# A Novel 3-Dimensional Image Analysis System for Case-specific Kidney Anatomy and Surgical Simulation to Facilitate Clampless Partial Nephrectomy

**Yoshinobu Komai, Yasuyuki Sakai, Naoto Gotohda, Tatsushi Kobayashi, Satoru Kawakami, and Norio Saito**

**OBJECTIVE** To report our initial experience with the novel 3-dimensional (3D) image analysis system Synapse Vincent in clampless partial nephrectomy (PN), describing its advantages with regard to short-term surgical outcomes and its usefulness as an informed consent tool.

**METHODS** Twenty-six patients with renal cell carcinoma underwent clampless PN navigated with the aid of case-specific 3D anatomic video images of the kidney, after surgical simulation using the same video system. Baseline characteristics were reviewed, and short-term surgical outcomes were recorded. Of the 26, 6 had imperative indications, and 22 were treated with a minimally invasive approach. Before tumor excision, the renal hilar vessels were meticulously dissected, and definite tumor feeders were selectively ligated. Before patients consented to PN, the surgical procedure and perioperative risks were explained to each patient using case-specific 3D video images; subsequently, surgeons asked patients whether the 3D images had helped them understand PN more clearly than 2D images would have.

**RESULTS** All operations were successfully completed without clamping, with negative surgical margins. No patients required blood transfusions. During PN, the surgeons confirmed the accuracy of the reconstructed 3D images and surgical simulations in all cases. All patients answered that the 3D images had helped them understand their disease status and surgical risks.

**CONCLUSION** This is the first report on the Synapse Vincent 3D image analysis system for kidney surgery. Its 3D images and surgical simulation helped not only surgeons in their performance of clampless PN but also patients in their understanding of the operation. UROLOGY 83: 500–507, 2014. © 2014 Elsevier Inc.

The European Association of Urology[1] and the American Urological Association[2] both recommend partial nephrectomy (PN) as the standard treatment for T1 renal tumors because of equivalent oncological and improved functional outcomes compared with those of radical nephrectomy. In recent years, minimally invasive techniques for PN have been developed and have yielded encouraging results, not only for peripheral masses but also for complex tumors.[3,4] Despite this progress in surgical techniques, however, the standard surgical procedures for PN fundamentally include warm or cold renal hilar clamping.[5,6] Clamping of the renal hilum in PN presents a dilemma, because any attempt at "nephron-sparing" surgery necessarily includes an ischemic procedure which itself can result in impairment of renal function, not only through nephron loss but also through ischemic damage.

To resolve this dilemma, a clampless PN technique that avoids global ischemia of the kidney has been proposed to achieve acceptable cancer control and minimal nephron damage.[7] One concern with this proposed technique regards management of the intrarenal vasculature to the tumor, which is invisible to the surgeon. Very recently, Ng et al[7] reported that 3-dimensional (3D) reconstruction images of renovascular and tumor anatomy based on 0.5-mm slice computed tomography (CT) facilitated this method of clampless PN.[8] Several other reports have also revealed that 3D images can help

**Financial Disclosure:** *The authors declare that they have no relevant financial interests.*

*From the Department of Urology, National Cancer Center Hospital East, Chiba, Japan; the Department of Hepatobiliary and Pancreatic Surgery, National Cancer Center Hospital East, Chiba, Japan; the Department of Diagnostic Radiology, National Cancer Center Hospital East, Chiba, Japan; the Department of Urology, Saitama Medical Center, Saitama Medical University, Saitama, Japan; and the Department of Colorectal Surgery, National Cancer Center Hospital East, Chiba, Japan*

*Reprint requests: Yoshinobu Komai, M.D., Ph.D., Department of Urology, National Cancer Center Hospital East, 6-5-1, Kashiwanoha Kashiwa-shi, 277-8577, Chiba, Japan. E-mail: yokomai@east.ncc.go.jp*

*Submitted: July 9, 2013, accepted (with revisions): September 4, 2013*


© 2014 Elsevier Inc.
All Rights Reserved
0090-4295/14/$36.00
http://dx.doi.org/10.1016/j.urology.2013.09.053

**Table 1.** Patient demographics and intra- and perioperative outcomes of 26 clampless partial nephrectomy

| Variable | RENAL Nephrometry Score[25] | | |
|---|---|---|---|
| | 4-6 Points | 7-9 Points | 10-12 Points |
| *n* | 6 | 14 | 6 |
| Sex (male/female) | | 17/9 | |
| Approach (open/minimally invasive) | 0/6 | 3/11 | 3/3 |
| Tumor size mean (range), cm | 2.9 (2.0-4.3) | 3.7 (2.5-6.4) | 5.3 (4.2-8.3) |
| Clinical T stage (T1a/T1b/T3a) | 5/1/0 | 10/3/1 | 0/5/1 |
| Tumor location (peripheral/central/hilar) | 6/0/0 | 10/2/2 | 0/2/4 |
| Indication of partial nephrectomy (imperative/elective) | 2/4 | 3/11 | 1/5 |
| Tumor margin status (negative/positive) | | 26/0 | |
| Pathology (RCC/others) | | 26/0 | |
| Operative time mean (range), min | 161 (111-207) | 211 (155-330) | 264 (233-301) |
| Duration of global ischemia, min | | 0 | |
| Estimated blood loss mean (range), mL | 99 (50-245) | 259 (35-685) | 712 (131-1050) |
| Blood transfusion | | 0 | |
| Collecting system entry | 1 | 5 | 5 |
| Complications Clavien grade $\geq$3 (urinary leakage in all cases)* | 1 | 2 | 0 |
| Decrease in eGFR (preoperative: 3 mo) mean (range) mL/min/1.73 $m^2$ | 9.2 (0-19.5) | 9.5 (0-23.2) | 20.5 (10.4-30.1) |
| Postoperative hemodialysis | | 0 | |

eGFR, estimated glomerular filtration rate; RCC, renal cell carcinoma.
* These 3 patients underwent ureteral stent placement and recovered quickly.

surgeons visualize the intrarenal inter-relationships of the tumor with its feeding arteries and create a working mental map for resection.[9-11] The evidence in favor of such preoperative evaluation continues to accumulate.

In the present study, we describe the application of a novel 3D image analysis system called Synapse Vincent (Fuji Medical Systems, Inc., Tokyo, Japan) before clampless PN. This system was originally developed for the preoperative evaluation of liver surgery, but it can be applied to kidney surgery as well. We report our initial experience with this system by describing its advantages with regard to short-term surgical outcomes and its usefulness as an informed consent tool.

## MATERIALS AND METHODS

### Patients

From November 2011 to May 2013, PN was performed for renal tumors suggestive of renal cell carcinoma (RCC) in 28 consecutive patients at our institution. Of those, 2 patients who underwent PN with hilar clamping were excluded, and the remaining 26 without hilar clamping were the subjects of the present study. The decision to perform clampless PN was based on tumor characteristics and the surgeons' skill. The institutional ethical review board approved this study, and all 26 patients had consented to clampless PN after learning about its possible risks and benefits. PN was elective in all but 6 patients; these 6 consisted of 2 patients suggestive of bilateral RCC and 4 patients with chronic kidney disease stage $\geq$3 with estimated glomerular filtration rates (eGFRs) of <60 mL/min/1.73 $m^2$. Baseline patient demographic data are presented in Table 1.

### 3D Image Reconstruction

Preoperative enhanced CT was performed with a 64-multidetector-row CT scan (Aquilion 64, Toshiba Medical Systems, Corp., Tokyo, Japan) with 0.3-mm interval. Contrast material was administered at a dose of 1.4 mg/kg through a peripheral venous catheter, and scans at early, late, and urinary phases were performed at 20, 80, and 250 seconds, respectively. Using a workstation (Zio Station, Ziosoft, Tokyo, Japan), a routine preoperative CT workup was performed in the axial and coronal imaging planes (Figs. 1A,B, 3D). The data were obtained in Digital Imaging and Communications in Medicine format and transmitted to a workstation running Synapse Vincent. Subsequently, a urologist (Y.K.) who worked as a member of the surgical team in all of the operations created 3D video images for each patient with the help of an expert radiologist (T.K.). The images were created according to the following steps.

1. Kidney Extraction

In the 3D imaging system, the affected kidney was semi-automatically extracted either by the region growing method[8] or by mask edit[12] with minor manual modification taking about 3-5 minutes (Fig. 1C).

2. Registration for Each Phase

We used the correct-positioning command and automatically registered images for each phase to avoid position deviation between phases.

3. Extraction of Organs

As shown in Figure 1D, we could include 10 or more items as extracted organs in the reconstructed images. It is worth noting that this system can produce detailed images of arterial branches and the urinary tract through high-speed automatic tracking (Fig. 1E) using the early-phase and urinary-phase images, respectively. This automatic tracking is an application of certain facial detection technology[13] that was also developed by the system's manufacturer (the United States patent No. 7,327,886). During clampless PN, it is extremely important for surgeons to identify intrarenal arterial feeders directly supplying the tumor. In all cases, therefore, we extracted at least 2 organs, the renal arteries and the target tumor, onto the kidney. Only in patients with moderate or high RENAL nephrometry scores[14] ($\geq$7) were renal veins and urinary tracts reconstructed. Renal veins were extracted by means of manual tracking using late-phase images.

Download English Version:

https://daneshyari.com/en/article/3899435

Download Persian Version:

https://daneshyari.com/article/3899435

Daneshyari.com