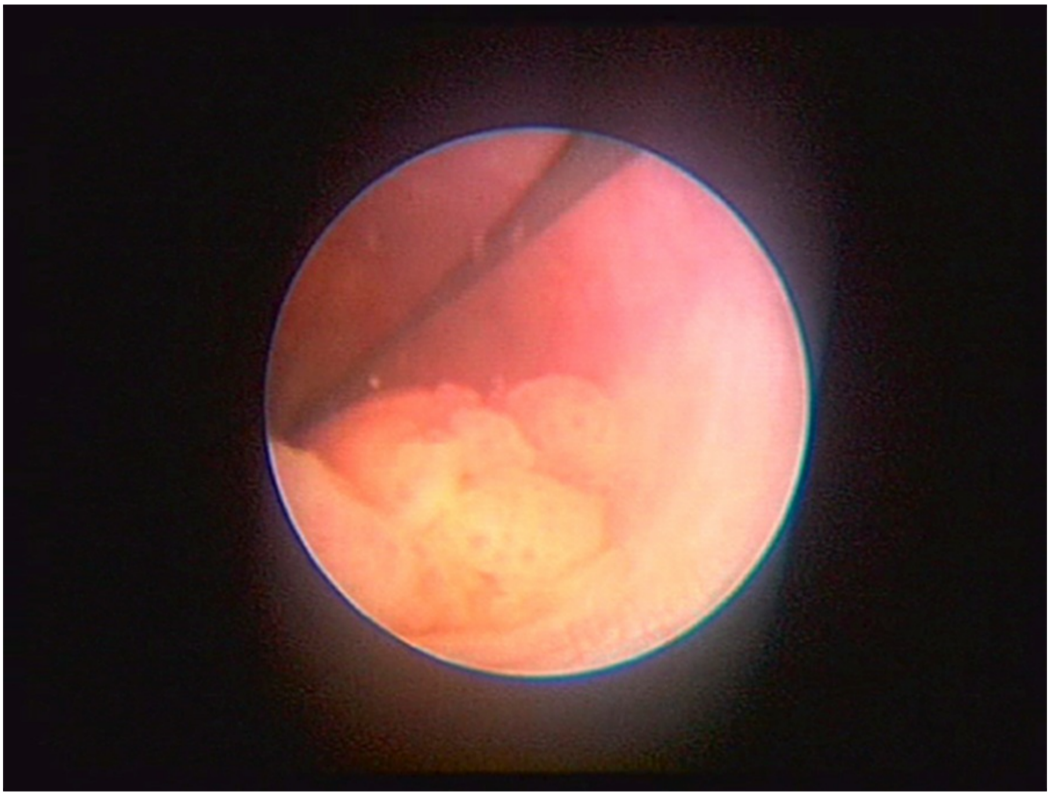

FIGURE 2: Endoscopic view of the tumor before radiosurgery

Endoscopic view of the tumor before radiosurgery. The tumor configuration at 6 o'clock is clearly visible.

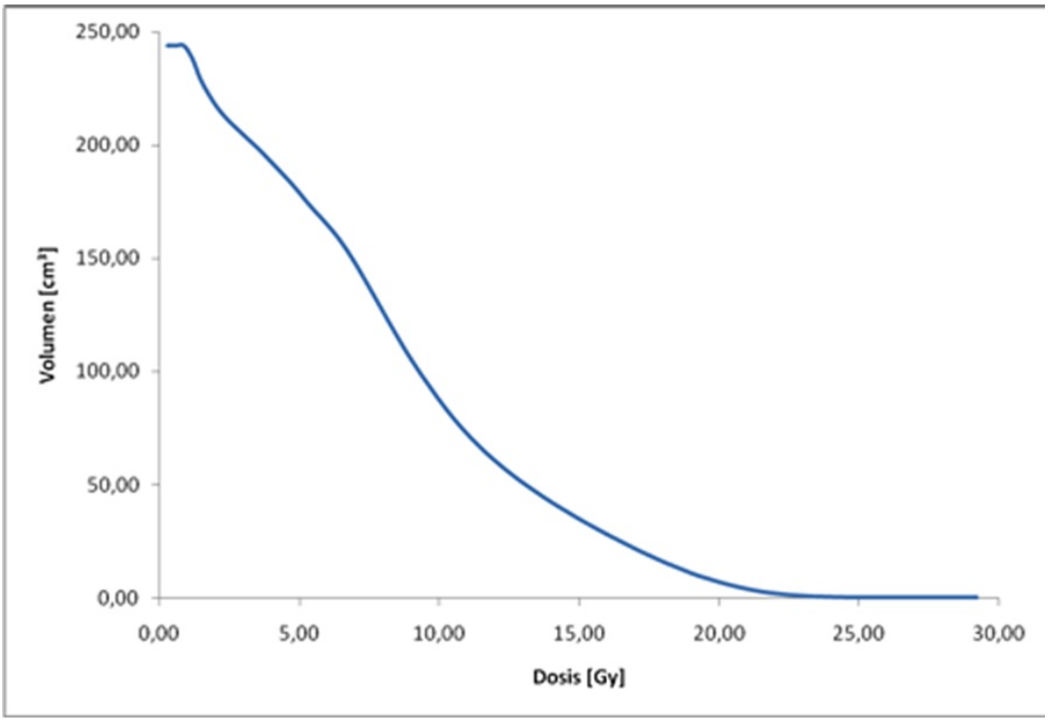

FIGURE 3: DVH of the renal parenchyma

DVH of the renal parenchyma. 50% of the renal parenchyma received 8 Gy or less, only 25 % of the parenchyma received 12 Gy or more.

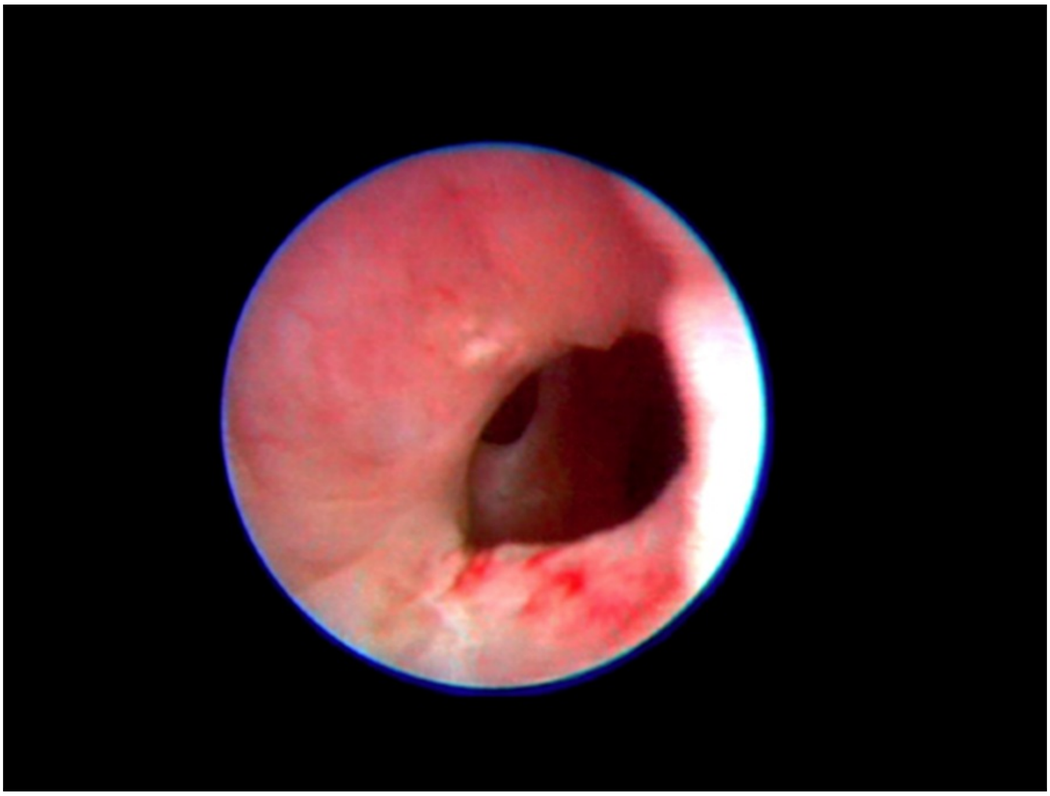

FIGURE 4: Endoscopic view of the tumor 30 months after radiosurgery

Endoscopic view of the tumor 30 months after radiosurgery. No tumor can be detected. The renal pelvis is intact without soft tissue damage.

Discussion

Renal pelvic tumors often are therapeutic challenges, particularly in patients who have already undergone unilateral nephrectomy [3-5]. The resection of the remaining kidney leads to chronic hemodialysis, with its well-known side-effects and reduction of quality of life and overall survival. We are the first to describe a single case of a patient treated for TCC of the renal pelvis by a radiosurgical approach. The selected dose was relatively high in order to overcome the radio-resistance of these tumors [2]. High-dose multi-fraction SRS for other kidney lesions has been reported in other small series with favorable results [6-7]. The current report is unique as to the fact that a tumor in the renal pelvis in the remaining kidney was treated in a single session procedure. Interestingly, no short- or intermediate-term clinical toxicity occurred and renal function was normal during the follow-up period. Ureteroscopy every three months did not reveal tissue destruction of the normal renal pelvis structures, although tumor destruction could be documented. The present case and its favorable outcome encouraged us to start a Phase II study to better understand the underlying mechanisms and gain more clinical experience in these difficult-to-treat cases.

Conclusions

Radiosurgery for renal pelvis tumors might play a future role as a minimal invasive treatment option in otherwise not effectively treatable patients.

Additional Information

Disclosures

Human subjects: Consent was obtained by all participants in this study. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

References

1. Karl A, Zaak D, Tilki D, Hungerhuber E, Staehler M, Denzinger S, Stanislaus P, Tritschler S, Strittmatter F, Stief C, Burger M: Diagnosis of urothelial carcinoma . Urologe A. 2008, 47:357-367. 10.1007/s00120-008-1675-8
2. Muacevic A, Drexler C, Wowra B, Schweikard A, Schlaefer A, Hoffmann RT, Wilkowski R, Winter H, Reiser M: Technical description, phantom accuracy, and clinical feasibility for single session lung radiosurgery using robotic image-guided real-time respiratory tumor tracking. Technol Cancer Res Treat. 2007, 6:321-328.
3. Ishimura H, Momose A, Narita S, Kurotaki H: Synchronous multiple carcinosarcoma of the renal pelvis and ureter: A case report. Hinyokika Kiyo. 2010, 56:381-384.
4. Raman JD, Messer J, Sielatycki JA, Hollenbeak CS: Incidence and survival of patients with carcinoma of the ureter and renal pelvis in the USA, 1973-2005. BJUInt. 2011, 107:1059-1064. 10.1111/j.1464-410X.2010.09675.x
5. Favaretto RL, Shariat SF, Chade DC, Godoy G, Adamy A, Kaag M, Bochner BH, Coleman J, Dalbagni G: The effect of tumor location on prognosis in patients treated with radical nephroureterectomy at Memorial Sloan-Kettering Cancer Center. Eur Urol. 2010, 58:574-580. 10.1016/j.eururo.2010.07.003
6. Beitler JJ, Makara D, Silverman P, Lederman G: Definitive, high-dose-per-fraction, conformal, stereotactic external radiation for renal cell carcinoma. Am J Clin Oncol. 2004, 27:646-648.
7. Svedman C, Karlsson K, Rutkowska E, Sandström P, Blomgren H, Lax I, Wersäll P: Stereotactic body radiotherapy of primary and metastatic renal lesions for patients with only one functioning kidney. Acta Oncol. 2008, 47:1578-1583. 10.1080/02841860802123196