PD07-10

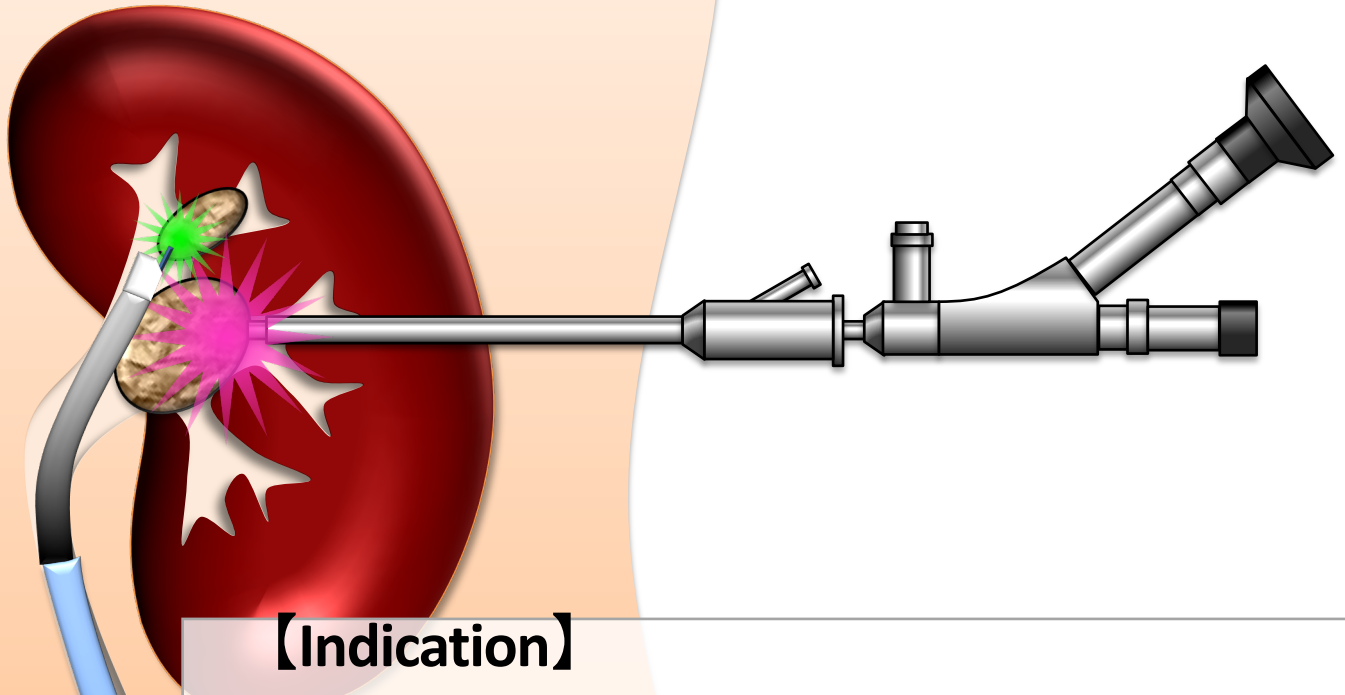
Usefulness of determination of renal puncture line in ECIRS using Virtual Reality

Atsushi Okada*, Yusuke Noda, Kazuya Ohashi, Tomoki Okada,
Ryosuke Chaya, Kengo Kawase, Taiki Kato, Kazumi Taguchi,
Shuzo Hamamoto, Yasujiro Hirose, Keiichi Tozawa, Kenjiro Kohri, and Takahiro Yasui

Department of Nephro-urology, Nagoya City University Graduate School of Medical Sciences

Backgrounds

ECIRS (endoscopic-combined intrarenal surgery)



【Characteristics】

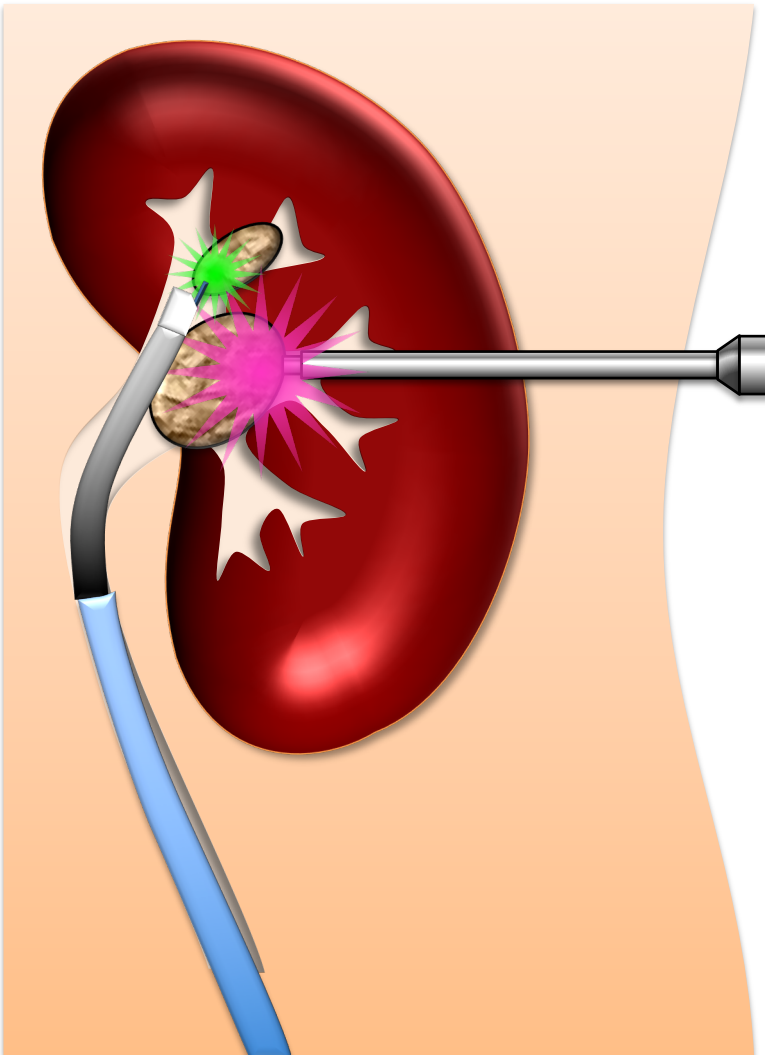
ECIRS is a surgical method that takes advantage of PNL (high stone removal rate and short operation time) and f-URS (wide operating range in collecting system).

【Indication】

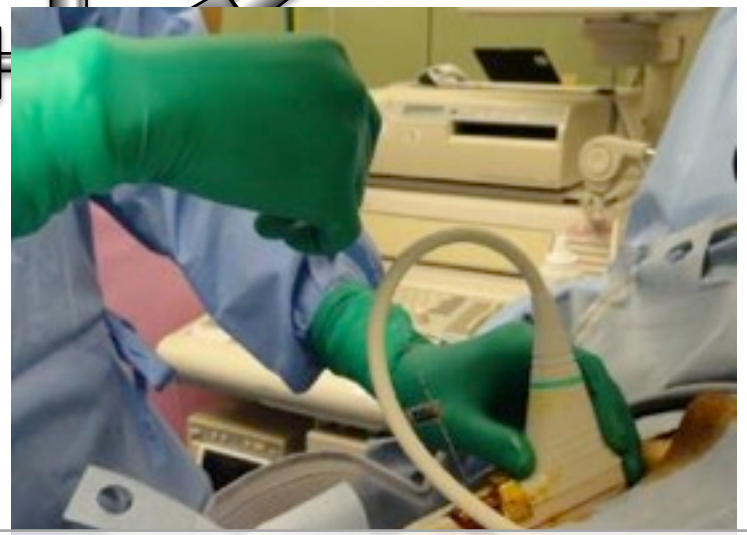
- PNL-compliant cases
- Multiple stones and Cases where stone-free is expected to be difficult with single URS / PNL
- Staghorn stone

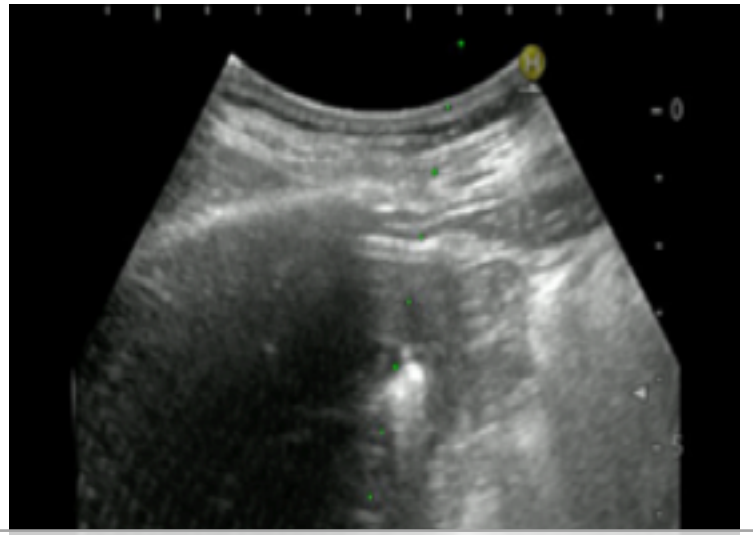
Backgrounds

ECIRS (endoscopic-combined intrarenal surgery)



Renal puncture is the most important technique for successful surgery and avoiding complications (bleeding and other organ damage).





Up to the present, the puncture site has been selected only by **ONE surgeon** based on ultrasonography or fluoroscopic findings.

Objectives

- Recently, we developed a method to determine the ideal renal puncture line for a three-dimensional renal collecting system constructed using Virtual Reality (VR) based on preoperative contrast-enhanced CT images.
- In this study, we observed the impact on success rates and perioperative complications by applying VR puncture data to actual ECIRS procedure.

Methods

- **Subjects**

  124 ECIRS cases performed in our hospital from January 2016 to June 2019
  - Conventional group (CON group, N = 117)
  - VR puncture group (VR group, N = 7)
- **Evaluation items**

  Patients' backgrounds, operation time, stone-free rate, perioperative complications

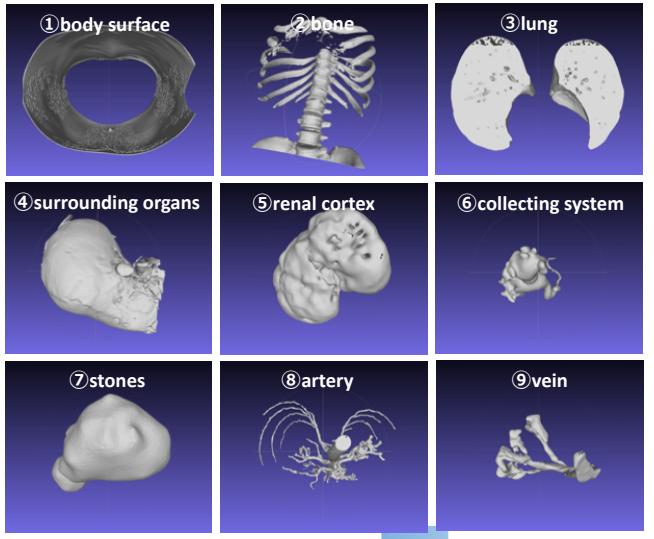
Methods

Contrasted-CT

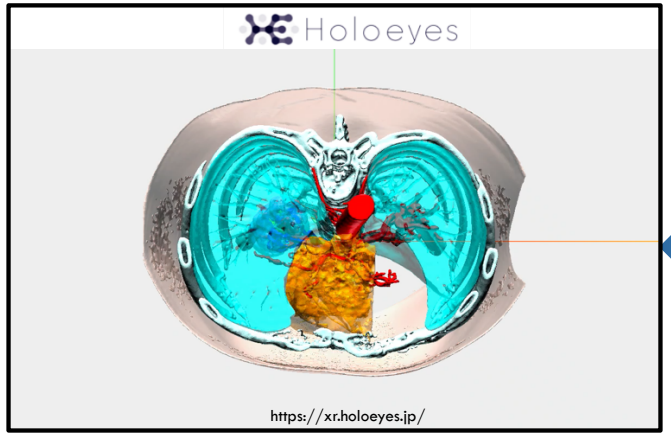
DICOM file creation

Medical imaging workstation
Ziostation®

Convert to STL files



Upload the STL files to web



https://xr.holoeyes.jp/

download

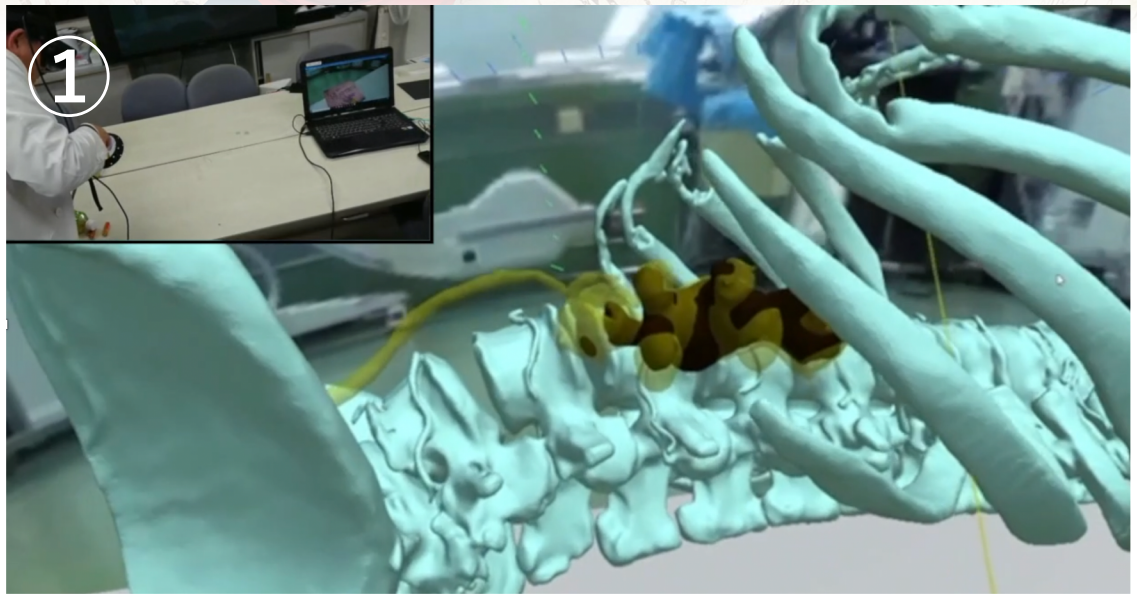
Automatic creation of VR data

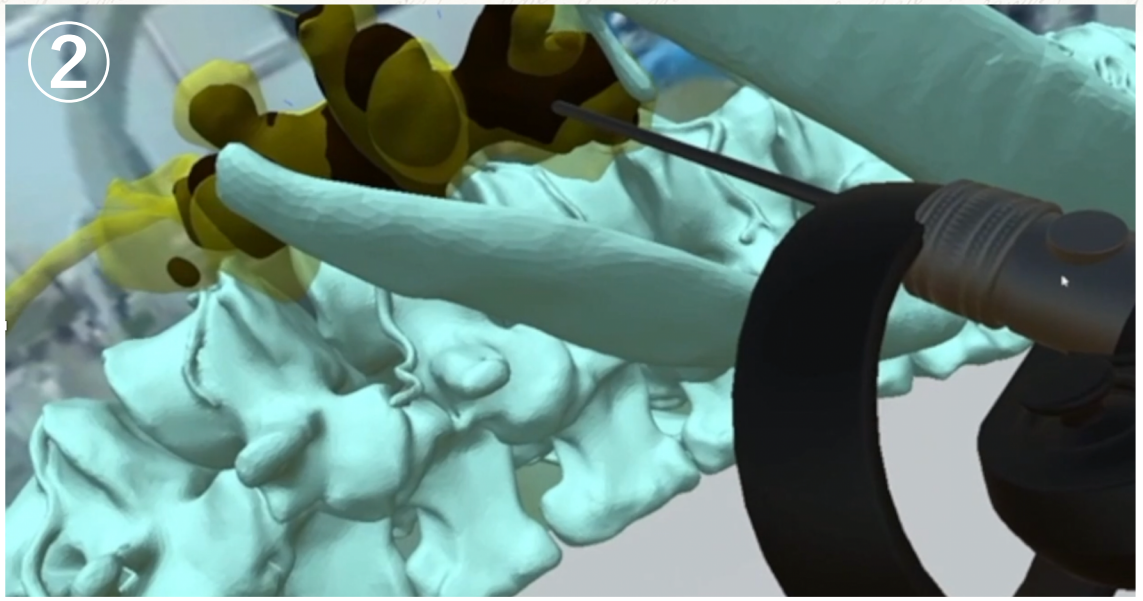
Viewable with VR goggles

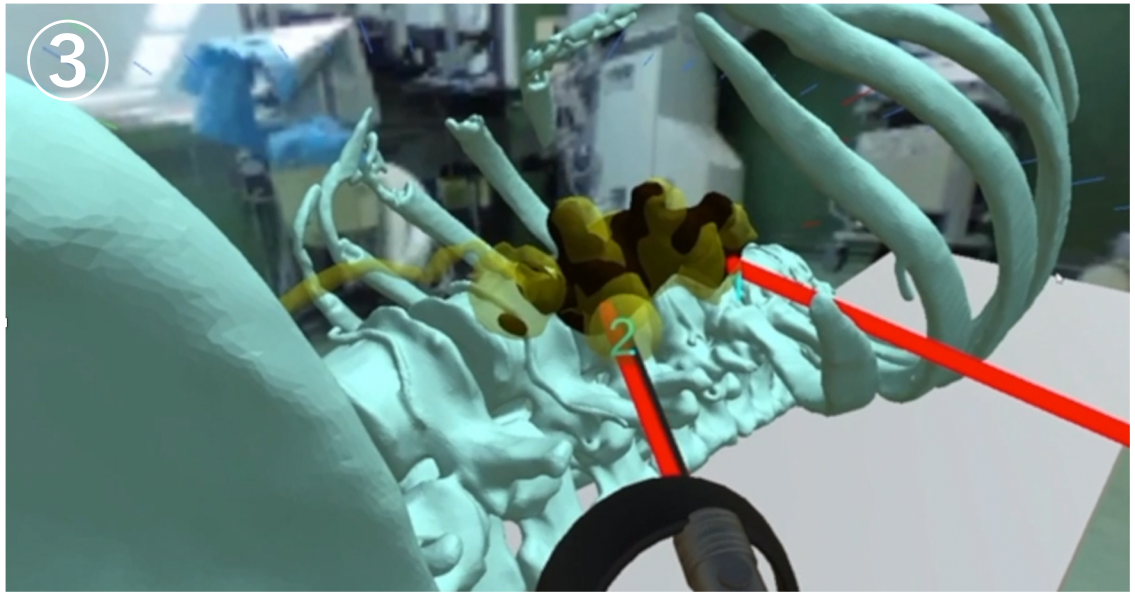
Methods

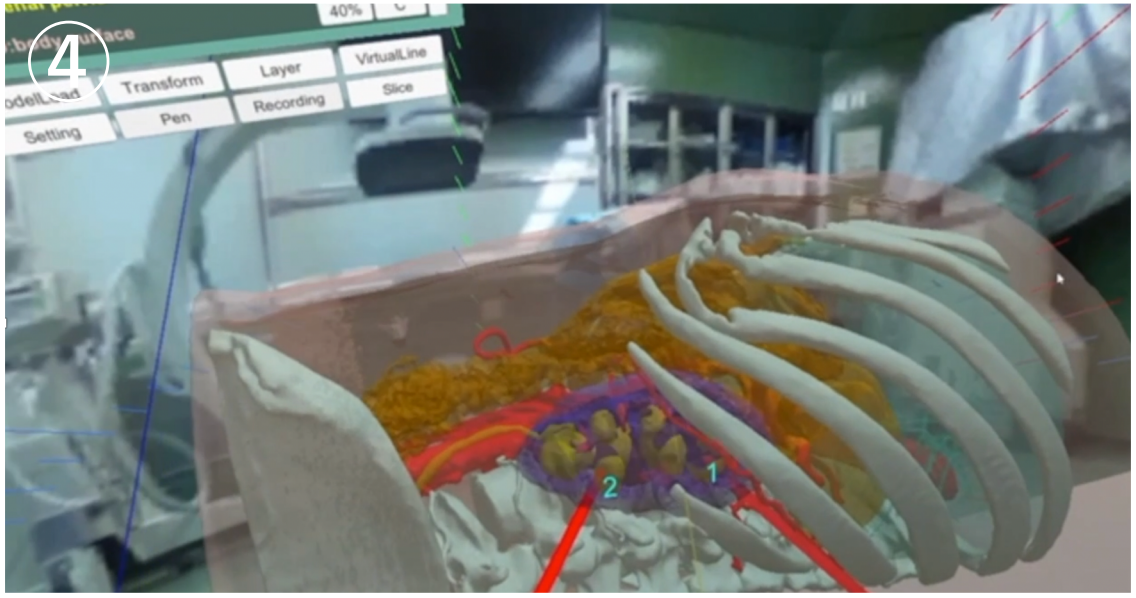
Actual VR puncture simulation

Methods

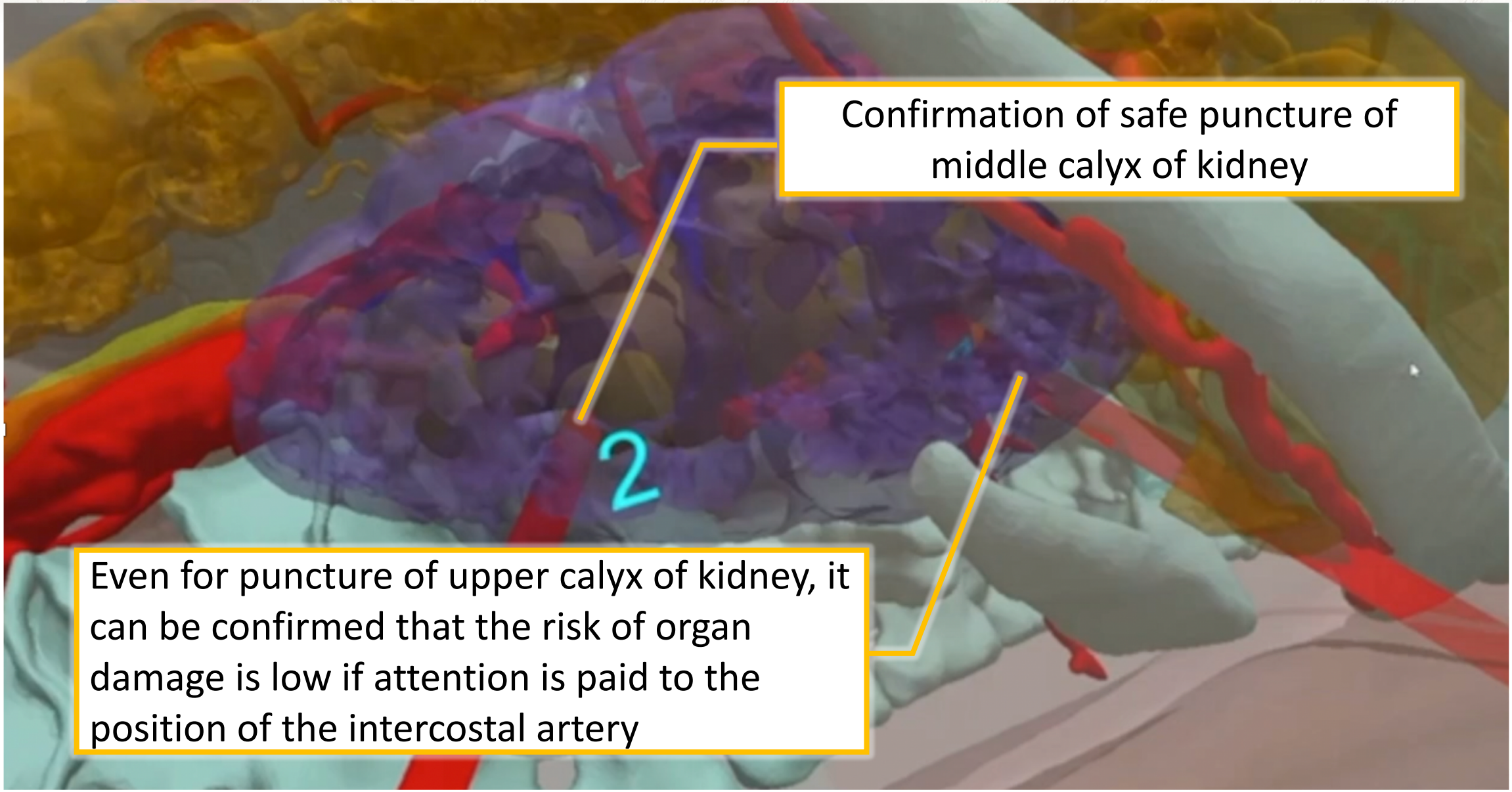

1


2


3
2


4
Transform
Layer
VirtualLine
Pen
Recording
Slice
Setting
2
1

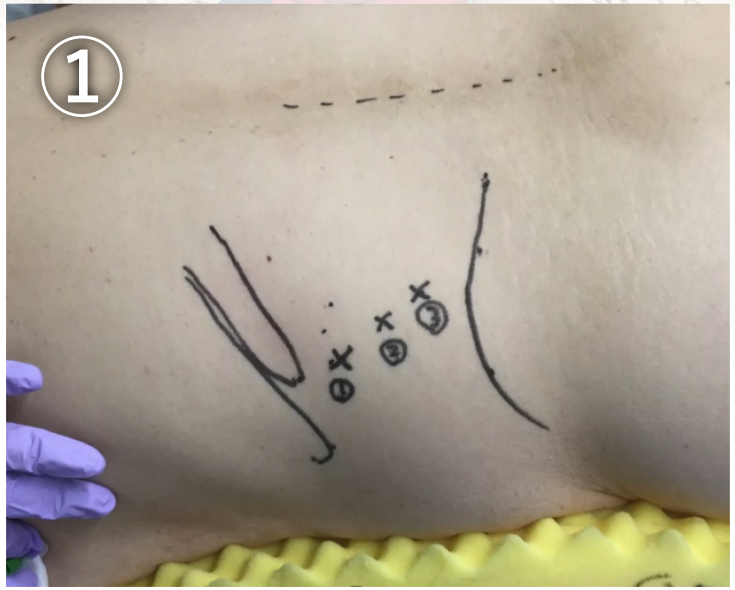
Methods


Confirmation of safe puncture of middle calyx of kidney
2
Even for puncture of upper calyx of kidney, it can be confirmed that the risk of organ damage is low if attention is paid to the position of the intercostal artery

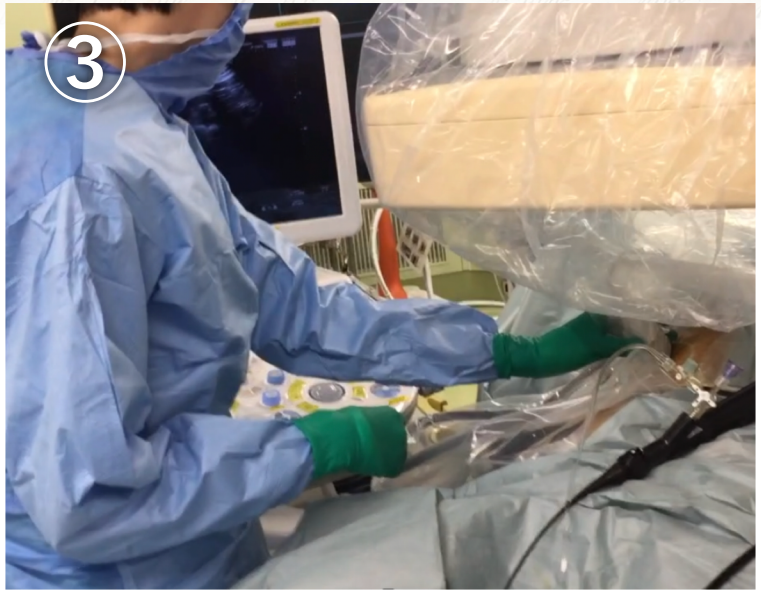
Methods

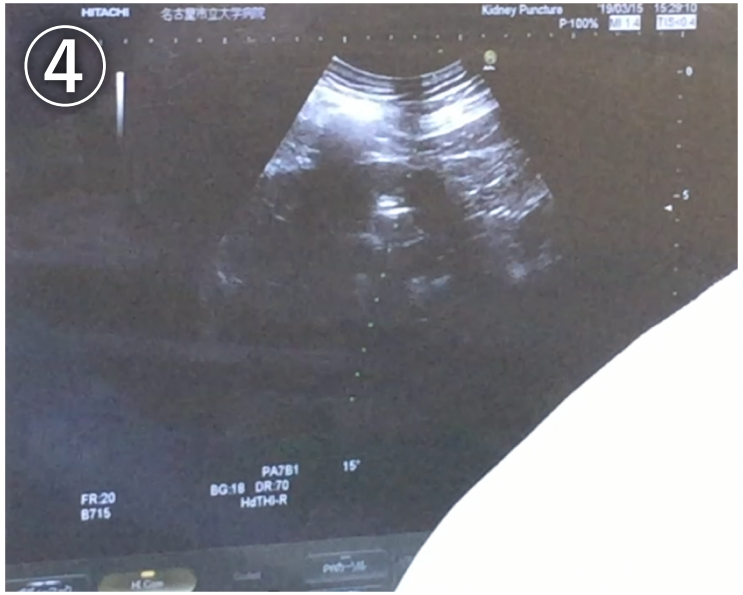
Renal puncture applying VR simulation

Methods

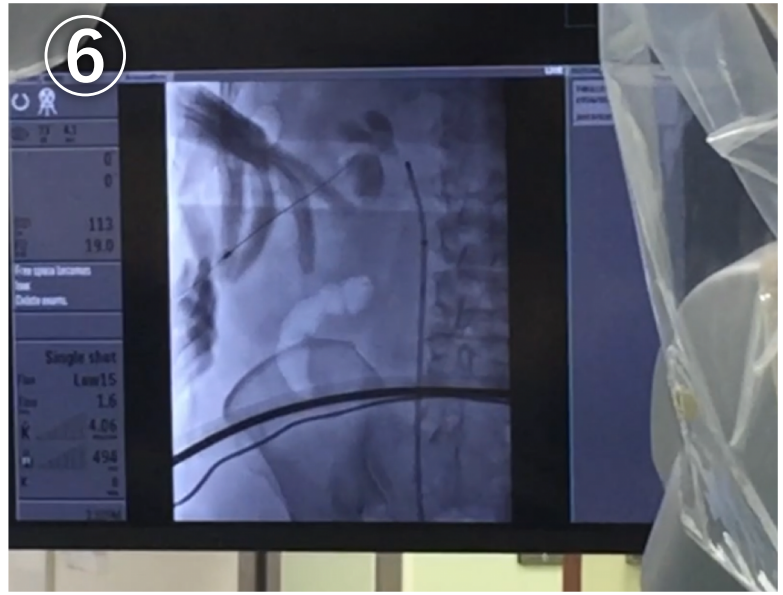

①


②


③


④
HITACHI
Kidney Puncture
FR:20
B715
PA7B1
BG:18 DR:70
HdTH9-R
15°


⑤


⑥

Results

① Patients' backgrounds

	CON	VR	p-value
Age (Median)[Min-Max]	57 [4-84]	64 [47-78]	0.095
Gender (Male, %)	70.1	57.1	0.471
Affected side (Left, %)	71.4	59.8	0.542
BMI (kg/m^2)(Median)[Min-Max]	24.2 [14.5-44.0]	20.8 [18.8-28.4]	0.543
Hydronephrosis (Yes, %)	53.9	57.1	0.868
Preoperative condition			
Obstructive pyelonephritis (Yes, %)	12.9	0.0	0.310
DJ stent (Yes, %)	12.1	0.0	0.329
Preoperative Nephrostomy (Yes, %)	6.4	0.0	0.503

Results

② Stone backgrounds

	CON	VR	p-value
Shape			0.484
Complete staghorn, n (%)	13 (13.2)	1 (14.3)	
Partial staghorn, n (%)	43 (44.3)	4 (57.1)	
Non-staghorn, n (%)	60 (58.5)	2 (28.6)	
Size (Maximum diameter), Median (mm)	22.5	24.0	0.847
Number of renal calix with stones			0.405
0, n (%)	67 (78.9)	5 (71.4)	
1, n (%)	15 (17.7)	1 (14.3)	
≥2, n (%)	3 (3.5)	1 (14.3)	

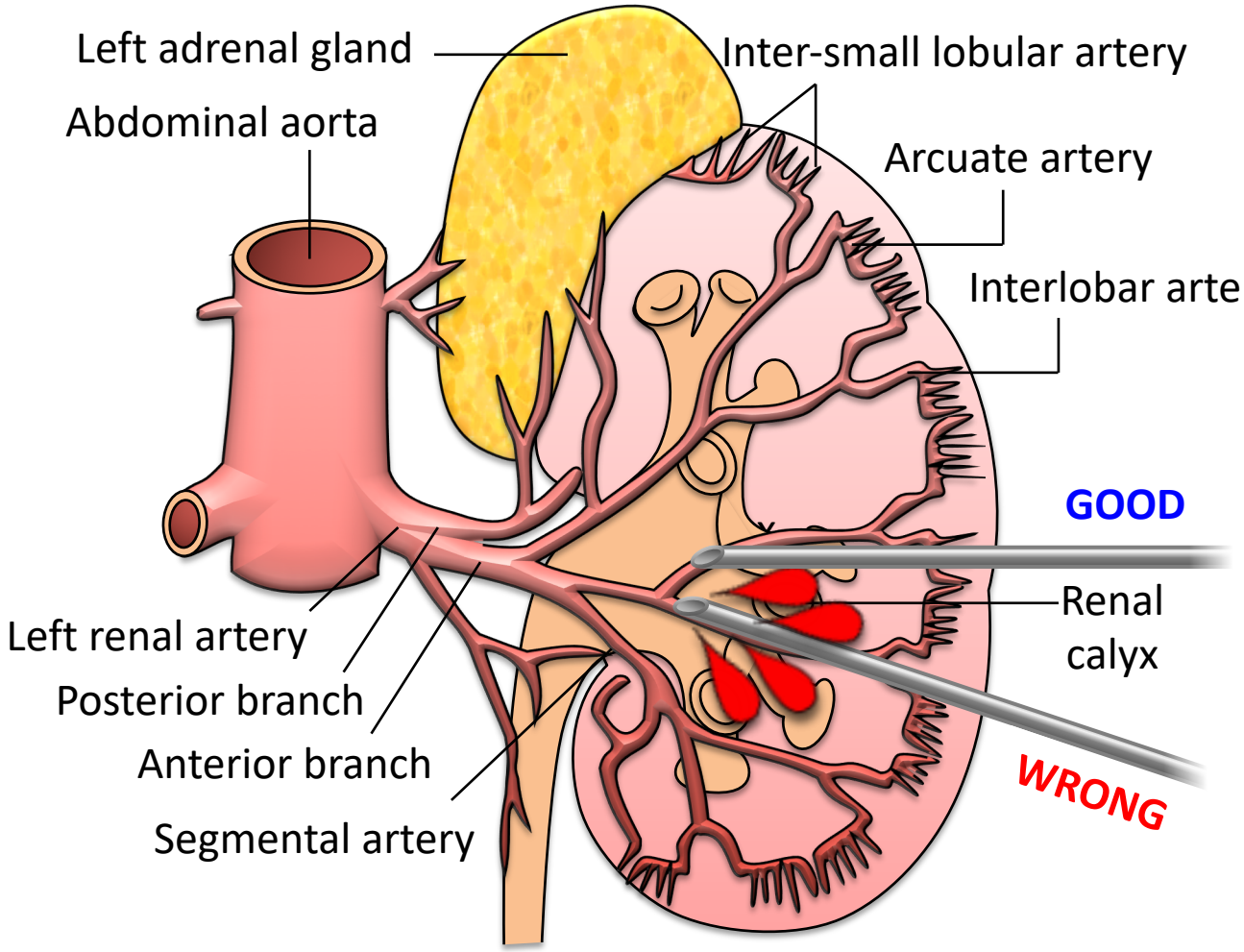
Results

③ surgical information

	CON	VR	p-value
Body position, Prone (%)	71.8	85.7	0.423
Nephroscope, mini-perc (%)	99.1	100	0.806
Number of tracts, 1 (%)	94.9	100	0.539
Tract outer diameter, median (Fr)	19.5	19.5	0.727
Operation time, median (min)	120.5	107.0	0.873
Intraoperative stone-free, n (%)	88 (77.2)	5 (71.4)	0.726
Day 1 after operation stone-free, n (%)	69 (60.0)	5 (71.4)	0.548
SSI, >38°C, ≥3 days, n (%)	23 (19.6)	0 (0.0)	0.228

Discussion

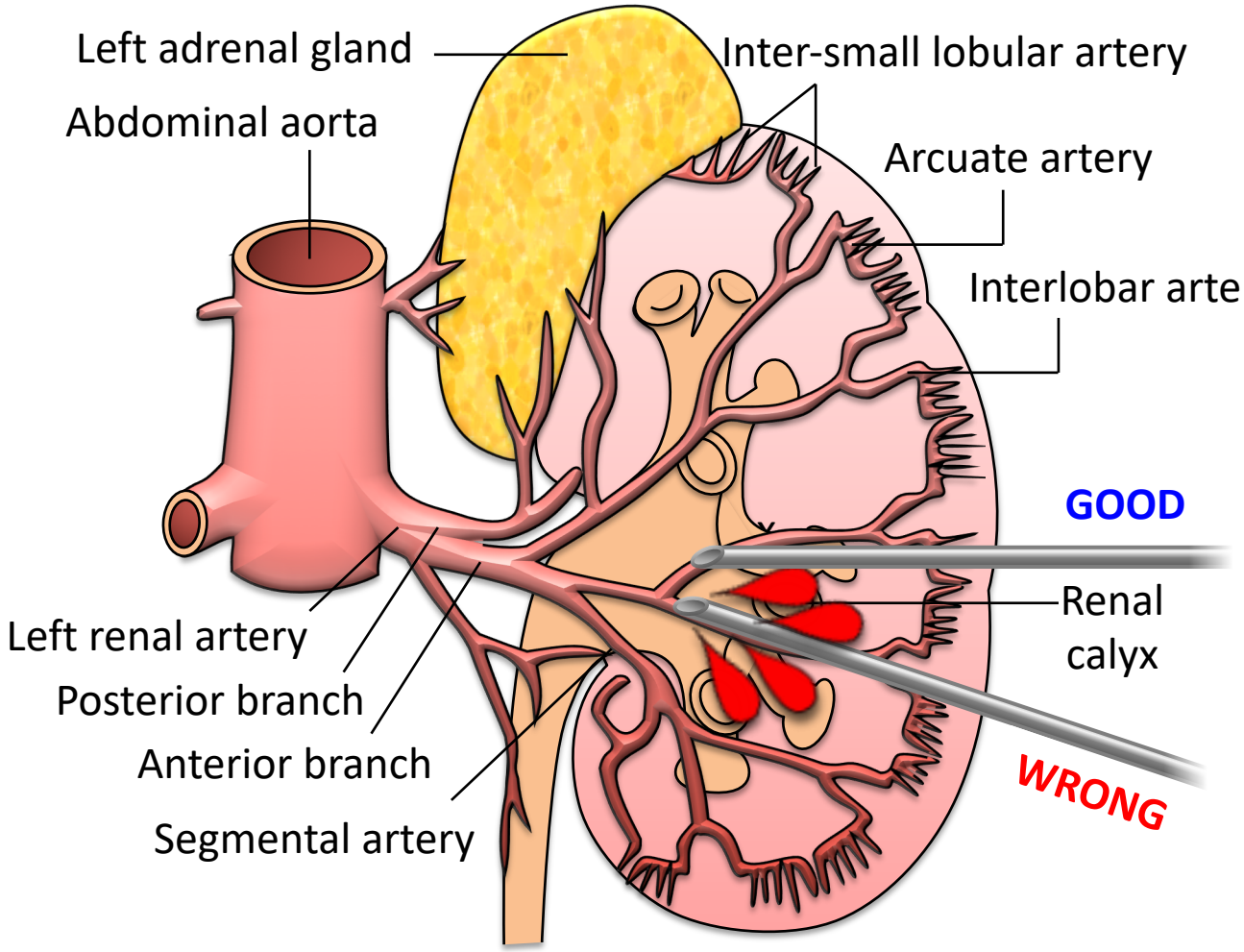
Percutaneous renal puncture
-Japanese endoscopic treatment manual for upper urinary stones-



Make a puncture
targeting the dorsal calyx
while paying attention to the
running of the renal arterial system

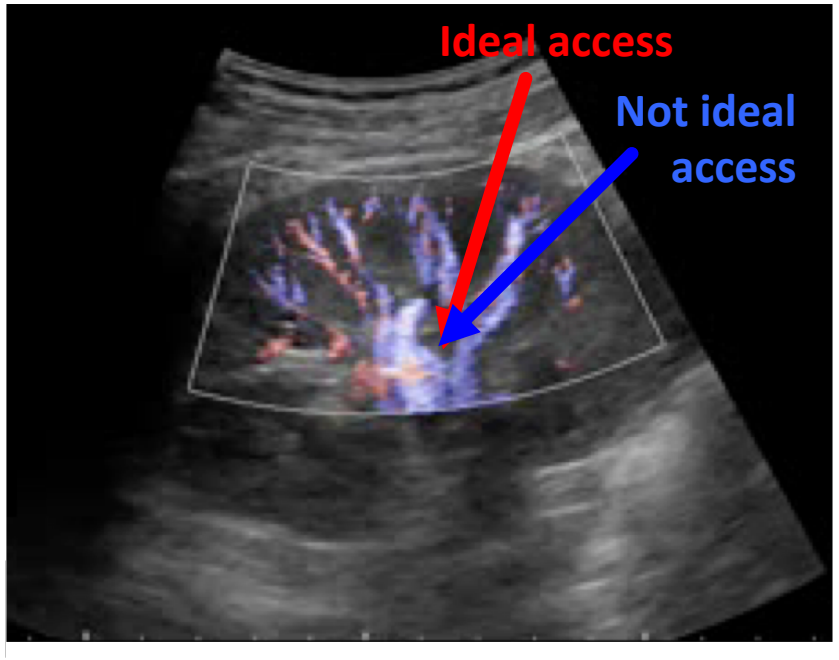
Discussion

Percutaneous renal puncture
-Japanese endoscopic treatment manual for upper urinary stones-



Wideband doppler US

- High resolution blood flow mode

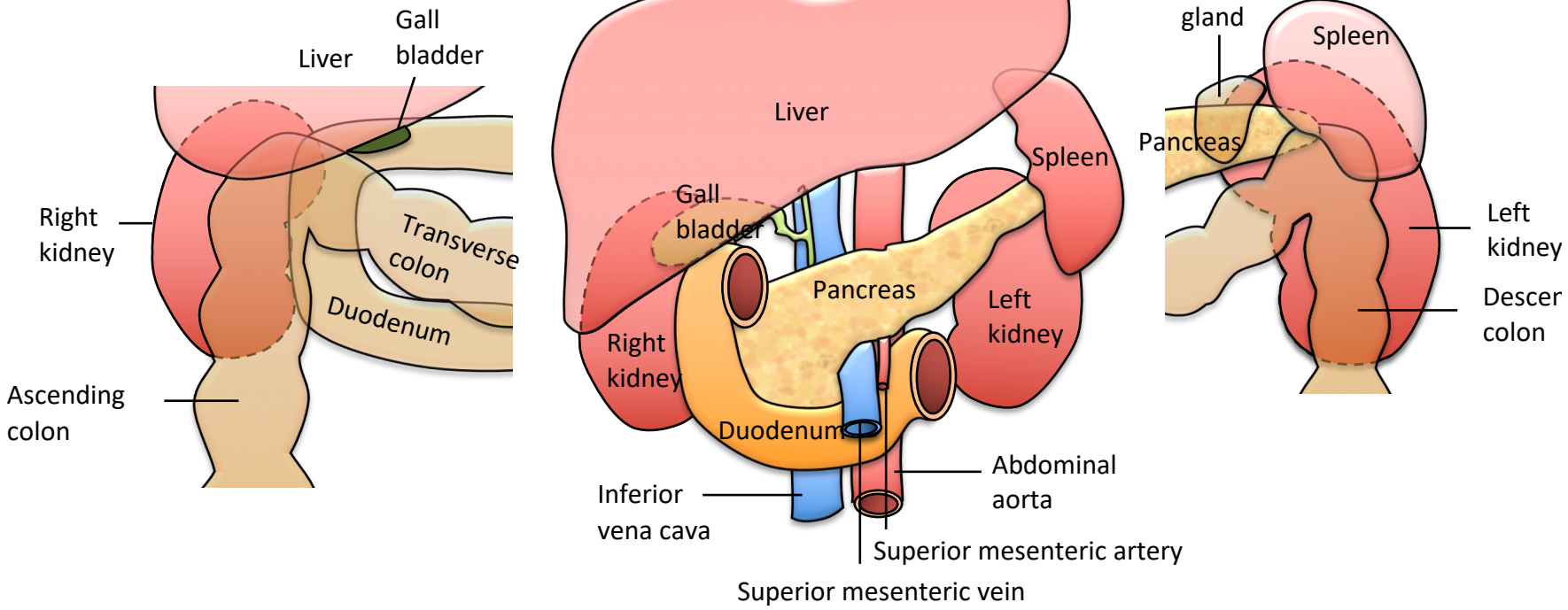


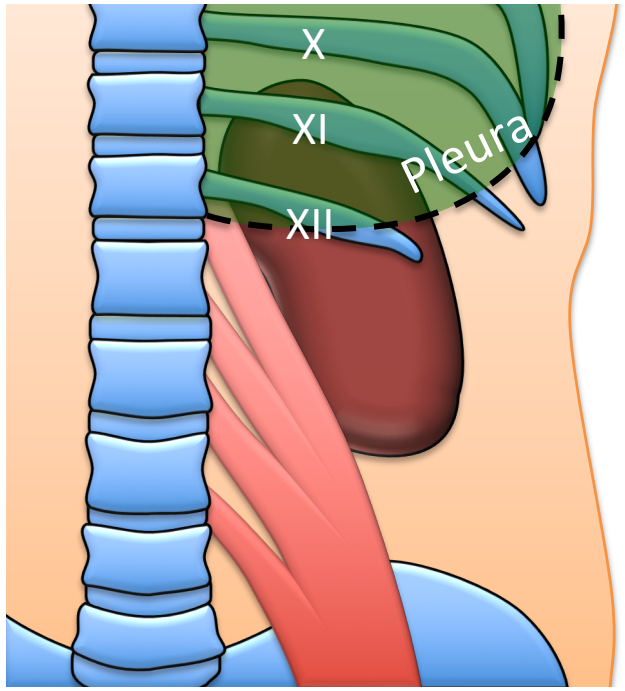
Inoue T et al. Urology 2016

Discussion

Percutaneous renal puncture
-Japanese endoscopic treatment manual for upper urinary stones-

Anatomy with surrounding organs



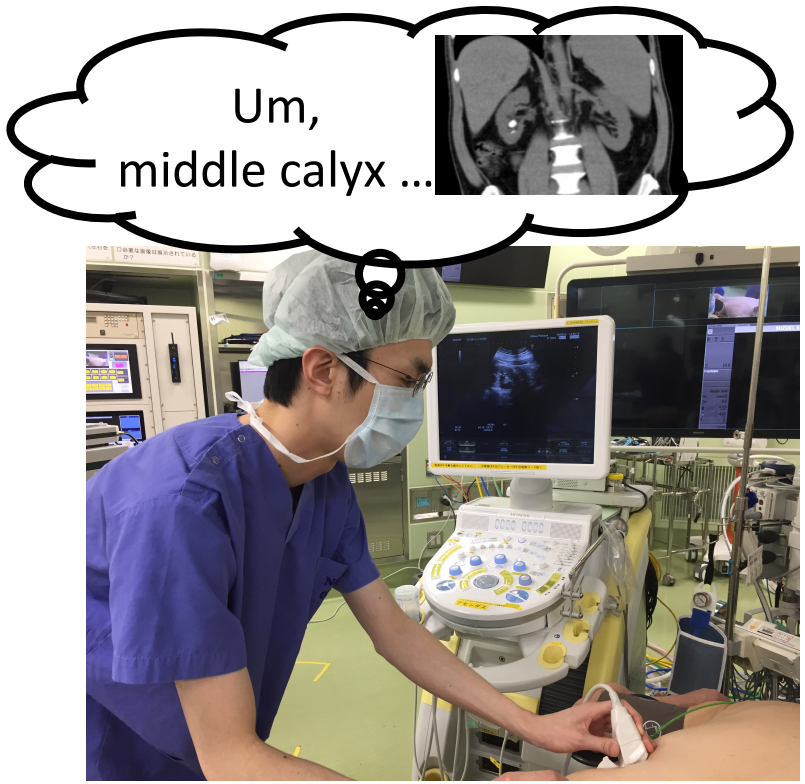


- Safe puncture route should be confirmed preoperatively by ultrasonography or CT
- Puncture from the head side of the 11th rib should be avoided
- Puncture should be performed with careful attention to the intercostal arteriovenous and nerves.

Discussion

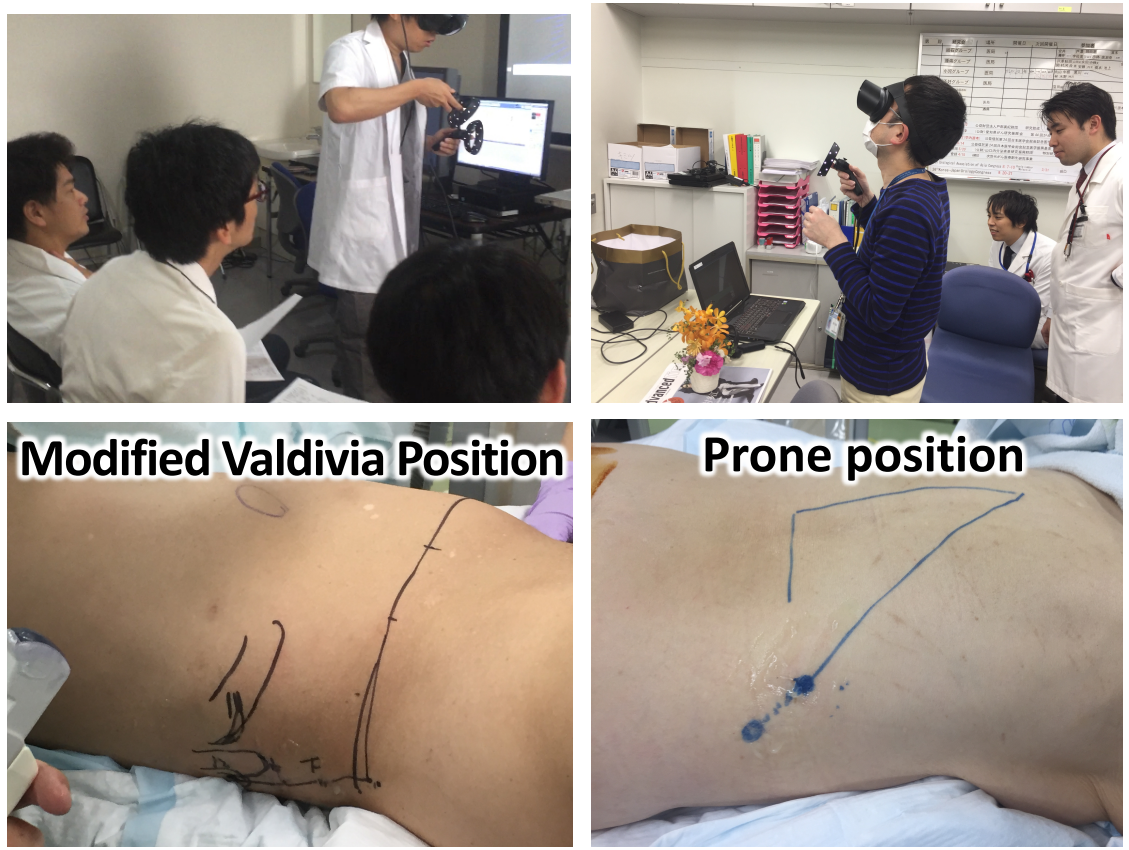
Usefulness of VR ① Identification of puncture point

Conventional renal puncture



- Depends only on the skill and experience of the surgeon
- Responsibility for treatment results and complications focused on the surgeon

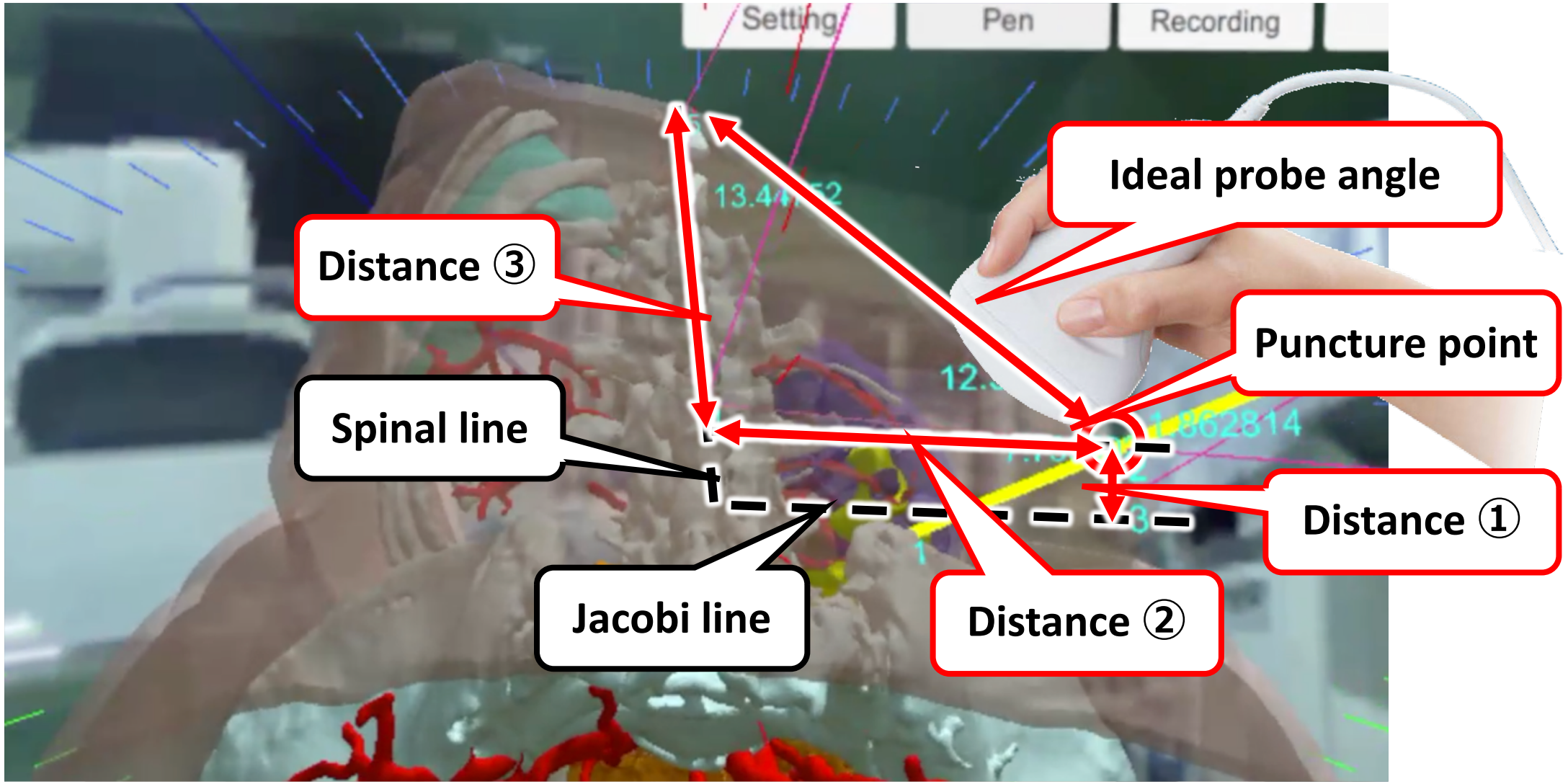
Renal puncture with reference to VR simulation



- Determine **the ideal puncture line** with multiple doctors including experienced one
- **Safe and effective puncture site** may be indicated

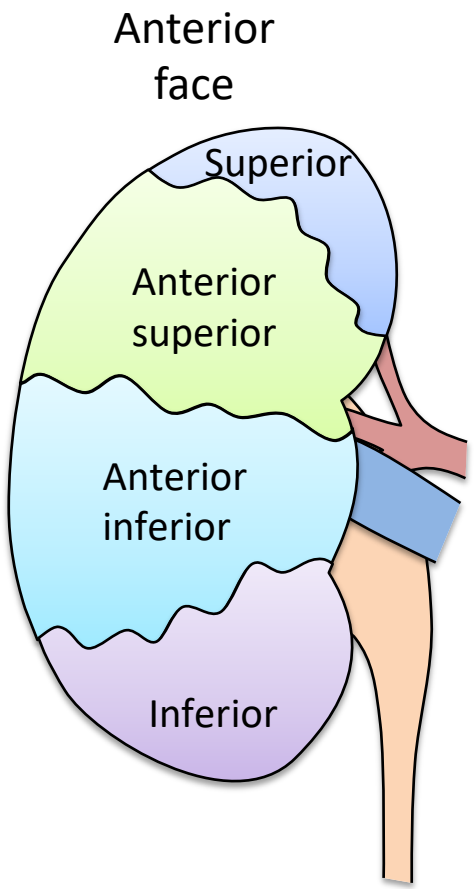
Discussion

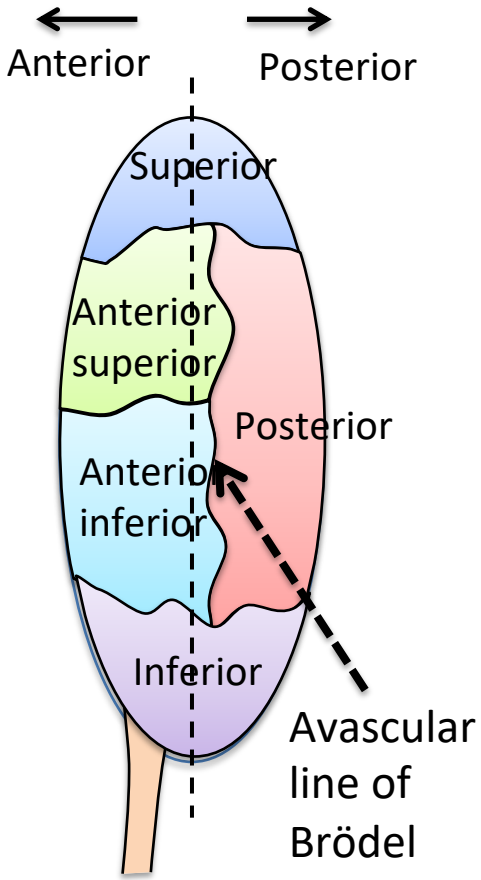
Usefulness of VR ② Determination of ultrasonic probe angle

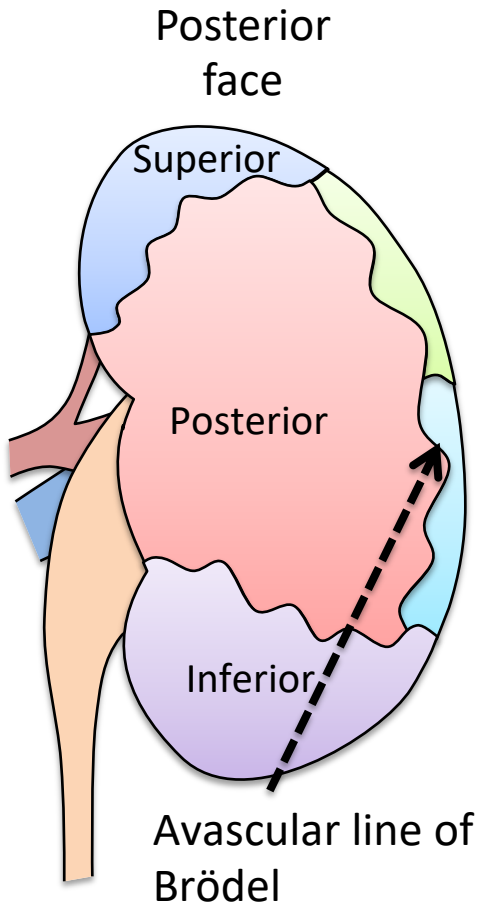


Discussion

Usefulness of VR ② Determination of ultrasonic probe angle



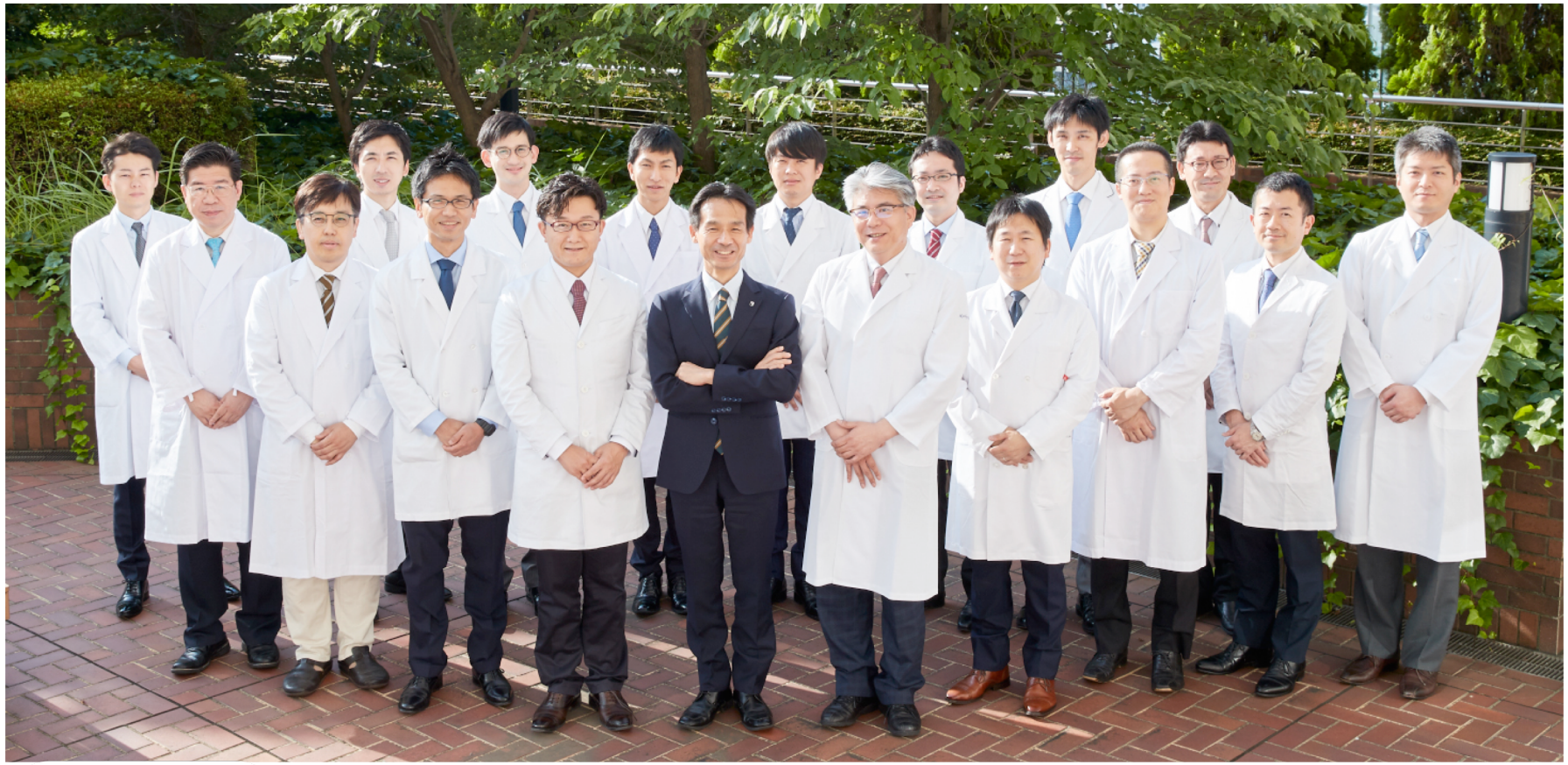




Conclusion

- We have developed a renal puncture simulation for ECIRS using Virtual Reality.
- This method not only allows an ideal puncture line to be determined by multiple doctors, but also has the possibility of performing the anatomically safest puncture.

Special Thanks



Thank you for your attention.

a-okada@med.nagoya-cu.ac.jp