

AV fistula and urinary fistula after partial nephrectomy: How to diagnose and manage?

MINYONG KANG, M.D.,Ph.D.

Department of Urology, Samsung Medical Center, Sungkyunkwan University
School of Medicine

Department of Health Sciences and Technology, SAIHST, Sungkyunkwan
University

Laboratory of Cancer organoid and Genomics, Research Institute for Future
Medicine, Samsung Medical Center

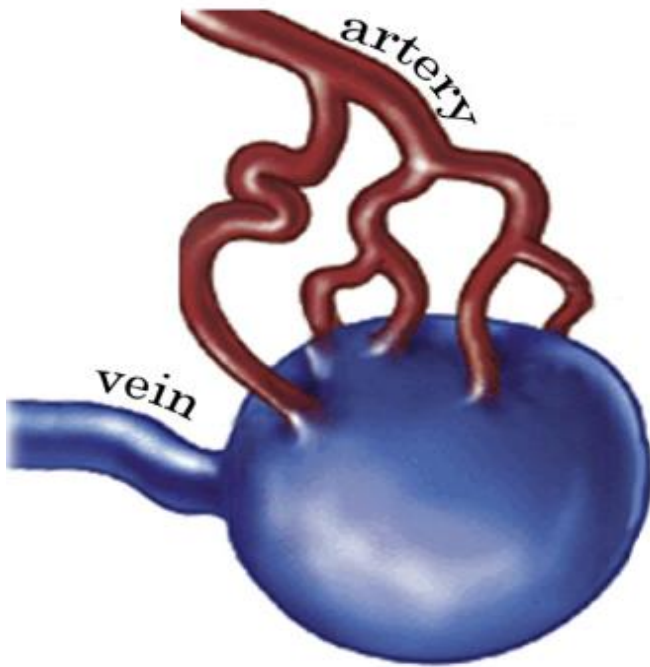


AV fistula and pseudoaneurysm



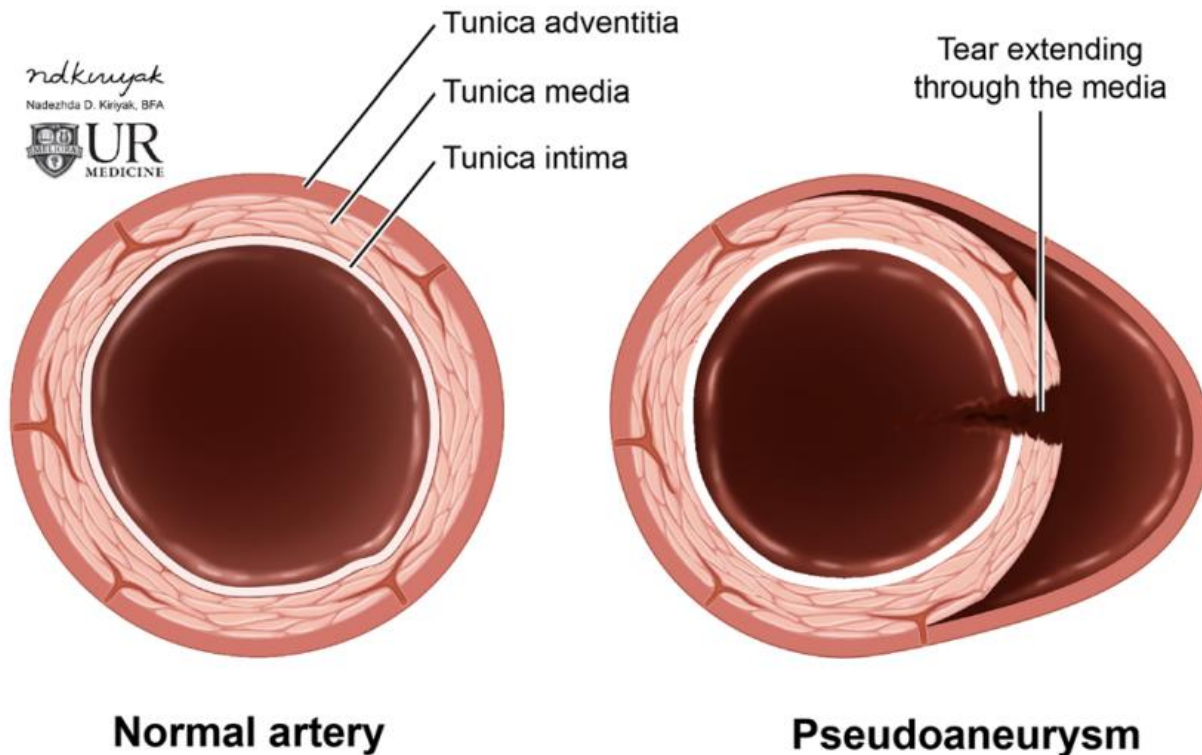
Definition of arterio-venous (AV) fistula

- Abnormal connection between an artery and a vein in which blood flows directly from an artery into a vein, bypassing some capillaries.



Definition of pseudoaneurysm

- "false aneurysm", or "pulsatile hematoma," or "communicating hematoma"
- pulsating, encapsulated hematoma in communication with lumen of a ruptured vessel



Incidence of AV fistula and pseudoaneurysm

- **Pseudoaneurysm >>> AV fistula**
- In systemic review, **0.4 ~ 4.1%** was reported after partial nephrectomy.
- In SMC (RPN), **1.7 %** (n=17/1,013); in my case (RPN), **1.5 %** (n=4/260).

References	Procedure	No. Pts	No. RAPs Diagnosed	Mean Presentation POD (range)	Treatment (No. pts)	Symptoms (No. pts)
Albani and Novick ¹¹	OPN	698	3	38.6 (5–90)	Successful angioembolization (2), failed angioembolization + spontaneous resolution (1)	Yes (2), no (1)
Heye et al ²⁰	OPN	251	7	8.9 (2–22)	Successful angioembolization (all)	Yes (7)
Taneja and Tan ²¹	OPN	96	4	18.5 (not available)	Successful angioembolization (all)	Yes (4)
Singh and Gill ⁹	LPN	345	6	11.7 (8–15)	Successful angioembolization (all)	Yes (6)
Zorn et al ²²	LPN	103	1	24	Successful angioembolization (all)	Yes
Nadu et al ²³	LPN	212	4	Not available	Successful angioembolization (all)	Yes (4)
Shapiro et al ²⁴	LPN	259	6	12.7 (5–23)	Successful angioembolization (all)	Yes (5), no (1)
Netsch et al ²⁵	OPN, LPN	289, 40	4, 2	12.5 (6–25), 24.5 (13–36)	Successful angioembolization (all)	Yes (6)
Inci et al ²⁶	LPN	25	3	14.5 (7–22)	Successful angioembolization (2), nephrectomy (1 asymptomatic)	Yes (2), no (1)
Simone et al ²⁷	LPN	210	2	(not available)	Successful angioembolization (all)	Yes (2)
Hyams et al ¹⁰	LPN/RALPN	998	17	14.5 (3–24)	Successful angioembolization (13), spontaneous resolution (2), neg angiography (2)	Yes (17)
Ghoneim et al ⁸	LPN, OPN	301, 1,160	8, 7	14 (not available)	Successful angioembolization (all)	Yes (15)
Jain et al (unpublished data)	LPN/RALPN	242	3	12 (10–15)	Successful angioembolization (all)	Yes (3)



Symptoms of AV fistula and pseudoaneurysm

- **Gross hematuria (most common)**
- **Flank pain**
- **Hemorrhagic shock**



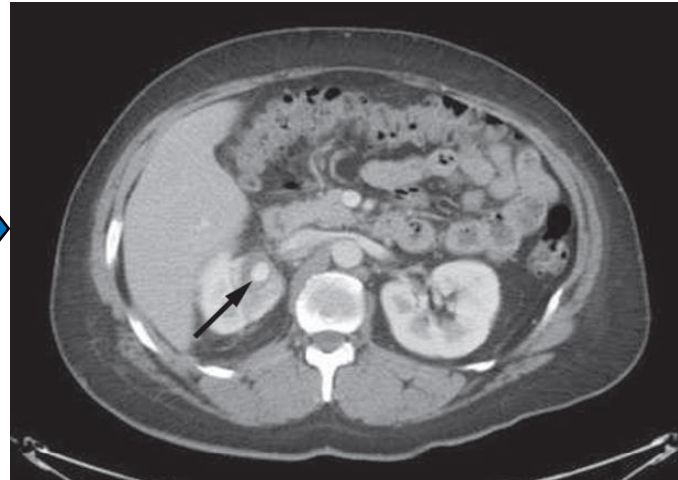
Diagnosis of AV fistula and pseudoaneurysm

- **Enhanced CT (prefer CT angiography)**
- **Angiography (=both a diagnostic and therapeutic modality)**

Preop CT scan



Abdominal CT scan



Angiograms



- MRI → avoids high radiation exposure of CT scan,
(potential drawbacks = length of time required in unstable patient)



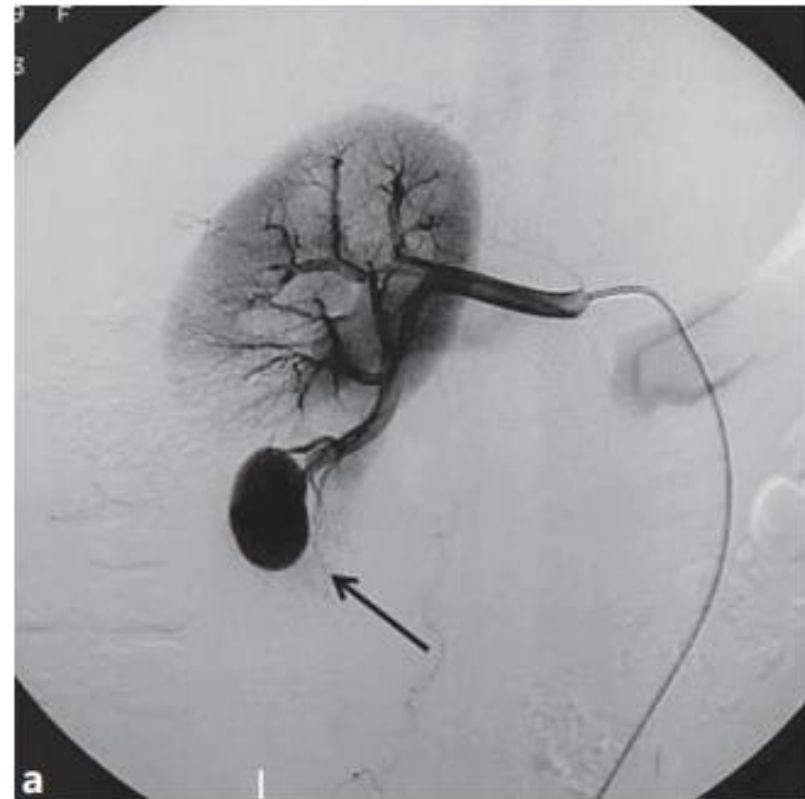
Diagnosis of AV fistula and pseudoaneurysm

arterial phase of the CT scan



oval enhancement (RAP) and a huge peripheral non-enhanced area (hematoma).

renal angiography

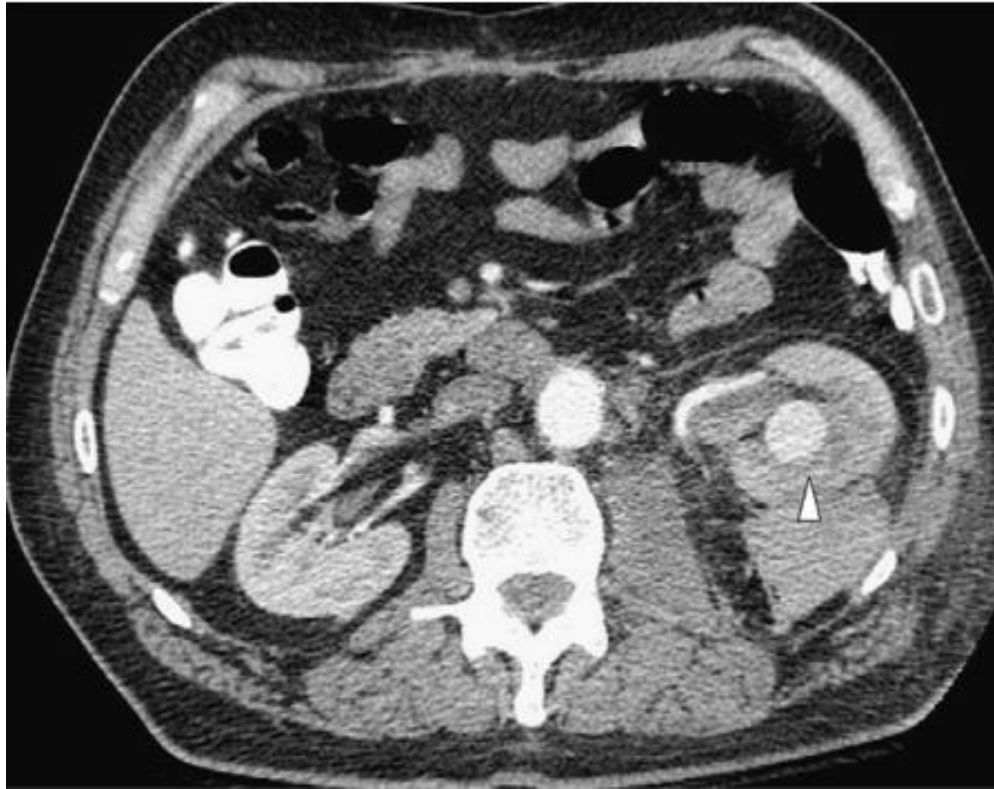


pseudoaneurysm of the renal artery branch (arrow).



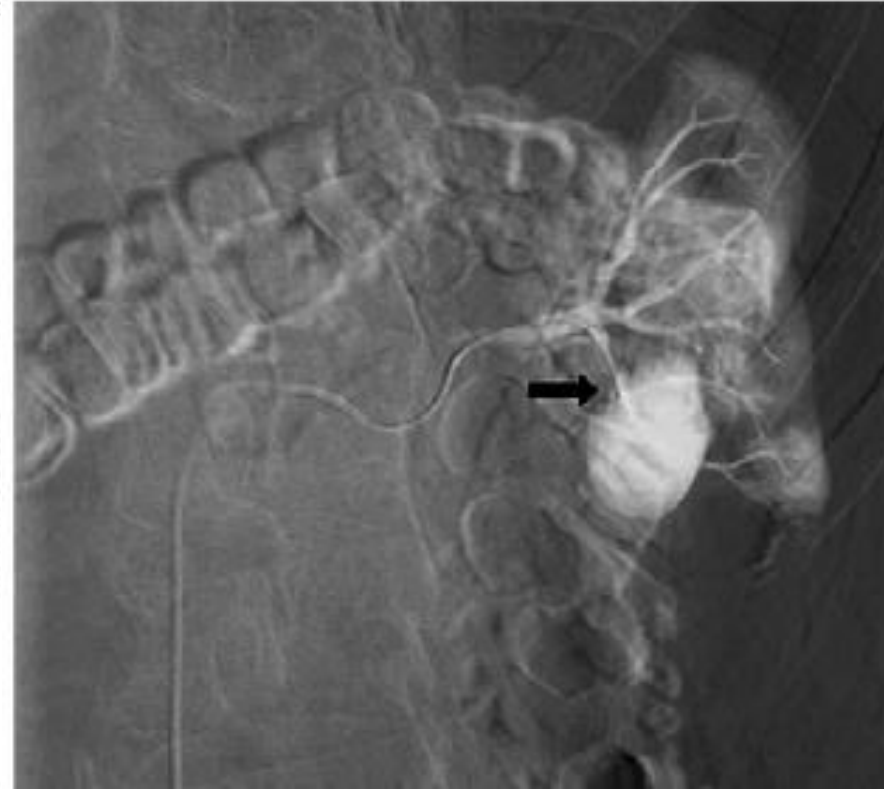
Diagnosis of AV fistula and pseudoaneurysm

contrast medium-enhanced CT



a well-circumscribed collection of contrast material near renal sinus of left kidney compatible with a pseudoaneurysm (arrowhead)

left renal artery angiogram



saccular pseudoaneurysm in the lower segment of the renal artery (arrow).



Risk factors of AV fistula and pseudoaneurysm

- Embolization group had **longer ischemic time** ($p=0.042$), **more endophytic** ($p=0.017$) and **more posterior tumors** ($p=0.035$).
- **Higher exophyticity (E) score** was significantly higher for severe postoperative hemorrhage.
- **Higher N component score (OR: 1.96; CI, 1.04-3.71)** associated with a significantly increased risk of RAPs or AVFs.
- **Renal sinus exposure (OR: 4.99; CI, 1.11-24.0)** was the only significant independent predictive factor for the occurrence of RAP.

Factor	Postoperative bleeding	
	Odds ratio (95% CI)	p-value
Univariate analysis		
Age	0.873 (0.726-1.050)	0.148
Sex (male vs. female)	0.341 (0.012-9.734)	0.529
Body mass index	0.848 (0.248-2.898)	0.793
Weight	1.041 (0.646-1.679)	0.868
Tumor size	0.261 (0.033-2.041)	0.201
R score	0.718 (0.417-1.518)	0.426
E score	0.727 (0.598-0.952)	0.033^a
N score	0.473 (0.287-0.966)	0.305
L score	0.750 (0.426-1.006)	0.638
Operative method (open vs. laparoscopic vs. robot)	0.104 (0.067-0.191)	0.140
Warm ischemic time	0.919 (0.898-0.941)	0.209
Estimated blood loss	0.989 (0.986-0.991)	0.102

Korean J Urol. 2014;55(1):17-22.

World J Urol. 2020;38(5):1235-1242.

Int Braz J Urol. 2021;47(1):149-158.

Int J Urol. 2015;22(4):356-61.

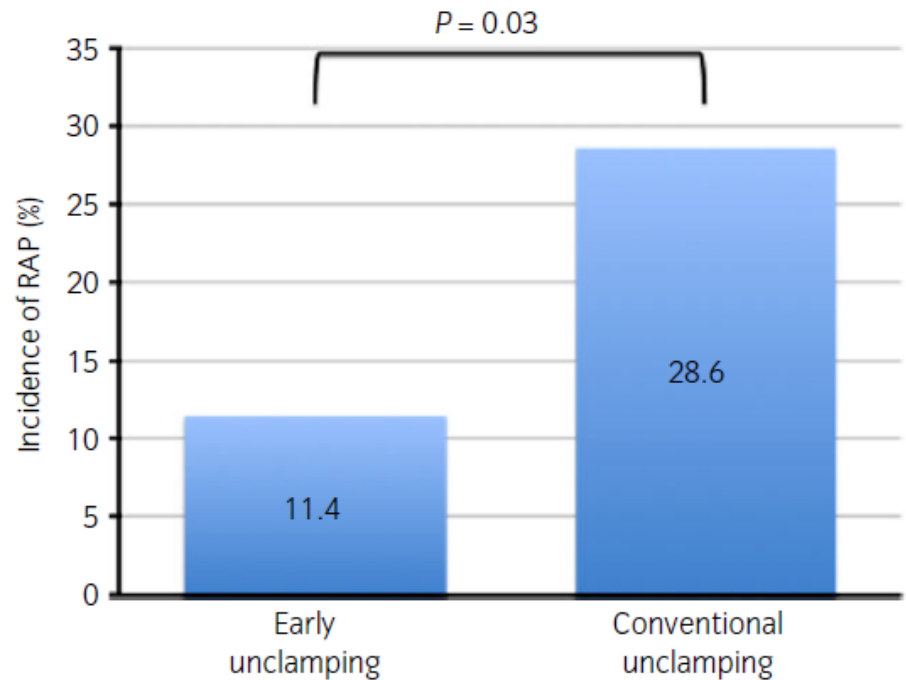
Risk factors of AV fistula and pseudoaneurysm

- Renal sinus exposure = significant factor predicting occurrence of renal artery pseudoaneurysm.

→ **Avoidance of deep excision into the renal sinus** could reduce the risk

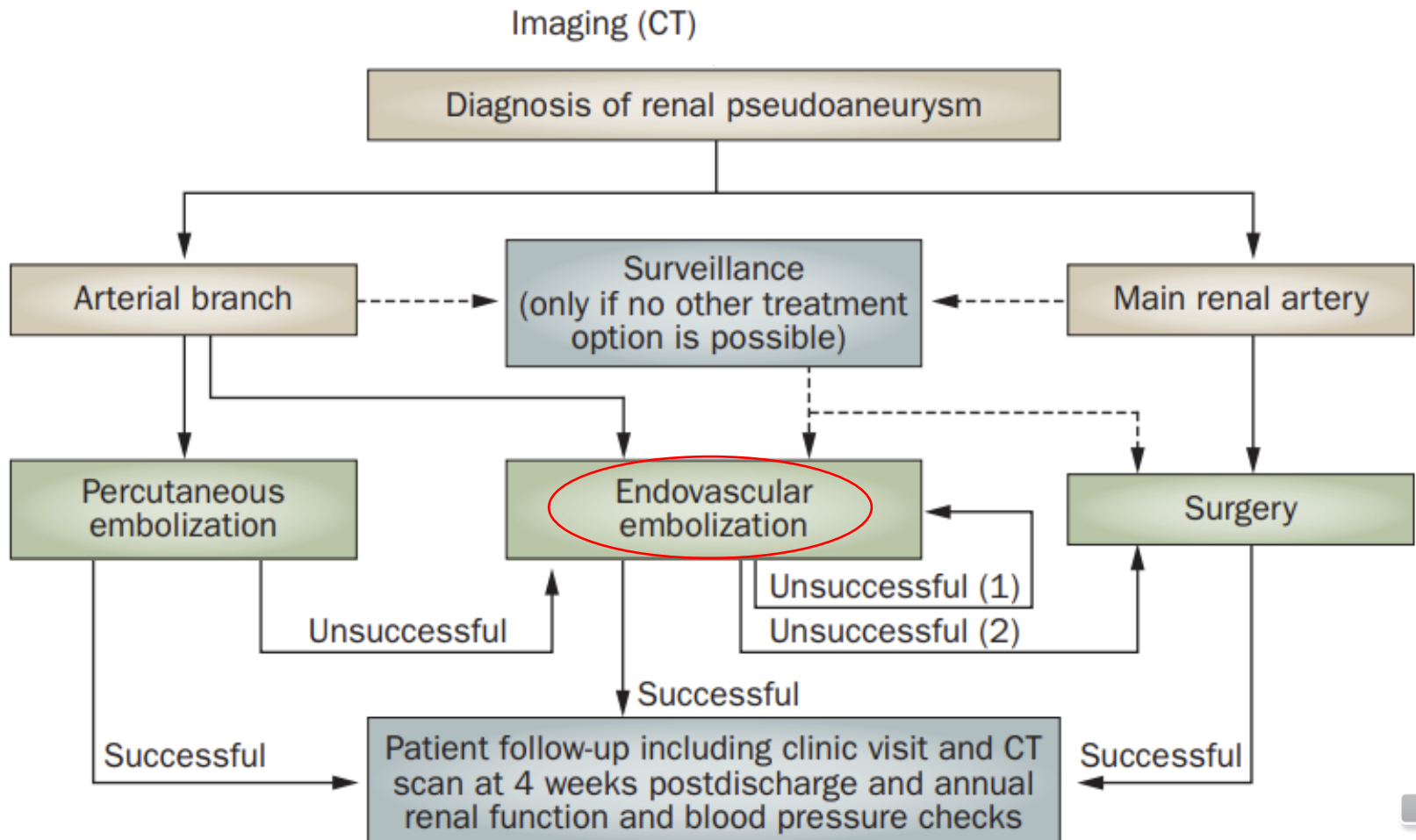
- **Early unclamping technique**
= reduce risk of renal artery pseudoaneurysm.

→ **Absence of arterial bleeding before renorrhaphy** is likely to be a key step in preventing renal artery pseudoaneurysm.



Treatment of AV fistula and pseudoaneurysm

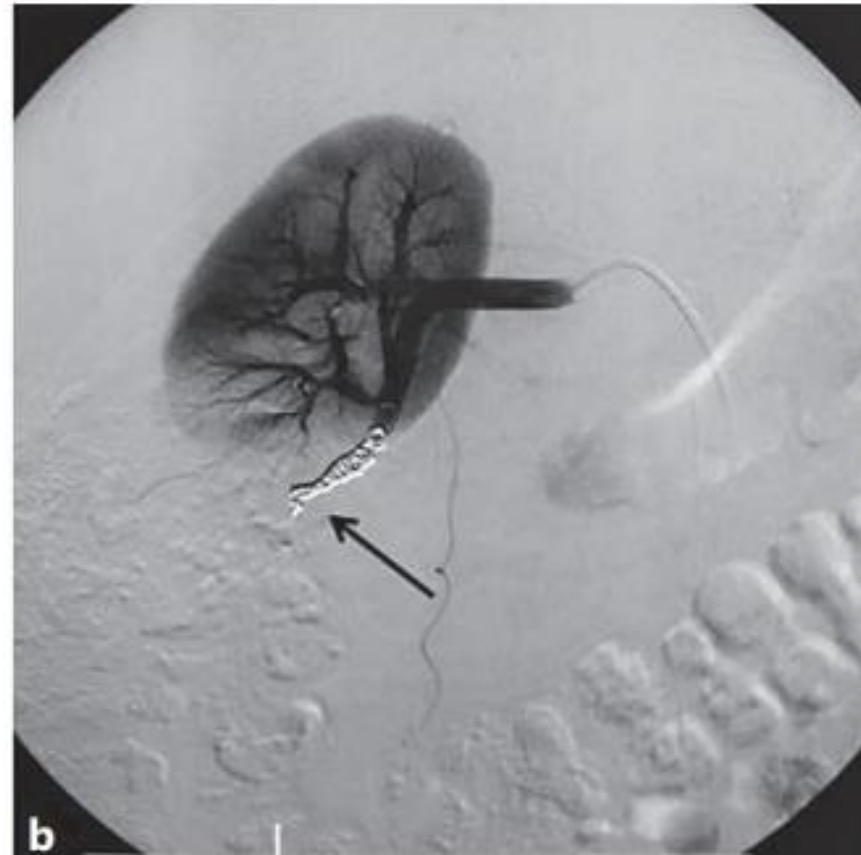
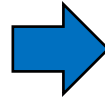
- Conservative with bed rest, serial monitoring of hematocrit and transfusion
→ Selective angioembolization (Extremely effective!)



Treatment of AV fistula and pseudoaneurysm



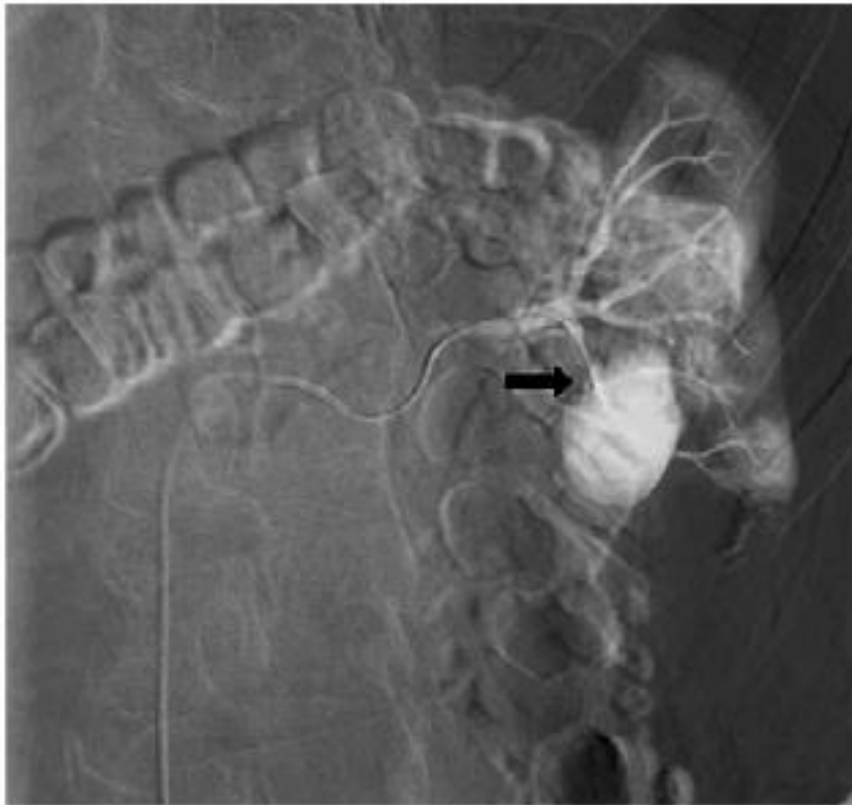
pseudoaneurysm of the renal artery branch (arrow)



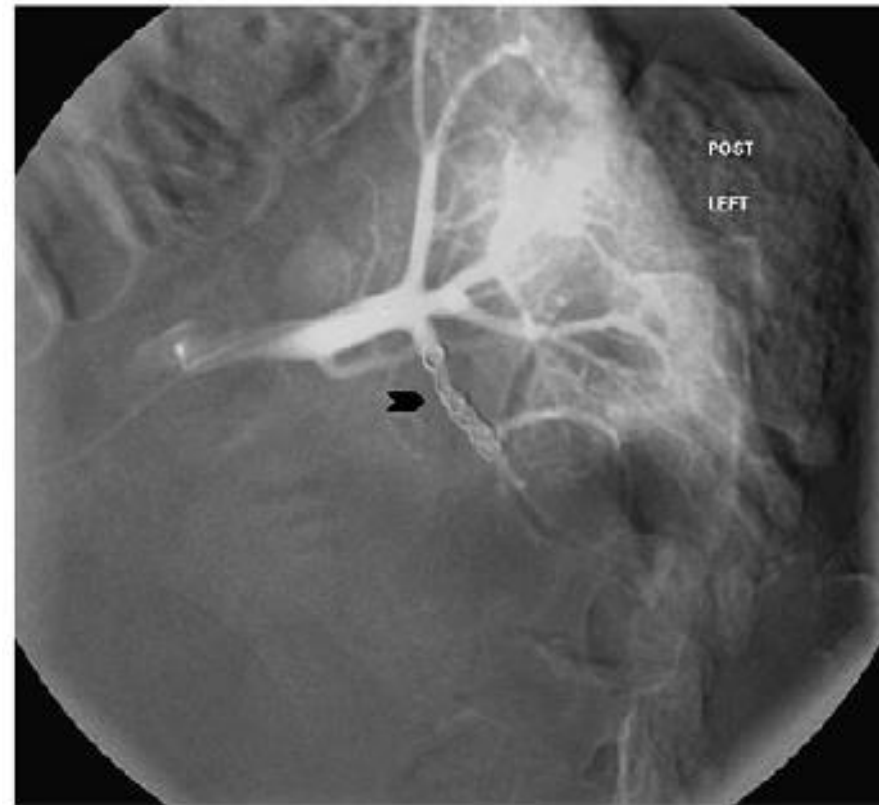
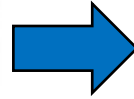
angiography after coil embolization revealed the disappearance of pseudoaneurysm



Treatment of AV fistula and pseudoaneurysm



saccular pseudoaneurysm in the lower segment of the renal artery (arrow).



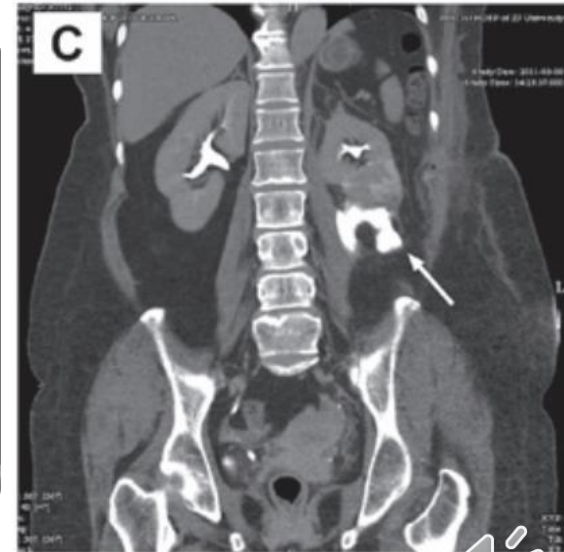
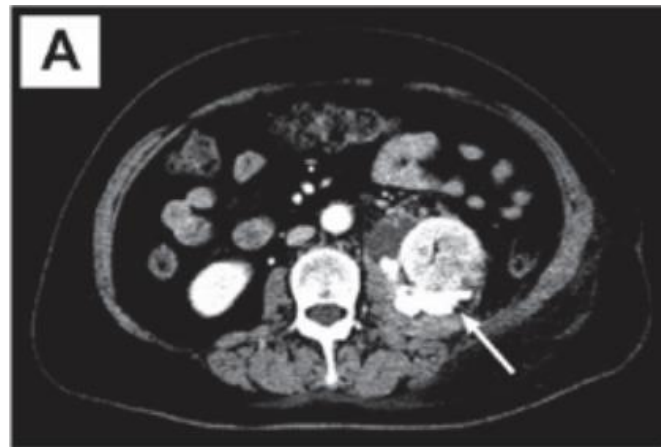
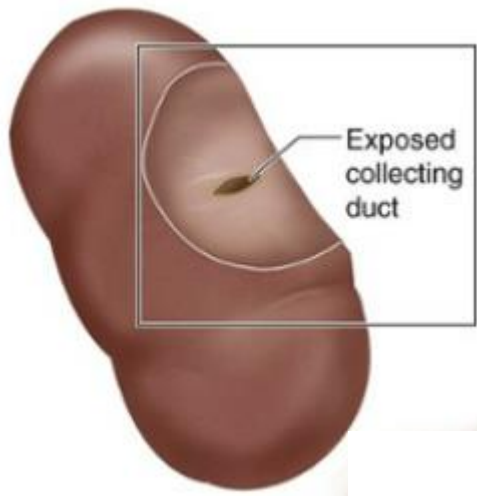
same arterial segment after embolization with microcoils (arrowhead).



Urinary fistula

Definition of urinary fistula

- Urinary fistula (after partial nephrectomy) = urine leakage persisting for > 4 weeks
 - **Early leak:** evident in the recovery room and persist
 - poor collecting system closure or unrecognized collecting system injury
 - this leakage rarely stops within the first few days
 - **Delayed leak:** manifest 5 to 14 days postoperatively and may become symptomatic
 - result of flank pain, fever, or drainage from a port site or incision



Incidence of urinary fistula

- **Open partial nephrectomy (OPN) = 1.1 ~ 17.4 %**
- **LPN = 1.6 ~ 16.5 %**
- but, **RPN = 0.6 ~ 3.0 %** (d/t enhanced visualization and suturing technique)
- In SMC (RPN), **1.0 %** (n=8/1,013); in my case (RPN), **0%, yet** (n=0/260).

Study	Number of patients	Mean (sd) or (range) or (IQR) tumour size, cm	Mean nephrometry score*	Urinary leak rate, %	Notes
OPN					
Redshaw et al., 2014 [16]	175	3.7 (1.9)	NA	1.1	Used ePTFE bolster
Tomaszewski et al., 2014 [20]†	355	3.7 (2.3)	6.1	11.8	
Stroup et al., 2012 [12]†	153	4.2 [‡] (IQR 3.4)	8	9.8	
Kundu et al., 2010 [21]†	1 023	2.6 [‡] (IQR 1.7)	NA	4.6	
Marszalek et al. 2009 [22]†	100	2.9 [‡] (IQR 1.2)	NA	2.0	
Lane et al., 2008 [23]†	169	3.2 [‡] (IQR 2)		4.7	
Gill et al., 2007 [15]†	1 029	3.3 (0.13–9.0)		2.3	
Patard et al., 2007 [24]	1 048	3.4 (2.1)		3.1	
Van Poppel et al., 2007 [25]	268	<5		4.4	
Fergany et al., 2006 [26]	400	4.18 (2.5)		9.0	
Pasticier et al., 2006 [27]	127	3.6 [‡] (1–12)		10.1	Compared elective to imperative PN
Thompson et al., 2005 [18]	823	3.1 [‡] (0.2–22)		1.5	Compared early (1985–1995) to contemporary (1996–2001) PN



Symptoms of urinary fistula

- **Early leak**

- drainage of >30 to 40 mL per shift is noted >48 hours after surgery
- large-volume drain outputs within the first 24 hours

- **Delayed leak**

- flank pain
- fever (infection sign)
- drainage from a port site or incision
- palpable mass



Diagnosis of urinary fistula

- Urine leak beyond 48 h → measurement of drainage Cr level relative to serum
- CT with IV contrast (with delayed images to identify urinary extravasation)

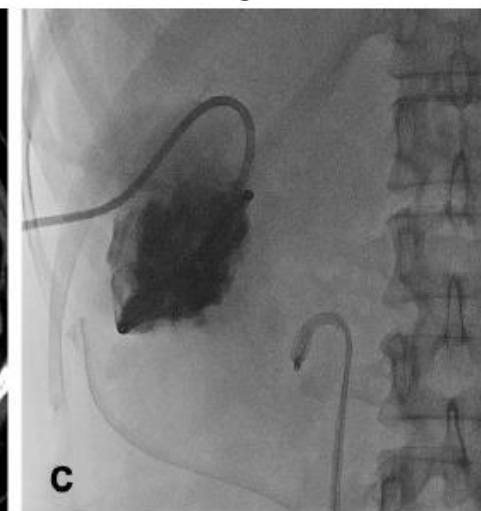
Preop CT scan



CT scan with contrast media



PCD



- If fever (+) → complete blood count, blood and urine cultures, and a chest radiograph to identify other potential sources of infection



Risk factors of urinary fistula

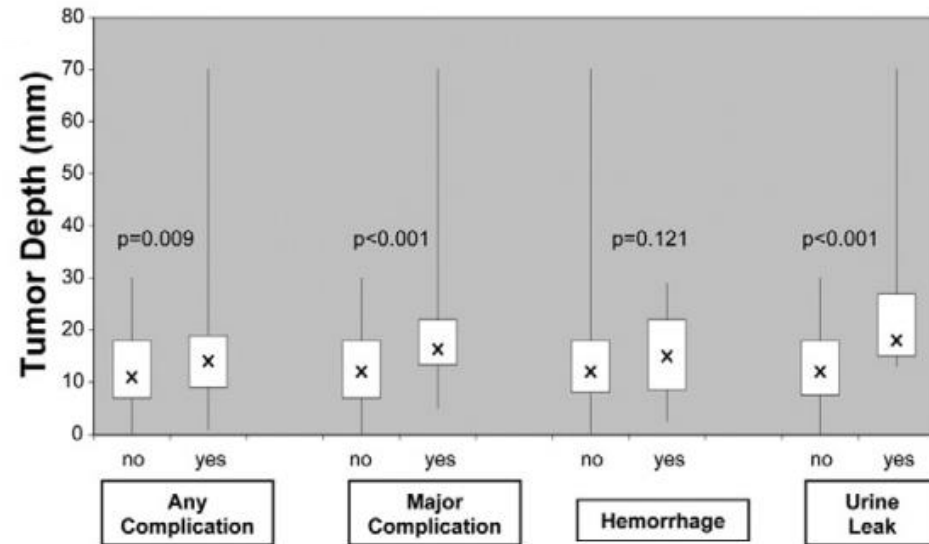
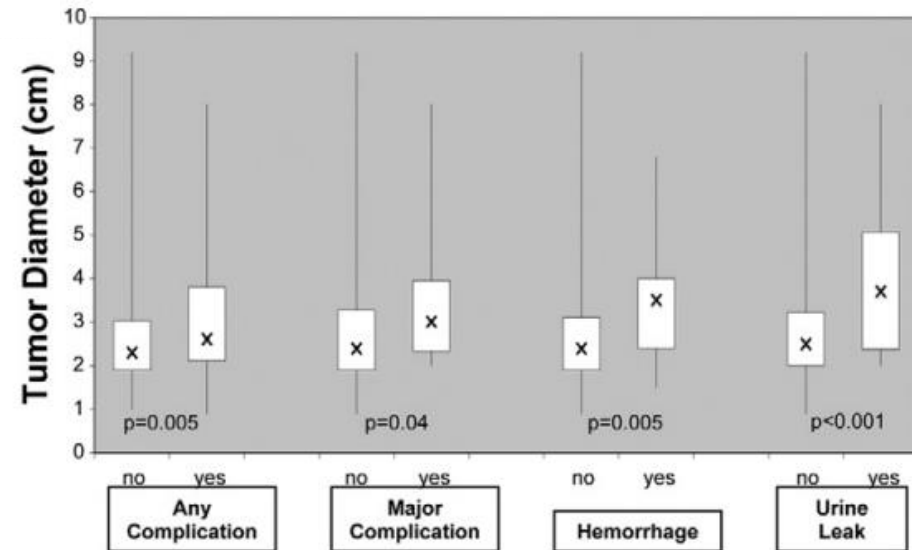
- **Tumor factors:** tumor size, nephrometry score, renal pelvic anatomy
- **Surgical factors:** learning curve, WIT, blood loss, collecting system repair

Study	Tumour size	Nephrometry score	WIT	Blood loss	Collecting system repair	Other
Current study	Y	N	Y	N	Y	Hilar tumour location; operative time
Zargar et al., 2014 [17]	N	N	N	Y	NA	Learning curve, Preoperative eGFR <60 mL/min/1.73 m ² , nearness to collecting system
Tomaszewski et al., 2014 [20]	N	N	Y	Y	Y	Intrarenal pelvis; completely endophytic tumour location
Wheat et al., 2013 [36]	Y	NA	NA	NA	NA	Mean tumour depth; proximity to collecting system
Stroup et al., 2012 [12]	NA	Y	NA	NA	NA	Decreasing body mass index
Wang et al., 2011 [39]	NA	NA	NA	Y	NA	CT angiogram examination
Kundu et al., 2010 [21]	Y	NA	Y	Y	N	
Patard et al., 2007 [24]	Y	NA	NA	NA	NA	Non-elective indication



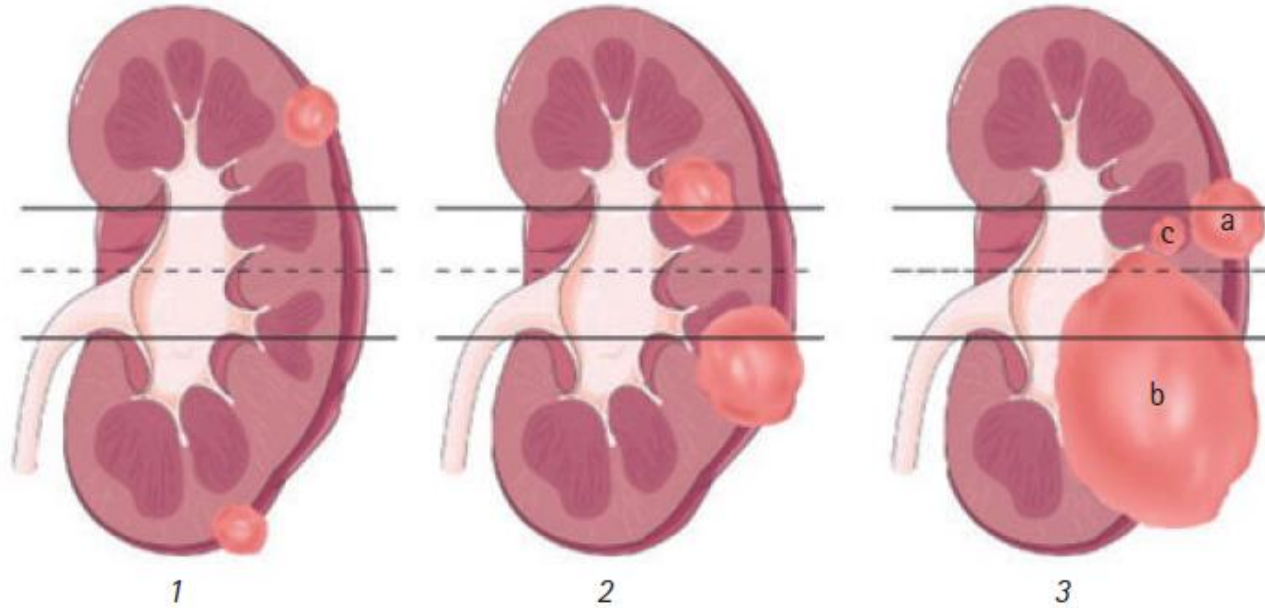
Risk factors of urinary fistula

Complications stratified by tumor diameter and tumor depth



Risk factors of urinary fistula

R.E.N.A.L. Nephrometry Score with scoring of (L)ocation component



Variable	OR	95% CI for OR		P Value
		Lower	Upper	
(E) Urine leak				
RENAL score, continuous	1.56	1.17	2.05	.002
BMI, continuous	0.89	0.795	0.997	.044

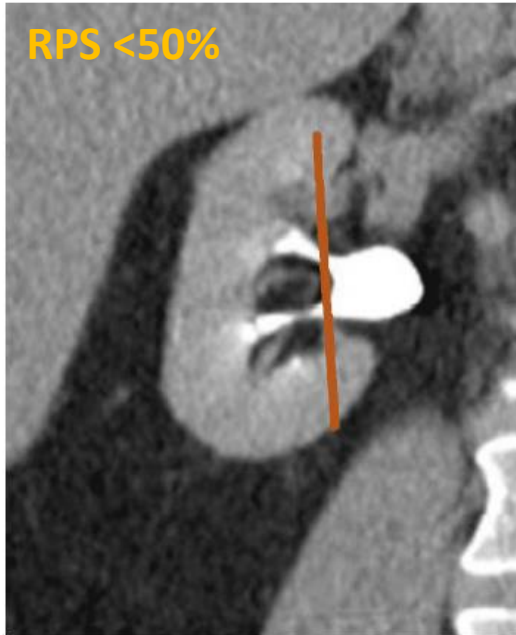
Risk factors of urinary fistula

Multivariable associations of RENAL score components with risk of urine leak using original location

	Cases (N = 31)	Controls (N = 124)	Odds ratio (95% CI)	P value
Radius, n (%)				
≤4 cm	21 (67.7)	97 (78.2)	1.0 (reference)	
>4 to <7 cm	10 (32.3)	27 (21.8)	2.00 (0.51–7.89)	0.323
Exophytic/endophytic properties, n (%)				
≥50% exophytic	3 (9.7)	67 (54.0)	1.0 (reference)	
<50% exophytic	15 (48.4)	34 (27.4)	16.65 (2.75–100.71)	0.002
Entirely endophytic	13 (41.9)	23 (18.6)	17.02 (2.88–100.55)	0.002
Nearness of tumour to collecting system, n (%)				
≥7 mm	6 (19.4)	54 (43.6)	1.0 (reference)	
>4 to <7 mm	4 (12.9)	31 (25.0)	0.57 (0.14–2.35)	0.435
≤4 mm	21 (67.7)	39 (31.5)	1.64 (0.49–5.47)	0.419
Location relative to polar lines (reversed), n (%)				
Mid kidney	10 (32.3)	60 (48.4)	1.0 (reference)	
Crosses polar line	7 (22.6)	26 (21.0)	2.58 (0.72–9.32)	0.148
Polar	14 (45.2)	38 (30.7)	4.34 (1.30–14.53)	0.017

Risk factors of urinary fistula

Extrarenal renal pelvis



Intrarenal renal pelvis



- **Renal pelvic score (RPS)** (N=255)
= % of renal pelvis contained inside volume of renal parenchyma

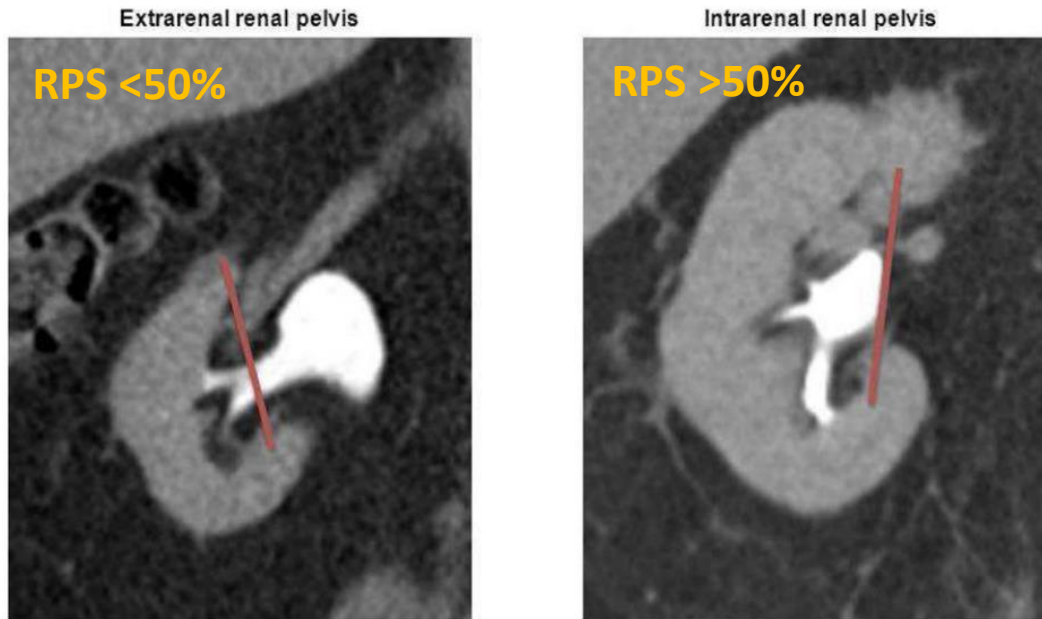
→ intraparenchymal (>50%) or extraparenchymal (<50%) renal pelvis

Variable	OR	95% CI	p value
Intrarenal pelvis	47.3	13.2-169.4	<0.001
NS complexity group	3.2	1.1-9.3	0.031
Charlson comorbidity index	0.99	0.79-1.2	0.904
Collecting system entry	23.9	2.7-215	0.005



Risk factors of urinary fistula

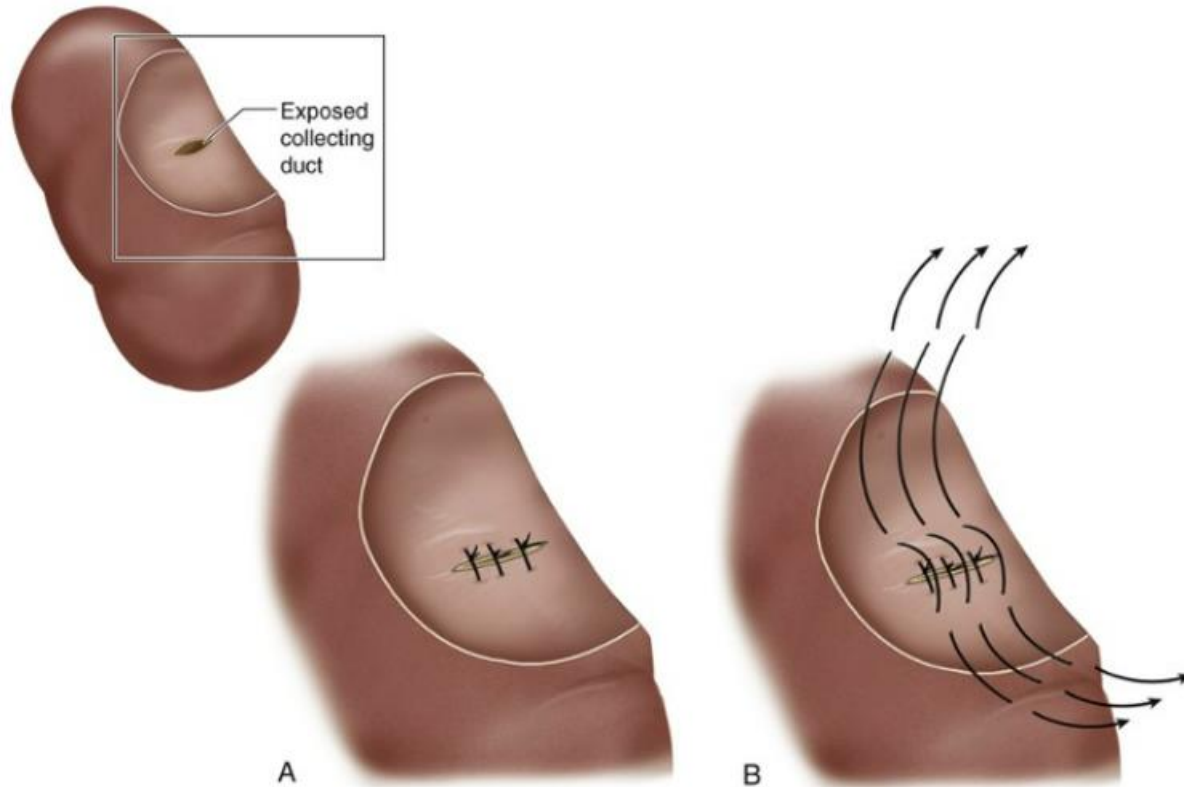
Internal validation of the Renal Pelvic Score (N=831)



Variable	OR	95% CI	p-value
Intrarenal pelvis	24.8	13.2–169.4	<0.001
“E”xophytic/Endophytic score	4.5	1.3–15.5	0.0182
3 (VS. 1)			
Collecting system entry	6.1	2.5–14.9	<0.001



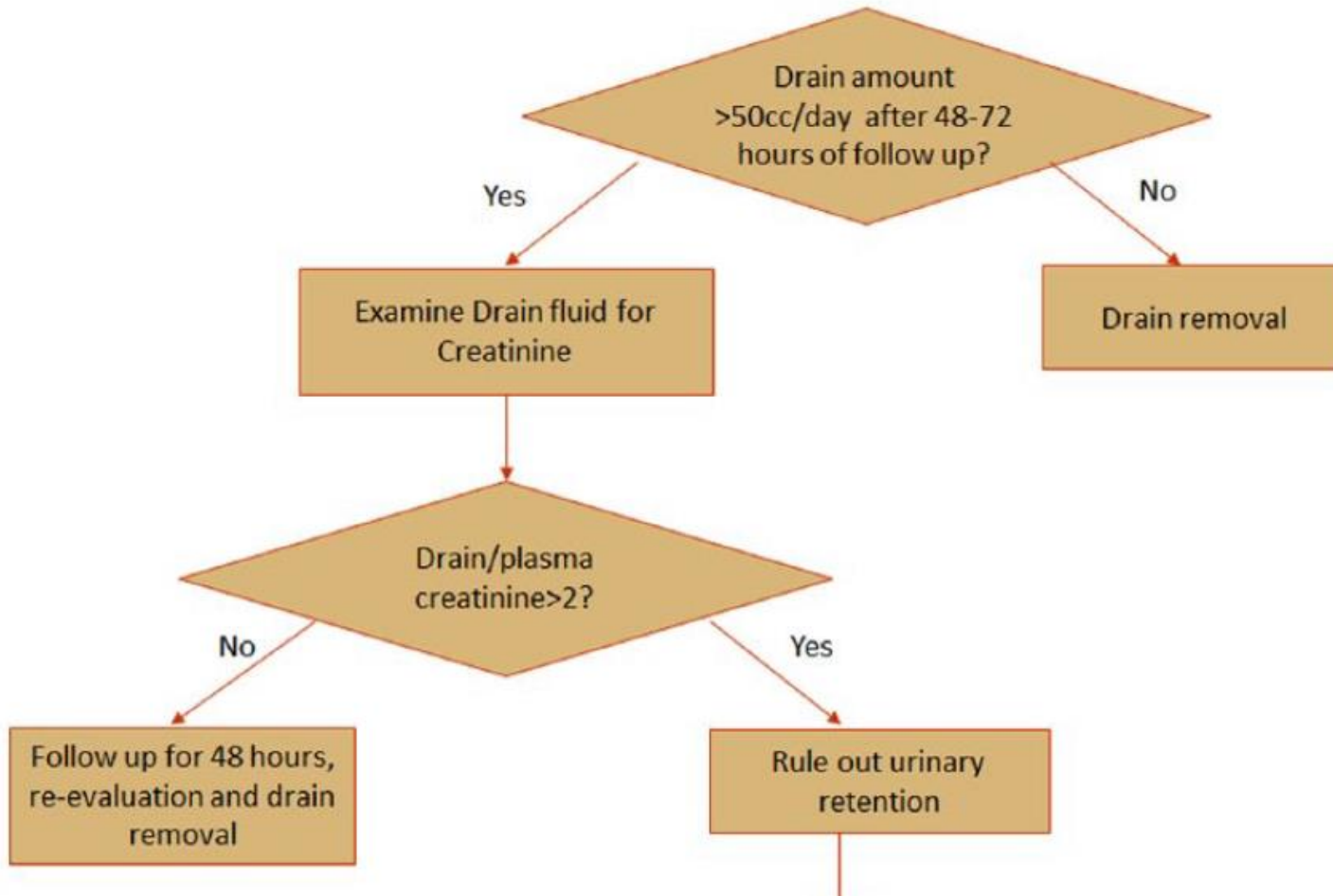
Risk factors of urinary fistula

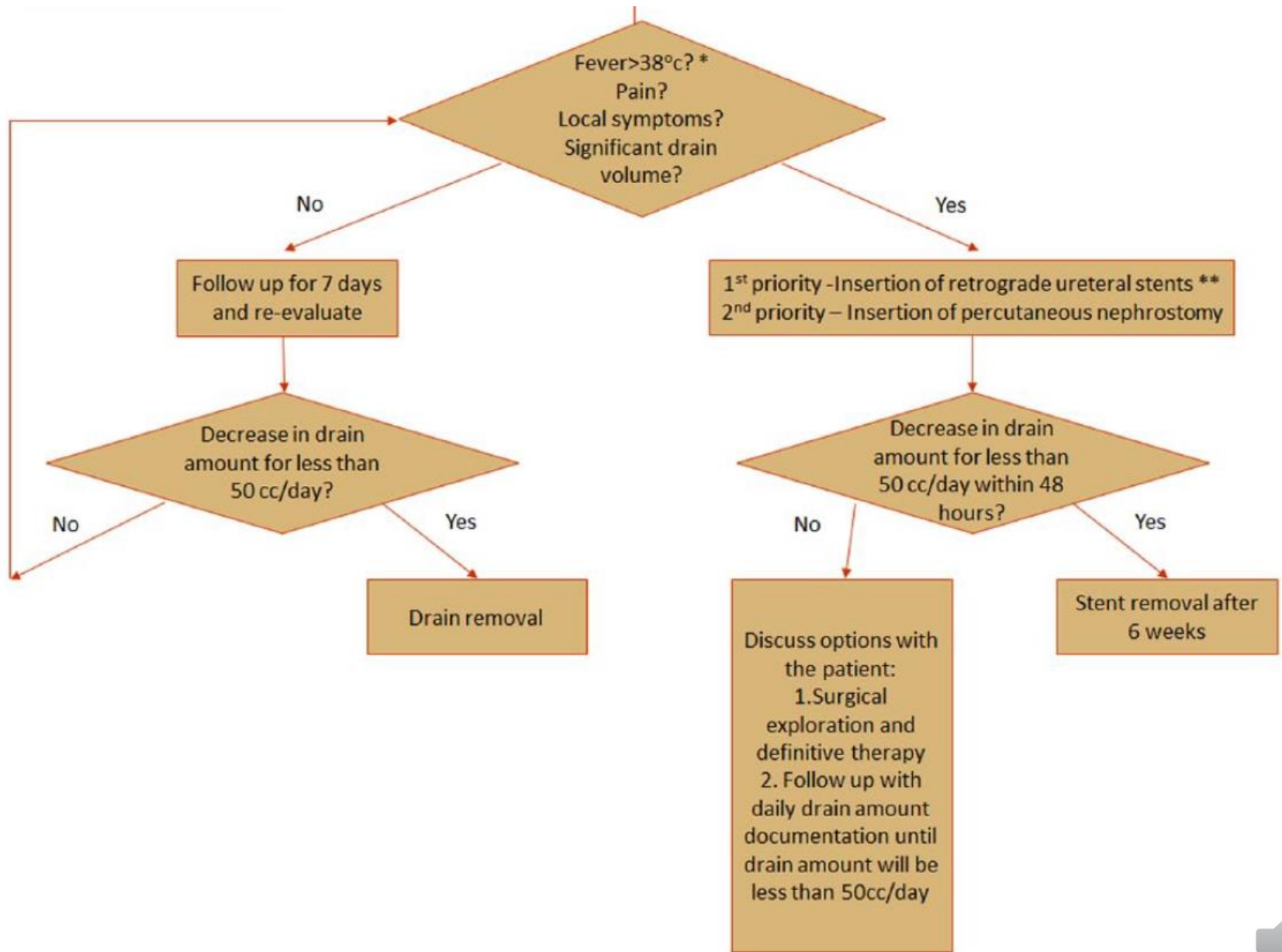


- **Careful closure of the collecting system** generally prevents urine leak.
- If large resection bed, small caliceal injuries may not be identified → often, site of persistent leak.



Treatment of urinary fistula





Treatment of urinary fistula

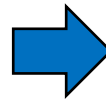
Treatment options for *prolonged leakage* after partial nephrectomy

Article Reference	Treatment Option	Time for Fistula Resolution	Complication	Number of Patients
Aliskafi N.F. et al ⁵	Double drainage	2 wk	None	1
Razzaghi M.R. et al ⁷	Desmopressin inhalation	28 d vs 48 d	1 hyponatremia	16
Meeks J.J. et al ⁸	Percutaneous access with dilatation, 1 patient took benefit from a secondary fulguration of the leaking calyx	2 d and several weeks		2
Bruner B. et al ⁹	Percutaneous access with endoscopic drainage associated. One patient had a balloon dilatation of a stenosis	Quick and several weeks	None	2
French D.B. et al ¹⁰	Fibrin sealant used in a retrograde pattern	Immediate	None	1
Aslan G. et al ¹¹	Endoscopic and percutaneous sealing of a persistent fistula	Immediate	Tip of the catheter remained glued in the kidney	1
Seo I.Y. et al ¹²	Percutaneous fibrin sealant (Tissucol) injection	Immediate	None	1

- **Urine leak rarely requires reoperation**, but in cases of *persistent ureteral obstruction perpetuating the leak, recurrent abscess, or severe intraperitoneal leak (laparoscopic)* → a repeat operation may be necessary.
- In most cases, reoperation for leak results in nephrectomy.



Treatment of urinary fistula



Obvious urinary fistulous tract (arrow) between the renal calyx and urinoma cavity

Urinary fistulous tract was obliterated by multiple coils (arrow), and urinoma cavity (arrowhead) was sealed by NBCA (1:1 mixture with ethiodized oil) injection



Take home messages

After partial nephrectomy...

- **AV fistula and pseudoaneurysm**

- Incidence: 0.4 ~ 5.0%
- Risk factor: endophytic/ posterior tumor, near to collecting system (or sinus), sinus exposure
- Diagnosis: CT (enhanced) & angiography
- Treatment: conservative treatment → selective angioembolization

- **Urinary fistula**

- Incidence: 0.6 ~ 3.0% (particularly, RPN)
- Risk factor: tumor size/depth, R.E.N.A.L score, RPS, learning curve, meticulous closure
- Diagnosis: drain Creatinine, enhanced CT (delayed image)
- Treatment: Proper positioning of drain, DJ stent or PCN > fibrin glue, surgical exploration.