Journal of Urology & Nephrology Studies

DOI: 10.32474/JUNS.2019.02.000128

ISSN: 2641-1687

Case Report

# Utility of Volumetric 3-Dimensions Rendering Technology in Laparoscopic Partial Nephrectomy for Intrarenal Lesions. Two Case Reports

**Mahmoud I Khalil, Mohamed H Kamel, Christopher M Campbell, Rodney Davis, and Bruno Machado***

*Department of Urology, University of Arkansas for Medical Sciences (UAMS), USA*

***Corresponding author:** Bruno Machado MD, Assistant Professor, Urology Department, University of Arkansas for Medical Sciences, USA

**Received:** June 20, 2019 **Published:** June 26, 2019

## Abstract

**Introduction:** The three dimensions (3D) virtual reality is a widespread technology that started gaining field at medicine in the last decades. This report demonstrates the use of pre-operative volumetric three dimensions rendering images to plan and guide laparoscopic partial nephrectomies for intra-renal lesions.

**Case reports:** We present two cases, one with left partially endophytic upper polar mass and other with right endophytic upper polar Bosniak III renal cyst. Three dimensional renderization was done using the open-source software: OsiriX®. It was utilized to guide lesion specific resection in the operative field. Laparoscopic partial nephrectomy was performed uneventfully in both patients in a relatively short timing and minimal blood loss.

**Conclusion:** Despite the incommodious application of the advanced 3D volumetric rendering in skillful surgical procedures, it allows better expectation of surgical challenging tasks with resultant good surgical and oncological outcome.

**Keywords:** 3D Printing; Kidney Neoplasms; Laparoscopic Partial Nephrectomy; Virtual Reality

**Abbreviations:** 3D: 3 Dimensions; CT: Computerized Tomography; LPN: laparoscopic Partial Nephrectomy; OR: Operating Room; PO3DR: Pre-operative 3D renderizations; VR: Virtual Realit

## Introduction

The diagnosis of small renal masses increased in the last 3 decades with the popularization of cross-sectional image modalities [1]. Currently, minimally invasive including laparoscopic partial nephrectomy (LPN) is the "gold standard" method for management of small renal masses (T1a and some T1b tumors). It permits the same oncological results as radical nephrectomy, with shorter hospital stay and complication rates [1,2]. Challenges in LPN are related to several conditions, narrow field of vision, small visual field of the scopes and the absence of tactile feedback and movement of target organs [1-4]. The medical community has been searching ways to enhance the surgeon's ability to overcome these difficulties [3]. The first medical surgical specialty to use visual reality (VR) solutions was neurosurgery followed by otorhinolaryngology and orthopedics [1,2]. Those areas have the advantage to work with target organs that don't suffer deformations; once rigid bone structures surround them [1-3,5]. The abdominal structures, however, have some particularities that made the application of VR in abdominal surgery harder to introduce [1-3,5-7]. This article describes the use of VR in planning the LPN in 2 cases of renal endophytic tumors using an open-source image software.

## Case Reports

**Case 1:** A 68-year-old female, BMI 16.6, with no co-morbidities. During her annual examination, a 3 cm solid mass was detected in the left kidney on the abdominal Ultra Sonography. The CT scan showed a 4.1cm contrast enhanced solid 40% endophytic upper polar left renal mass (Figure 1).


**Figure 1:** Standard contrast CT scan demonstrates left upper polar lesion.

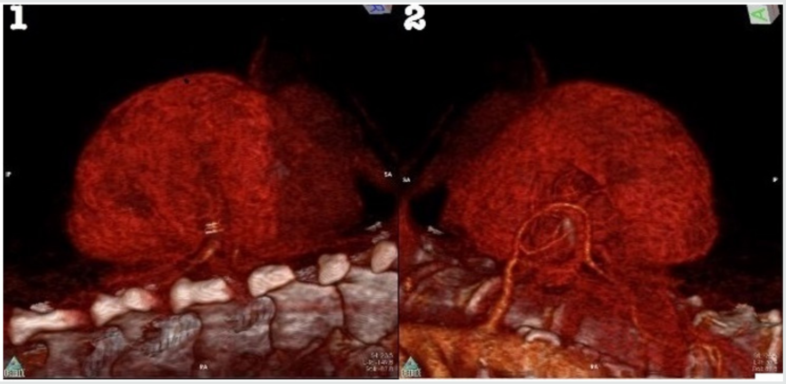


**Figure 2:** 1) Posterior view of 3 D rendering showing upper polar lesion, 2) anterior view showing the arterial tree.

**Case 2:** A 38-year-old man, BMI 25.18, with history of controlled hypertension. The patient presented at the emergency department by acute pancreatitis. Abdominal ultra-sonography was performed and showed cholelithiasis and intra-renal hyperechoic cyst in the right kidney. The CT scan showed a 2.6 cm right endophytic complex renal cyst (Bosniak III) which was partially enhanced by contrast. The case was consulted by the general and urological surgical teams, and it was decided to perform cholecystectomy before managing the urological condition. The CT images were used by the surgeon to obtain the pre-operative 3D renderizations (PO3DR) with the open-source software: OsiriX® [8] (Figure 2). The PO3DR for surgical planning was utilized to find the relationship between the tumor with the surrounding renal parenchyma and the collecting system. The external landmarks on surface of the renal parenchyma were annotated in order to guide the resection in the operative field. It can provide the anatomy of the renal arterial vascular tree. Patients were positioned in lateral position and the trocars were placed in the traditional points. The colon was released from the anterior surface of the kidney, and the pedicle was identified and dissected. The main artery was isolated. The PO3DR images were placed on a second monitor side by side with the laparoscopic video screen in the operating room (OR) (Figure 3). This allowed the surgeon to find the anatomical landmarks previously annotated and mark it *in vivo*. The main right renal artery was clamped with a disposable bulldog clamp. During resection, the collecting system was opened. Closure of the collecting system was done by a running suture 2.0 poliglecaprone's hem-o-lock$^{tm}$ anchored to the external parenchyma. The renal parenchyma was closed with 4 single 0 polyglactin stitches hem-o-lock$^{tm}$ anchored. In case 2, 5 ml of collagen glue (bio-glue$^{tm}$) was applied over the suture line. The warm ischemia time was 18 minutes and 28 minutes in case 1 and 2 respectively. Hemostasis was reviewed 5 minutes later with a lower pneumoperitoneum. The operating time was 110 min in the 1$^{st}$ case and 122 min in the 2$^{nd}$. Estimated blood loss was 200ml and 60ml in case 1 and 2 respectively. Both patients were discharged on the 2nd post-operative day. In case 2, the patient developed gross hematuria on the 8$^{th}$ post-operative day. Patient was readmitted to the hospital and arteriography was performed and revealed a pseudo-aneurysm at the upper pole of right kidney. It was handled by endovascular embolization. Two days later, the patient was discharged. The patient reported 3 minor self-limited gross hematuric episodes without clinical significance. The total time to perform the PO3DR was 20 min in both cases. After renderization, intimate relationship between the lesions and the collecting system was identified and opening of the system intraoperatively was expected. The accuracy of the prediction of the opening of collecting system was 100%. The reviewed literature supports these findings [4,9]. In case 2, an accessory artery, directly branched from Aorta was identified supplying the right kidney's inferior pole. The pathological report showed RCC with free margins in both cases. The use of PO3DR was successful to demonstrate the relationships between the tumor and the major vessels of the kidney. Although the second case experienced a pseudo aneurysm, it was controlled by selective embolization 12 hours after diagnosis without any further major complication.


**Figure 3:** The PO3DR images aside with the laparoscopic video screen in the operating room.

## Discussion

The use of affordable solutions may help to expand the VR application and to attain advantages to patients and surgeons [5]. However, the majority of the articles in literature were focused only on the potential but not on the practical cost of VR application in the OR [1,2,6,7]. OsiriX® can manipulate several sets of data image (CT, MRI) in advanced 3D volumetric rendering with low costs. It has wide acceptance in the medical community, with more than 45000 users all over the world and it is easy to use even by non-expert physicians [10]. The PO3DR of the images is performed by the surgeon himself which is highly profitable. He can decide himself which aspects are important to keep in reconstruction to be used later in the OR. It allows more accurate pre-operative planning, previous familiarization with the patient's anatomy and the evaluation of feasibility LPN over laparoscopic radical nephrectomy [4,5]. The opportunity to have the previously annotated landmarks on PO3DR side by side on a second screen at the OR was extremely useful in challenging cases. It eases decision making based on availability of more accurate data, without need to be highly dependent on the surgeon memories [1,4,5]. As a second benefit, the PO3DR images can be showed to the patients preoperatively allowing them a better comprehension of their conditions. Also, it helps surgical assistants to be aware of the operative steps intended [5]. The use of 3D VR technology represents a considerable advantage in the aspect of lesion-specific surgical planning and skill training.

## Conclusion

Laparosopic partial nephrectomy is an attractive option in the management of small renal masses. The advantages of the LPN overcome its drawbacks. The use of less expensive solutions to bring 3D VR technology in the OR can benefit not only surgeons but the patients as well.

## Acknowledgement

I would like to thank the department of Urology for the opportunity provided to draft this case report.

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**DOI:** 10.32474/JUNS.2019.02.000128