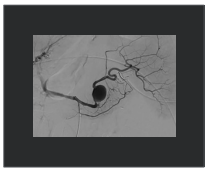
Natural history of untreated visceral and renal artery aneurysms: from large series with mid to long term follow up



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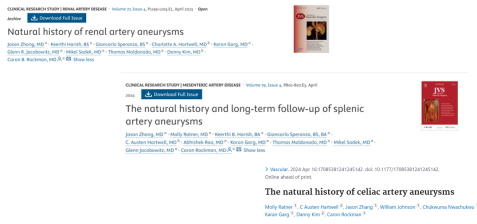

Natural history of renal artery aneurysms

The natural history and long-term follow-up of splenic artery aneurysms

The natural history of celiac artery aneurysms

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Study Objectives

- To elucidate the natural history of initially untreated VAA and RAA
- Most of literature published is regarding treatment, limited data on natural history
- Outcomes focused on incidence of:
  - aneurysm enlargement
  - intervention
  - rupture

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Methods

- Single institution retrospective analyses
- Patients diagnosed with VAA or RAA from 2015-2020 in institutional radiology database
- Imaging studies were reviewed by reading radiologists and study team members

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Results- Splenic Artery Aneurysms

- Total of 853 patients identified
- 514 (60.3%) had both clinical and imaging follow up at a mean of 3.8 years

Follow Up Type (%)	N (%)	Follow Up Duration, years (mean ± SD)
No Follow Up	41 (4.8%)	-
Clinical Only	298 (34.9%)	4.1±4.0
Clinical and Imaging	514 (60.3%)	3.8±2.3
Total	853 (100%)	

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Baseline Characteristics- SAA

Demographics	
Mean age at diagnosis, years	70.9 (28-100)
Female	81.2 %
Comorbidities	
Active Smoking	3.5%
Prior Smoking	32.2%
Hypertension	70.2%
Hyperlipidemia	54.7%
Diabetes Mellitus	21.5%
Coronary Artery Disease	23.7%
Connective Tissue or Rheumatologic Disease	6.1%
Obesity	30.2%
Prior Stroke	7.5%
Peripheral Arterial Disease	4.6%

Demographics	
Immunosuppressive Medications	5.0%
Portal Hypertension	5.6%
Cirrhosis	3.0%
Liver Transplant	.82%
Malignancy	25.3%
Atrial Fibrillation	12.3%
Splenomegaly	1.1%

37 or about 5.3% of the women were of childbearing age

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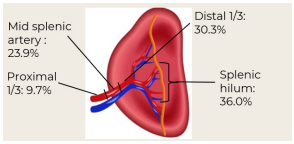
Baseline Characteristics- SAA

Imaging Indications	
Abdominal Pain	37.3%
Follow-up of unrelated pathology	28.0%
Follow-up of visceral aneurysm	8.6%
Other/Unknown	26.1%



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Imaging Characteristics- SAA

Aneurysm Characteristics	
Mean diameter at diagnosis, mm	13.3 ± 6.3
Multiple SAA	41 (4.8%)
Saccular aneurysm	648 (72.4%)
Thrombus	124 (13.9%)
Calcification	792 (88.6%)
Pseudoaneurysm	2 (0.2%)
Aortic atherosclerosis	501 (58.7%)
Abdominal aortic aneurysm	60 (7.0%)
Additional visceral aneurysm	37 (4.3%)

Table II. Splenic artery aneurysm (SAA) characteristics and associated imaging findings

Aneurysm characteristic (N = 890)	Percent of total
Size, mm	
Mean diameter at diagnosis	13.3 ± 6.3
SAA <10	22.7
SAA 10-20	66.6
SAA 20-30	8.5
SAA >30	2.1
Location	
Proximal 1/3 splenic artery	9.7
Mid 1/3 splenic artery	23.9
Distal 1/3 splenic artery	30.3
Splenic hilum	36.0

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Primary Outcomes SAA: Enlargement

- Imaging follow-up of 514 patients
- 122 patients (23.7%) experienced growth
- Average growth: 2.5 mm at mean 3.8 ± 2.3 years

- Annual growth rate stratified by aneurysm size:

- Initial size <10 mm (n=123): 0.166 mm/yr
- ***Initial size 10-19 mm (n=353): 0.172 mm/yr***
- Initial size 20-29 mm (n=34): 0.383 mm/yr
- Initial size >30 mm (n=4): 0.246 mm/yr

- There was no difference in annual growth rate or in percent of patients with growth between the different size cohorts

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Primary Outcomes SAA: Factors Associated with Growth

Characteristic	OR	95% CI	pvalue
Age at diagnosis	0.98	0.96, 1.00	0.093
Female gender	0.78	0.45, 1.39	0.4
Childbearing Age	0.27	0.05, 1.05	0.079
Atrial fib	1.43	0.57, 3.37	0.4
Connective tissue disease or rheumatologic disease	1.11	0.38, 2.83	0.8
Coronary artery disease	1.31	0.75, 2.25	0.3
Diabetes	1.48	0.88, 2.47	0.13
Hypercholesterolemia	0.99	0.62, 1.58	>0.9
Hypertension	1.01	0.58, 1.78	>0.9
Liver transplant	0.14	0.00, 6.81	0.3
Malignancy	1.06	0.51, 2.11	0.9
Obesity	1.40	0.86, 2.26	0.2
Peripheral arterial disease	1.56	0.59, 3.88	0.3
Portal hypertension	2.65	0.92, 7.45	0.067
Prior tobacco use	**1.69**	**1.06, 2.71**	**0.026**
Location	1.06	0.85, 1.32	0.6
Calcification	0.64	0.34, 1.24	0.2
Thrombosis	0.63	0.30, 1.24	0.2

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Primary Outcomes SAA: Intervention

Interventions	N=27 (3.2%)
Indications for Intervention	
Size/growth criteria	19 (70.4%)
Symptom development	5 (18.5%)
Pseudoaneurysm	2 (7.4%)
Intervention Performed	
Embolization	22 (81.5%)
Splenectomy	2 (7.4%)
Bypass	1 (3.7%)
Ligation	2 (7.4%)

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SAA: Women of Childbearing Age

	Women of Childbearing age (n= 35)
Mean aneurysm size (mm)	15.97±7.8 mm
Rupture	1 (2.9%)
Intervention	9 (25.7%)
Aneurysm growth	4 (11.4%)

Table III. Women of childbearing age aneurysm characteristics

Characteristic	Women of childbearing age (n = 35)	Women of nonchildbearing age (n = 657)	*P* value
Mean aneurysm size, mm	15.97 ± 7.8	12.59 ± 5.52	.0004
Rupture, No. (%)	1 (2.9)	0	N/A
Intervention, No. (%)	9 (25.7)	11 (1.7)	<.0001
Aneurysm growth, No. (%)	4 (11.4)	87 (13.2)	.627

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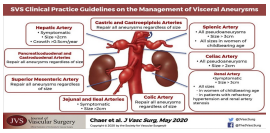
Primary Outcomes SAA: Summary and Conclusions

- 23.7% incidence of enlargement among those with imaging follow up
- 3.2% incidence of intervention among total cohort
- 0.12% incidence of rupture
- Only a minority of women of childbearing age underwent intervention



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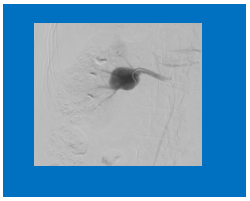
Renal Artery Aneurysms

- Cohort of 331 patients
- Predominantly female (61.3%) with 11 (3.3%) of childbearing age.
- Mean age of diagnosis 71.5 years (range 24-99 years).



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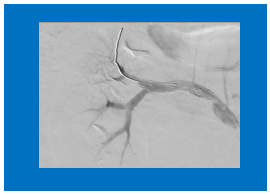
Results: RAA



Follow Up Type (%)	N (%)	Follow Up Duration, months (mean ± SD)
No Follow Up	20 (6%)	-
Clinical Only	174 (53%)	37±26
Clinical and Imaging	137 (41%)	36±20
Total	331 (100%)	

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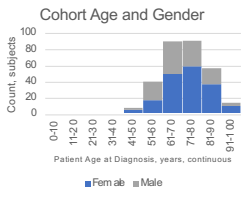
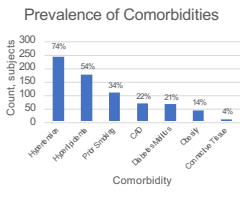
Baseline Characteristics: RAA

Table 1. Demographics of patients with renal artery aneurysm (RAA)

Characteristics	No. of patients (%)
Demographics	
Total patients	331 (100)
Age at initial presentation, years	71.5 ± 12.8 (range, 24-99)
Female	203 (61.9)





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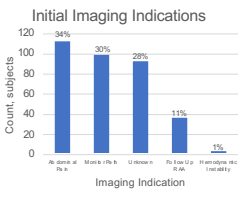
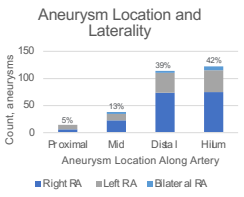
Baseline Characteristics: RAA





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Imaging Characteristics: RAA

Table II. Renal artery aneurysm (*RAA*) characteristics and associated imaging findings

Aneurysm characteristic (n = 338)	Percent of total
Laterality	
Right	61.9
Left	35.1
Bilateral	3.0
Size	
Mean diameter at diagnosis, mm	12.9 ± 5.9
RAA <15 mm	69.9
RAA 15-25 mm	27.1
RAA >25 mm	3.0
Location	
Proximal renal artery	5.2
Mid renal artery	15.1
Distal renal artery	26.7
Renal bifurcation	12.8
Renal hilum	42.4

Characteristics	
Fusiform	72.3
Saccular	27.7
True aneurysm	98.0
Pseudoaneurysm	2.0
Calcification	82.2
Thrombosis	15.9
Dissection	0.9
Rupture	0
Associated imaging findings (n = 331)	
Presence of AAA	19 (5.7)
Atherosclerosis of abdominal aorta/branches	217 (65.6)
Additional visceral aneurysms	24 (7.3)
Additional visceral anomalies other than aneurysm	16 (4.8)

AAA Abdominal aortic aneurysm.

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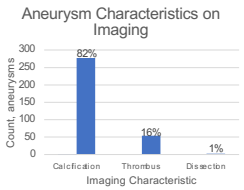
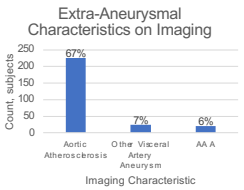
Imaging Characteristics: RAA





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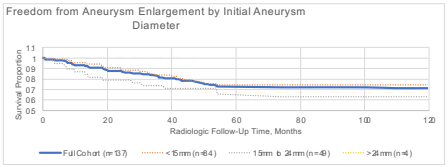
Primary Outcomes RAA: Enlargement



- Mean radiological follow up among 137 patients was 26 ± 21.4 months
- 43 (31/4%) of patients experienced growth; mean rate of 0.23 ± 4.7 mm / year
- Initial diameter of > 25 mm was associated with intervention but not with growth
- 4 / 5 RAAs with initial diameter of > 30 mm did not undergo intervention

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RAA Outcome: Growth, intervention and rupture

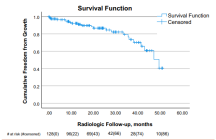

Fig 2. Kaplan-Meier curve showing freedom from growth on radiologic follow-up.

Fig 3. Kaplan-Meier curve showing freedom from intervention or rupture on clinical follow-up.

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Primary Outcomes RAA: Factors Associated with Growth

Univariate Analysis

Factor	Odds Ratio	Significance	95% Odds Ratio CI
Gender	1.54	0.40	(0.57, 4.05)
Age	1.00	0.91	(0.96, 1.04)
Active Smoking	2.23	0.29	(0.51, 9.66)
Prior Smoking	0.87	0.78	(0.34, 2.27)
Hypertension	0.35	0.03	(0.13, 0.91)
Diabetes	0.40	0.16	(0.11, 1.45)
CAD	0.45	0.60	(0.16, 2.23)
PAD	0.82	0.86	(0.09, 7.36)
Hyperlipidemia	0.51	0.16	(0.20, 1.29)
Immunosuppression	0.35	0.32	(0.04, 2.84)
Obesity	3.34	0.03	(1.13, 9.92)
Location	0.94	0.94	(0.54, 1.64)
Thrombosis	0.73	0.64	(0.19, 2.76)
Calcification	0.47	0.15	(0.17, 1.32)

Multivariable Analysis

Factor	Odds Ratio	Significance	95% Odds Ratio CI
Gender	4.24	0.10	(0.75, 23.87)
Age	1.03	0.49	(0.94, 1.13)
Active Smoking	33.03	0.06	(0.83, 1309.89)
Prior Smoking	2.45	0.35	(0.38, 15.84)
Hypertension	0.70	0.75	(0.08, 6.09)
Diabetes	0.07	0.10	(0.00, 1.58)
CAD	0.32	0.38	(0.02, 4.12)
Hyperlipidemia	0.60	0.58	(0.09, 3.78)
Immunosuppression	0.26	0.34	(0.02, 4.13)
Obesity	7.53	0.04	(1.11, 51.2)
Location	0.99	0.97	(0.44, 2.23)
Thrombosis	1.16	0.90	(0.11, 12.67)
Calcification	0.20	0.15	(0.02, 1.83)

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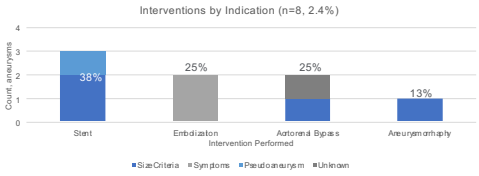
Primary Outcomes RAA: Intervention



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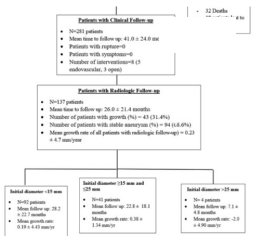
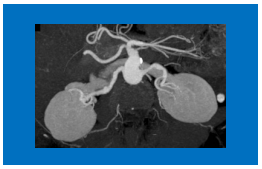
Primary Outcomes RAA: Summary and Conclusion

- 31% incidence of enlargement among those with imaging follow up
- 2% incidence of intervention among total cohort
- Of 4 RAAs with initial diameter of >30 mm who did not undergo intervention, none ruptured over mean follow up of 24 months
- 0% overall incidence of rupture



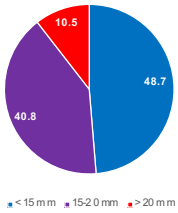
Celiac Artery Aneurysms

- 76 patients identified
- 86.8% male, mean age 69.8 years
- 76.3% saccular, but all radiologically classified as true aneurysms.
- Most common comorbidities
- Hypertension (64.5%)
- Hyperlipidemia (46.1%)
- Prior tobacco use (34.2%)



CAA: imaging characteristics

- Most common indication for imaging : follow up other intraabdominal pathology
- Mean diameter 15.4 ± 3.8 mm
- 23.7% saccular
- Concomitant AAA 13.2%
- Additional VAA 10.5%
- Visceral artery anomalies 11.8%
- Only 47.4% referred for vascular surgical consultation



CAA: outcome

- Clinical follow up mean 31.2 months ±21.6 months
- No patients developed symptoms or rupture
- Mean radiological follow up among 45 patients was 25.2 months
- 16 patients (35.6%) enlarged
- One patient underwent intervention for increasing size in the setting of chronic dissection

Table 3. Univariate analysis of patient and aneurysm characteristics on CAA growth.

Variable	Odds ratio	95% confidence interval	p value
Age ≥70	**0.087**	**0.02–0.46**	**.004**
Gender	2.083	0.44–9.79	.35
Prior or current tobacco	1.636	0.48–5.62	.43
Hypertension	0.530	0.14–1.99	.35
Coronary artery disease	0.375	0.07–2.03	.26
Hypercholesterolemia	1.378	0.40–4.70	.61
Obesity	2.00	0.35–11.32	.43
Thrombosis	0.417	0.04–4.09	.45
Calcification	0.982	0.28–3.46	.98
Initial diameter >20 mm	1.442	0.28–7.44	.66

27

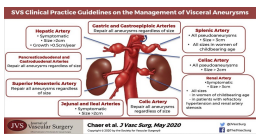
CAA: outcome

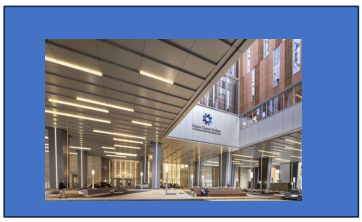
Table 4. Multivariate regression analysis of patient and aneurysm characteristics on CAA growth.

Factor	Odds ratio	95% confidence interval	p value
Age ≥70	**0.027**	**0.01–0.31**	**.004**
Gender	5.365	0.54–53.10	.151
Prior or current tobacco	0.673	0.09–5.03	.700
Hypertension	2.457	0.27–22.10	.438
Coronary artery disease	0.322	0.04–2.83	.307
Hypercholesterolemia	2.251	0.34–14.73	.397
Obesity	3.260	0.19–57.39	.522
Thrombosis	0.917	0.03–28.08	.960
Calcification	1.333	0.16–11.25	.791
Initial diameter >20 mm	0.205	0.02–2.48	.205

Conclusions

- Asymptomatic visceral aneurysms are usually indolent
- 1 rupture / 1260 patients = 0.07%
- 36 interventions / 1260 patients = 2.8%
- Most do not require intervention
- SVS guidelines seem reasonable…..
- However, all of these lesions need individualized patient care with attention paid to etiology, morphology, burden of follow up, and options for intervention





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