

# INTERACTIVE VIRTUAL REALITY (iVR) RENAL MODELS AS AN EDUCATIONAL AND PREOPERATIVE PLANNING TOOL FOR LAPAROSCOPIC DONOR NEPHRECTOMY: INITIAL EXPERIENCE

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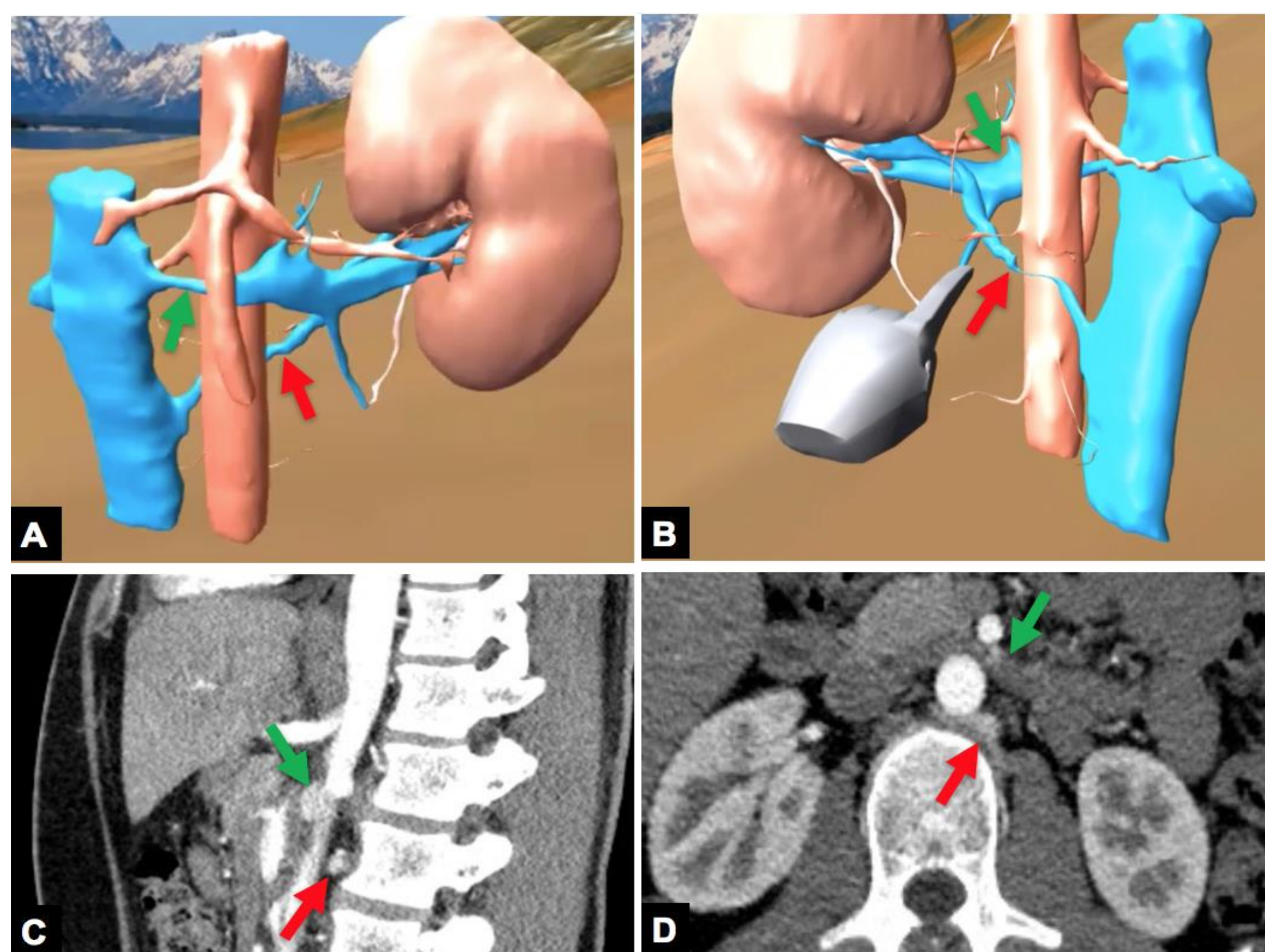


## INTRODUCTION

It is challenging for surgeons to assimilate the more than 2,500 two-dimensional (2D) images provided by computed tomography (CT) into a three-dimensional (3D) understanding optimal for laparoscopic donor nephrectomy (LDN). We sought to evaluate whether interactive virtual reality (iVR) enhances preoperative planning by allowing for an interactive, 3D comprehension of the anatomy.

## METHODS

- Seventeen patients scheduled for LDN were recruited.
- CT image data were obtained in DICOM file format and were manually segmented (3D Slicer) to create a 3D object file. These 3D models were then uploaded to an iVR platform (Bosc) for viewing with an Oculus Rift VR headset paired with Leap Motion Hand Tracking.
- Preoperatively, surgeons (JL, HI) and patients viewed and interacted with the iVR models (Figure 1).
- Surgical outcomes were stratified by surgical approach (laparoscopic vs. hand-assisted laparoscopic) and compared to a retrospectively matched cohort of LDN patients (Table 1).
- Preoperative and postoperative questionnaires assessed the accuracy of the iVR models, surgeons' understanding of the anatomy, and patients' iVR experience (Table 2).



**Figure 1. iVR Models (A-B):** iVR model of laparoscopic donor nephrectomy patient. (C-D): CT images of the same patient. (A) Anterior coronal view of the anatomy demonstrating a circumaortic branch of the left renal vein as it passes anterior (green arrow) and posterior (red arrow) to the aorta. (B) Posterior coronal view of anatomy with virtual hand pointing to retroaortic component of renal vein. (C) Sagittal view showing branching of circumaortic left renal vein. (D) Axial view.

## RESULTS

**Table 1. Patient Characteristics and Surgical Outcomes**

	Laparoscopic			Hand-Assisted Laparoscopic		
	Control (n=14)	iVR (n=10)	P	Control (n=30)	iVR (n=7)	P
Age	38.8	45.8	0.13	40.2	43.4	0.58
Male/Female	6/8	3/7	0.52	9/21	5/2	0.04
BMI	24.9	26.7	0.13	25.6	25.1	0.70
ASA	1.4	1.5	0.37	1.4	1.6	0.51
Laterality (L/R)	13/1	9/1	0.80	30/0	5/2	0.003
Operative time (min)	192	151	0.03	284	239	0.05
EBL (cc)	36	34	0.85	61	54	0.77
Intraoperative complications	0 (0%)	0 (0%)	--	1 (3%)	0 (0%)	0.64
30-day postoperative complications	2 (14%)	0 (0%)	0.17	8 (27%)	2 (29%)	0.92

**Table 2. Surgeon and Patient Questionnaires (Mean ± SD)**

Surgeon Imaging Assessment (0=poor, 10=excellent)			
	CT (n=17)	iVR (n=17)	P
Arterial Vasculature	7.4 (±1.4)	9.9 (±0.3)	<0.001
Venous Vasculature	7.0 (±1.6)	9.9 (±0.3)	<0.001
Collecting System	6.9 (±2.3)	9.4 (±0.8)	0.001
Surrounding Anatomy	8.6 (±0.9)	8.8 (±2.5)	0.92
Surgeon Preoperative Assessment (1=strongly disagree, 5=strongly agree)			
iVR Improved Understanding & Confidence for the Surgery	4.9 (±0.2)		
iVR Altered the Preoperative Surgical Approach	4.6 (±0.8)		
Valuable Surgical Planning Tool	4.9 (±0.2)		
Use iVR for Future LDN	4.9 (±0.2)		
Surgeon Postoperative Assessment (0=poor, 10=excellent)			
iVR Correlated with Arterial Anatomy	9.8 (±0.4)		
iVR Correlated with Venous Anatomy	9.5 (±0.7)		
iVR Correlated with Collecting System Anatomy	9.6 (±0.7)		
iVR Correlated with Surrounding Anatomy	8.5 (±3.5)		
Patient iVR Preoperative Assessment (1=strongly disagree, 5=strongly agree)			
Improved Understanding of the Kidney Size/Shape	4.9 (±0.3)		
Feel Less Concerned About Surgery After Viewing iVR model	4.5 (±0.5)		

## CONCLUSIONS

- The initial experience with interactive virtual reality models prior to laparoscopic donor nephrectomy improved surgeons' understanding of the renal anatomy and altered the surgical approach in 94% of cases.
- Use of interactive virtual reality models was associated with a significant reduction in operative time.
- Use of interactive virtual reality models improved patients' understanding of the procedure and reduced their anxiety.