Title

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Journal

Journal of Surgical Research, 295

ISSN

0022-4804

Authors

Shakir, Mustafa N

Woods, Alexis L

Sun, Kiyomi A

et al.

Publication Date

2024-03-01

DOI

10.1016/j.jss.2023.09.064

Revised Manuscript – Marked 9/8/23

Incidence, Presentation, and Natural History of Adrenal Hemorrhage: An Institutional Analysis

Mustafa N. Shakir, BS,[a] Alexis L. Woods, MD,[b] Kiyomi A. Sun, BS,[b] Roger E. Goldman, MD, PhD, [c]
Michael J. Campbell, MD, [b] Michael T. Corwin, MD, [c] Claire E. Graves, MD [b]

a. University of California Davis School of Medicine, Sacramento, CA, USA
b. Department of Surgery, University of California Davis, Sacramento, CA, USA
c. Department of Radiology, University of California Davis, Sacramento, CA, USA

Short Title: Incidence and Natural History of Adrenal Hemorrhage

Meeting Presentation: This study was presented as an oral podium presentation at the American College of Surgeons Clinical Congress in San Diego, CA, October 17, 2022.

Author Contributions: MNS, CEG, MJC, and MTC contributed to conception and design of the study. MNS and KAS acquired and compiled the data, which was analyzed by MNS and CEG. MNS, ALW, and CEG drafted the article, with content

analysis and critical revisions by REG, MJC, and MTC. All authors provided final approval of the article in its current form.

Corresponding Author:
Claire E. Graves, MD
4501 X Street, Suite 3010
Sacramento, CA 95817
Phone 916-734-0133
Fax 916-703-5267
cegraves@ucdavis.edu

Abstract:

Background

Adrenal hemorrhage (AH) can occur due to multiple etiologies with variable radiographic appearance, often indistinguishable from underlying adrenal neoplasms. There is a lack of AH literature and evidence-based guidelines. Our study aimed to understand the prevalence and etiology of AH, follow-up, and incidence of underlying neoplasm.

Materials and Methods

An institutional database was queried from 1/2006 to 10/2021 for patients with AH on imaging, excluding patients with known malignancies, adrenal masses, or prior adrenal surgery. Demographics, medical history, hematoma size, laterality, biochemical evaluation, intervention, and additional imaging were reviewed.

Results

Of 490,301 imaging reports queried, 530 (0.11%) with AH met inclusion criteria. Most imaging (n=485, 91.5%) was performed during trauma evaluation. Two patients underwent dedicated intervention at presentation. Interval imaging was performed in 114 (21.5%) patients at a median of 2.6 (IQR 0.99-13.4) months, with resolution (n=84,73.7%) or decreased size of AH (n=21, 18.4%) in most patients. Only 10 patients (1.9%) saw an outpatient provider in our system to address AH or evaluate for underlying mass, and 9 (1.7%) underwent biochemical screening. Thirteen patients (11% of 118 patients with any follow-up) had evidence of an

adrenal mass, confirmed on serial imaging (n=10) or adrenalectomy (n=3). Scans performed for non-trauma indications were significantly more likely to have an underlying mass (n=6/26 (23.1%)) than those performed for trauma evaluation (n=7/92 (7.6%), p=0.04).

Conclusion

AH is a rare finding associated with an increased rate of underlying adrenal mass compared to adrenal incidentaloma, particularly when unrelated to trauma. Most AH resolves spontaneously without intervention. Follow-up imaging at 6 months can help distinguish mass-associated AH from simple hemorrhage.

Keywords: adrenal hemorrhage, adrenal hematoma, adrenal bleed, adrenal incidentaloma, adrenal tumor, adrenal mass

Introduction

Adrenal hemorrhage (AH) can occur as a result of trauma, as well as non-traumatic etiologies including infection, coagulopathy, severe stress, or an underlying neoplasm.[1–3] While bilateral AH can be life-threatening and lead to acute adrenal insufficiency,[3] unilateral AH is often clinically silent. With the increasing use of diagnostic imaging, particularly computed tomography (CT), identification has become more frequent.[4–6] The radiographic appearance of AH can vary widely and is often indistinguishable from adrenal neoplasms or concurrent AH within an underlying neoplasm.[7] Determining the underlying etiology of AH is important in order to diagnose possible primary or metastatic adrenal neoplasm.[5,8–10] One literature review found that 83% (110/133) of patients with spontaneous AH had an adrenal neoplasm, of which 48% were pheochromocytoma and 20% were malignant lesions including adrenocortical carcinoma or metastatic disease.[11]

While there are standardized guidelines on the evaluation and management of adrenal incidentalomas,[12–14] there is a lack of research and evidence-based guidelines on AH. Given the paucity of data on this topic, we performed a retrospective analysis of AH at our institution. Our study aimed to determine the prevalence and etiology of AH, the rate of follow-up, the incidence and type of underlying neoplasm, and patient outcomes.

Methods

This study is a retrospective cohort analysis of patients with evidence of AH on imaging performed from January 2006 to October 2021 at our institution, a quaternary care academic health center with high volume endocrine surgery practice and level one trauma center. This study was approved by our institutional review board, which allowed for waiver of informed consent. An institutional database was queried for any radiology report containing the words “adrenal” and “hematoma” or “hemorrhage” within three words of each other. This method was chosen based on our group’s previous experience with our institutional database,[15,16] and a relatively specific query was chosen due to the relatively high frequency of the words “hematoma” and “hemorrhage” in the database. A secondary screening of all identified reports was performed manually to confirm the read suggested adrenal hemorrhage or hematoma. Any inpatient or outpatient cross-sectional CT imaging that visualized the adrenal glands, including chest, abdominal, or spinal CT was included. If multiple studies were performed within 24 hours, with a different scan ruling out AH, that patient was excluded. To focus this study on patients with “de novo” adrenal hemorrhage, patients with prior known adrenal masses, history of adrenal surgery, and known malignancy

were also excluded, as these factors change the index of suspicion for adrenal mass, and therefore clinical decision-making.

Electronic charts of identified patients were reviewed for data including patient demographics and medical history, size of hematoma, laterality, biochemical evaluation, and follow-up, including intervention and additional imaging. Interval imaging was defined as additional cross-sectional imaging (CT or MRI) that included the adrenal glands performed at least 21 days after index imaging. This 21-day period was chosen based on our aim to capture scans that were outside of the immediate surveillance period (e.g. for immediate surveillance of traumatic hemorrhage) and that we thought would be able to capture evolution of hemorrhage. For patients with more than one additional scan after the finding of AH, we collected data on the first scan after the 21-day interval and the most recent applicable study in our system. Using the hospital's picture archiving and communicating system (PACS), interval imaging without documented resolution of hemorrhage underwent dedicated review by an attending radiologist with adrenal expertise for evidence of underlying mass.

All data was collected and recorded using Research Electronic Data Capture (REDCap).[17] STATA software (StataCorp LLC, College Station, TX, USA) was used to calculate all statistics. Interval data between groups was analyzed using the Wilcoxon rank sum test, and categorical data was analyzed with Pearson's chi

square analysis. Fisher's exact test was used if more than 20% of an analysis table's cells had expected frequencies of less than five. Significance was set at $P < 0.05$. Time to resolution data was generated using Kaplan-Meier survival analysis via Prism 9 (GraphPad, San Diego, CA, USA). Only patients with interval imaging were included in this analysis. Scans with hemorrhage resolution were counted as having a resolution "event," while interval scans without demonstrated resolution were considered a censored observation.

Results

Index Imaging and Presentation

A total of 490,301 imaging reports were queried from our database, yielding 778 possible scans from our search criteria. Secondary manual screening confirmed a total of 579 reports describing AH. After excluding 17 patients with known adrenal masses on prior imaging, 12 patients with prior adrenal surgery, 19 patients with known history of malignancy, and one patient with same-day repeat contrast-enhanced imaging clearly ruling out hemorrhage, 530 (0.11%) scans reported evidence of AH. Imaging was predominately contrast-enhanced CT abdomen with or without pelvis (n = 500, 94.3%, Supplementary Table 1). Most scans (n=485, 91.5%) were performed during trauma evaluation, predominately following motor vehicle collision (n=292, 55.0% of trauma scans) or pedestrian or

bicycle struck by a motorized vehicle (n=90, 17.0% of trauma scans). Of the 213 scans that included measurements, the median maximum diameter of AH was 3cm, with an interquartile range (IQR) of 2.3 - 3.7cm. Full cohort characteristics are described in Table 1.

Two patients underwent dedicated intervention at the time of presentation. One patient, who presented as a trauma with multiple stab wounds, had down trending hemoglobin and active extravasation on CT into a hematoma of the left adrenal gland. Supraceliac angiography also demonstrated contrast extravasation in the region of the left adrenal gland, which was embolized. The patient stabilized and was discharged home after a 7-day hospitalization. No interval imaging was obtained. The second patient had a 9.8cm left adrenal hematoma (no prior trauma, presumed spontaneous) and developed fever and leukocytosis concerning for infection. This patient underwent percutaneous aspiration, with cytology demonstrating “hemorrhagic fibrinous material with histiocytes and neutrophils.” The patient was discharged the day after the procedure, and follow-up CT 5 months later showed a 2.7cm evolving hematoma with peripheral calcification.

Follow-up

A total of 114 (21.5%) patients had interval imaging at our institution at least 21 days

after index imaging. Initial follow-up imaging was performed at a median of 2.6 (IQR 0.99-13.4) months after the index scan. The majority of scans were abdominal (+/- pelvis) CT with contrast (n = 94, 82.5%), and only two patients (1.8%) received dedicated adrenal-protocol CTs (Supplementary Table 1). Forty-six patients (8.9% of total cohort) had more than one follow-up scan, with their most recent imaging at a median of 15.9 (IQR 4.3 – 100.9) months after the index scan. The longest interval was 14.6 years. Patients with non-trauma index scans were more likely to have interval imaging (23/45 , 51.1% vs. 91/485, 18.8%, $p < 0.01$), and AH measuring larger than 3cm were more likely to receive interval imaging than those 3cm or smaller (36/102, 35.3% vs. 23/111, 20.7%; $p = 0.02$).

On follow-up imaging, 84 patients (73.7%) demonstrated resolution of hemorrhage at a median of 8.3 (IQR 2.5 – 30.7) months after the index scan. Figure 1 demonstrates our time to resolution Kaplan-Meier plot. A representative example of index imaging and resolution is shown in Figures 2a and 2b, respectively. An additional 21 patients (18.4%) showed decreased size of hemorrhage at a median of 1.5 (IQR 1.1-3.6) months following the index scan. There was no difference in resolution or decreased size between patients with AH larger than 3cm and those 3cm or smaller (33/36, 91.7% vs. 18/23, 78.3%, $p=0.14$).

Very few patients (10/530, 1.9%) had a note in our system by an outpatient provider that addressed the hemorrhage or possibility of adrenal mass for follow-

up evaluation. These visits were distributed amongst multi-disciplinary providers: surgeon (4 patients), primary care provider, including family medicine or internal medicine practitioner (4 patients), and endocrinologist (2 patients). Only 9 patients (1.7%) had blood and/or urine tests performed for evaluation of adrenal function, with 4 performed during the acute presentation and 5 performed at outpatient follow-up. Only one patient had clear evidence of abnormal function with markedly elevated plasma metanephrines; this patient ultimately had a confirmed pheochromocytoma on pathology following surgical resection.

Patients were more likely to have a follow-up visit or imaging if the radiologist noted concern for an underlying mass on their index imaging (41/118 (34.8%) vs. 77/412 (18.7%), $p<0.01$) or if a recommendation for additional evaluation was explicitly stated in the report (27/74 (36.5%) vs. 91/456 (20.0%), $p<0.01$).

Confirmed Adrenal Masses

Thirteen patients (11.0% of the 118 patients with any clinical or imaging follow-up) had confirmed evidence of an adrenal mass, either on serial imaging (n=10) or at adrenalectomy (n=3). One patient was found to have an adrenal adenoma contralateral to the side of AH. Imaging characteristics and biochemical

workup (when applicable) of patients with confirmed masses are described in Table 2.

The final pathology of the three resected glands demonstrated one adrenocortical carcinoma, one pheochromocytoma, and one ganglioneuroma. The first patient was a 44 year-old man who presented with acute flank pain and emesis, found to have a 13.4cm left-sided AH with high suspicion for underlying mass. He was followed outpatient by endocrine surgery with normal biochemical evaluation and repeat imaging 6 weeks after initial presentation that showed resolving hematoma posteriorly but enhancement anteriorly that was concerning for underlying mass of at least 6cm. He underwent open adrenalectomy 2 months after initial presentation, with pathology confirming adrenal cortical carcinoma with oncocytic features. The second patient was a 43 year-old woman who presented with right flank pain, headache, and hypertension and was found to have a 3cm heterogeneous right adrenal mass with surrounding fat stranding. Biochemical evaluation was significant for elevated plasma and 24-hour urine metanephrine and normetanephrine, consistent with pheochromocytoma. She was started on alpha blockade with doxazosin, increasing doses over two weeks, then underwent laparoscopic adrenalectomy approximately one month after initial presentation. Pathology confirmed a pheochromocytoma, Pheochromocytoma of the Adrenal gland Scaled Score (PASS) = 2. The third patient was a 12-year-old girl

who presented with acute left upper quadrant pain, nausea, and emesis, and was found to have a ruptured ovarian cyst and 5.4cm left adrenal hemorrhage vs. mass on ultrasound and subsequent CT. MRI was performed two days after admission, consistent with indeterminate, mildly enhancing adrenal mass. She was followed by pediatric surgery, and biochemical evaluation demonstrated normal urine cortisol and metanephrines. Resection was recommended based on size of mass, and she underwent laparoscopic left adrenalectomy 3 weeks after presentation. Final pathology was consistent with a ganglioneuroma.

The subset of patients with follow-up evaluation, with and without underlying mass, is described in Table 3. Patients with index scans performed for non-trauma indications were significantly more likely to have an underlying mass (n=6/26 (23.1%)) than those performed for trauma evaluation (n=7/92 (7.6%), p=0.04). Patients with an underlying mass were also more likely be non-Hispanic or Latino (p = 0.01) and to have a left-sided AH (p = 0.04). The majority of patients with an underlying mass were noted to have concern for a mass on their index imaging and were recommended to undergo additional evaluation (76.9%, 10/13). This was significantly higher than those without an underlying mass who were noted to have concern for mass (29.5%, (31/105)) or were recommended to undergo additional imaging (16.2% (17/105), $p<0.01$ for both.

Discussion

In this study, we aimed to determine the prevalence and etiology of AH, the rate of follow up, the incidence and type of underlying mass, and patient outcomes at our high-volume trauma and endocrine surgery center. AH was a rare phenomenon that was present in 0.1% of CT scans performed over a nearly sixteen-year interval. Our cohort consisted predominately of trauma-associated AH (91.5%), which correlates with the most common etiology of AH reported in the literature,[18] as well as our institution's position as a high-volume trauma center. The rate of underlying mass in our cohort overall was low at 2.3%, but this was limited by a low rate of follow-up, including imaging and/or outpatient clinical evaluation, of 22.3%. Focusing on only patients with follow-up, the rate of underlying mass was 11%. Patients with AH identified on a non-trauma-related index scan were significantly more likely to have an underlying mass than those with trauma-related AH (23% vs. 8%). Notably, both rates are higher than the recently-reported prevalence of adrenal incidentaloma in the general population, 0.5-1.4%.[19,20] While most identified masses were consistent with adenoma or presumed benign due to stability on serial imaging, our cohort included an adrenocortical carcinoma, which is associated with significant mortality, and a pheochromocytoma, which is associated with significant clinical morbidity, risk of malignancy, and is often heritable.[14]

Due to the heterogeneous appearance of AH on imaging, a single study is often insufficient to differentiate AH from adrenal neoplasms or coexisting AH and neoplasm. Most CT examinations performed for trauma or abdominal pain are acquired during a single phase after IV contrast administration, and differentiation between high density blood and an enhancing mass can be challenging or impossible. Comparison to prior and follow-up imaging can evaluate the expected evolution of AH, including decrease in size and attenuation, liquification, calcification, and often complete resolution over time.[6,7] In this retrospective study, 74% of patients with follow-up imaging demonstrated complete resolution of AH at a median of 8.3 (IQR 2.5 – 30.7) months. Based on this data, our practice in our endocrine surgery team is now to recommend follow-up imaging with an “adrenal protocol” CT approximately 6 months after a finding of AH. Our adrenal protocol specifies an upper abdominal scan with fixed kVp of 120 and slices of 1-3mm with an unenhanced phase, IV contrast injection with 100mL of Omnipaque-350 (GE Healthcare, Chicago, IL) at a rate of 2.5 mL/second, portal venous phase 70 seconds after contrast injection, and a 15-minute delayed phase. Interval imaging that is suspicious for an underlying mass is then treated according to guidelines for adrenal incidentalomas with imaging characterization and biochemical evaluation.[13,14] Imaging consistent with resolving hemorrhage is again followed at 6-month intervals until complete resolution is demonstrated. A shorter interval for

repeat imaging is recommended if the imaging findings have any features that raise concern for an adrenocortical carcinoma, which can present with intratumoral bleeding, particularly central areas of necrosis and hemorrhage, with contrast retention on delayed contrast-enhanced CT.[21–23] Though patients with known malignancies were not evaluated in this study, the adrenal gland is a common site for metastases, particularly in melanoma and lung, renal cell, breast, and colon cancer.[11] Patients with AH should be asked about history of malignancy, and positive history should raise suspicion for metastatic lesions and shorter interval imaging to evaluate for growth.

The characteristics of our trauma-related cohort support previous analyses of trauma populations, indicating that AH is relatively rare, most commonly seen as the result of blunt trauma such as motor vehicle collisions, predominately right-sided, and associated with other injuries.[4,24–27] Dedicated adrenal acute intervention was rare (2/530, 0.4%) and performed only in the setting of secondary infection of a hematoma or penetrating trauma to the adrenal gland resulting in persistent active bleeding. Though clinically significant, isolated persistent hemorrhage of the adrenal is uncommon, both due to the frequency of coexisting injuries requiring intervention and the typically self-limited nature of AH, adrenal angiography and embolization is an effective minimally-invasive alternative to surgical exploration, as demonstrated in our patient.[28,29]

Our study had multiple limitations. As a retrospective cohort analysis, this study was unable to examine the true natural progression of an adrenal hematoma over time and was limited to often unrelated follow-up imaging at nonstandard time intervals. As our institution is a high-volume level one trauma center, trauma-associated index imaging was predominant in our cohort, with a relatively small volume of non-trauma AH patients. This cohort was also selected based on radiology reports, with no dedicated overreads of the index imaging. Though all reports were signed by an attending radiologist per institutional protocol, variations or mistakes in reporting may have led to selection bias.

Finally, the rate of follow-up in this study was low, at 22%, which limited our evaluation of these patients' AH and clinical course. One factor related to this low rate may be the high proportion of trauma patients, who may have been acutely evaluated at our trauma center and had follow-up elsewhere. An institution-wide prospective study of AH is warranted to better evaluate the natural history of hemorrhage and true rate of underlying masses. Notably, patients were more likely to have a follow-up outpatient visit or imaging if their index imaging report specified concern for an underlying mass or explicitly recommended additional evaluation. This again highlights the effectiveness of clear recommendations in radiology reports and suggests that standardized report macros may be useful in improving follow-up of AH. This intervention has been previously demonstrated by

our group in increasing adherence to clinical guidelines for evaluation and follow-up of adrenal incidentalomas.[30]

Conclusions

AH is a rare imaging finding associated with an increased rate of underlying adrenal mass, particularly when identified on imaging unrelated to trauma. Most AH resolves spontaneously without intervention. Follow-up imaging can evaluate for signs of hemorrhage evolution to distinguish simple hemorrhage from mass-associated hemorrhage and should be considered at an interval of approximately 6 months from index imaging.

Acknowledgements

This project was supported in part by the National Center for Advancing Translational Sciences (NCATS), National Institutes of Health (NIH), through grant UL1 TR001860.

Disclosures

MTC is a consultant for Corcept Therapeutics. The remaining authors report no proprietary or commercial interest in any product mentioned or concept discussed in this article.

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TABLES

Table 1: Characteristics of patients with adrenal hemorrhage on imaging performed for trauma and non-trauma indications. Percentages are out of column header denominator, except as noted. AH= adrenal hemorrhage

Patient Characteristic	**Full Cohort** (n= 530)		**Trauma** (n= 485)		**Non-Trauma** (n=45)		**P-value**
Age, years, median (IQR)	36	(17-53)	34	(17-51)	44	(32-62)	<0.01
Male, n (%)	347	(65.5)	331	(68.3)	16	(35.6)	<0.01
Race, n (%)							0.2
White	196	(37.0)	176	(36.3)	20	(44.4)	
Black	33	(6.4)	28	(5.8)	5	(11.1)	
Asian	22	(4.2)	22	(4.5)	0	(0)	
American Indian or Alaska Native	6	(1.1)	6	(1.2)	0	(0)	
Native Hawaiian or Other Pacific Islander	6	(1.1)	4	(0.8)	2	(4.4)	
More than one race	4	(0.8)	3	(0.6)	1	(2.2)	
Unknown/Not Reported/Missing	263	(49.6)	246	(50.7)	17	(37.8)	
Ethnicity, n (%)							0.8
Not Hispanic or Latino	273	(51.5)	248	(51.1)	25	(55.6)	
Hispanic or Latino	106	(20.0)	98	(20.2)	8	(17.8)	
Unknown/Not Reported/Missing	151	(28.5)	139	(28.7)	12	(26.7)	
BMI, kg/m^2, median (IQR)	27.3	(24.0-31.7)	27.2	(24.0-31.6)	29.0	(25.1-34.9)	0.3
Antihypertensive medication, n (% of patients with known medications)*	47	(11.0)	31	(6.4)	16	(35.6)	<0.01
Number of antihypertensives, median (range)	2	(1-4)	2	(1-4)	2	(1-4)	
Anticoagulation medication, n (%)**	15	(3.5)	6	(1.2)	9	(20.0)	<0.01
Antiplatelet medication, n (%)***	17	(3.9)	13	(2.7)	4	(8.9)	0.04
Trauma-related index imaging, n (%)	485	(91.5)					
Motor vehicle collision, n (% of trauma scans)			292	(60.2)			
Pedestrian or bicycle struck by motorized vehicle			90	(18.6)			
Fall from above ground level			42	(8.7)			
Fall from ground level			14	(2.9)			
Assault with knife			3	(0.6)			
Assault other (fight, bludgeoning, etc.)			7	(1.4)			
Gunshot			3	(0.6)			
Other/unknown			34	(7.0)			
Other injuries on scan, n (%)			434	(89.5)			
Non-trauma imaging indications, n (%)	45	(8.5)					

Abdominal pain, n (% of non-trauma scans)					16	(35.6)	
Post-procedure					14	(31.1)	
Concern for bleeding					10	(22.2)	
Other					22	(48.9)	
Right-sided AH, n (%)	367	(69.3)	352	(72.6)	15	(33.3)	<0.01
Left-sided AH	129	(24.3)	106	(21.9)	23	(51.1)	<0.01
Bilateral AH	34	(6.4)	27	(5.6)	7	(15.6)	<0.01
Largest dimension of AH, cm, median (IQR)^	3.0	(2.3-3.7)	3.0	(2.3-3.7)	3.1	(2.3-4.2)	0.7
Concern for adrenal mass noted on index scan, n (%)	118	(22.3)	105	(21.7)	13	(28.9)	0.3
Recommendation for additional evaluation or imaging	74	(14.0)	62	(12.8)	12	(26.7)	0.01
Follow-up scan performed	114	(21.5)	91	(18.8)	23	(51.1)	<0.01

*n=101 unknown/missing
**n=99 unknown/missing
***n=98 unknown/missing
^ n=272 missing

Table 2: Characteristics of cohort with confirmed adrenal masses on imaging or adrenalectomy

Patient	Age	Sex	Indication for index scan	Laterality of hemorrhage	Size on index scan	Imaging Characteristics	Outcome
1	44	M	Trauma	Right	4.2cm	Adenoma	Stable on serial imaging, normal 24h urine cortisol, no intervention
2	57	M	Trauma	Right	not measured	Myelolipoma	3.3 cm on recent imaging, no intervention
3	53	F	Non-trauma	Left	not measured	Indeterminate mass	Patient died from septic shock 3 months after index imaging
4	43	F	Trauma	Left	2.6cm	Adenoma	Stable on 10-year follow-up imaging, no biochemical evaluation
5	56	M	Trauma	Left	4.1cm	Indeterminate	Stable over 4 years on imaging (contrast-enhanced only), no biochemical evaluation, lost to follow-up
6	58	M	Trauma	Right	3.4cm	Adenoma with hemorrhage	Serial imaging with initial decrease size due to resolving hemorrhage; follow-up MRI confirmed underlying adenoma
7	53	F	Trauma	Left	1.7cm	Indeterminate	Stable over 2 years on imaging (contrast-enhanced only), no biochemical evaluation
8	12	F	Non-trauma	Left	5.4cm	Indeterminate	Adrenalectomy; pathology consistent with ganglioneuroma
9	58	F	Non-trauma	Left	3.6cm	Adenoma with hemorrhage	Smaller on 6-week follow-up imaging, no biochemical evaluation, lost to follow-up
10	44	M	Non-trauma	Left	13.4cm	Indeterminate	Adrenalectomy; pathology consistent with adrenocortical carcinoma
11	43	F	Non-trauma	Right	3.2cm	Indeterminate	Adrenalectomy; pathology consistent with pheochromocytoma
12	69	F	Non-trauma	Left	2.9cm	Indeterminate	Decrease in size over 2 years on imaging, no biochemical evaluation
13	36	M	Trauma	Right	Right: 3.7cm Left: 1cm	Right: hematoma Left: adenoma	Right hematoma resolved on 1 year imaging; small left-sided adenoma stable, biochemical evaluation of plasma metanephrines only - normal

Table 3: Characteristics of patients with follow-up with and without confirmed adrenal mass. Percentages are out of column header denominator, except as noted. AH= adrenal hemorrhage

Patient Characteristic	**Full Cohort** (n= 118)		**No mass** (n= 105)		**Mass** (n=13)		**P-value**
Age, years, median (IQR)	40.5	(29-53)	40	(27-53)	53	(43-57)	0.06
Male, n (%)	78	(66.1)	72	(68.6)	6	(46.2)	0.1
Race, n (%)							0.07
White	55	(46.4)	46	(43.8)	9	(69.2)	
Black	9	(7.6)	6	(5.7)	3	(23.1)	
Asian	0	(0)	0	(0)	0	(0)	
American Indian or Alaska Native	2	(1.7)	2	(1.9)	0	(0)	
Native Hawaiian or Other Pacific Islander	4	(3.4)	4	(3.8)	0	(0)	
More than one race	1	(0.9)	1	(1.0)	0	(0)	
Unknown/Not Reported/Missing	47	(39.8)	46	(43.8)	1	(7.7)	
Ethnicity, n (%)							0.01
Not Hispanic or Latino	70	(59.3)	58	(55.2)	12	(92.3)	
Hispanic or Latino	27	(22.9)	27	(25.7)	0	(0)	
Unknown/Not Reported/Missing	21	(17.8)	20	(19.0)	1	(7.7)	
BMI, kg/m^2, median (IQR)	28.3	(24.4-33.9)	27.4	(24.4-33.9)	29.6	(25.1-34.4)	0.5
Antihypertensive medication, n (% of patients with known medications)*	19	(16.1)	14	(13.3)	5	(38.5)	0.1
Number of antihypertensives, median (range)	2	(1-4)	2	(1-4)	2	(2-4)	
Anticoagulation medication, n (%)**	9	(7.6)	9	(8.6)	0	(0)	0.3
Antiplatelet medication, n (%)***	5	(4.2)	5	(4.8)	0	(0)	1.0
Trauma-related index imaging, n (%)	92	(78.0)	85	(81.0)	7	(53.9)	0.04
Other injuries on scan, n (%)	89	(75.4)	83	(79.1)	6	(46.2)	0.6
Laterality, n (%)							0.04
Right-sided AH	68	(57.6)	63	(60.0)	5	(38.5)	
Left-sided AH	37	(31.4)	29	(27.6)	8	(61.5)	
Bilateral AH	13	(11.0)	13	(12.4)	0	(0)	
Largest dimension of AH, cm, median (IQR)^	3.3	(2.4-4.4)	3.3	(2.4-4.5)	3.5	(2.8-4.2)	0.7
Concern for adrenal mass noted on index scan, n (%)	41	(34.6)	31	(29.5)	10	(76.9)	<0.01
Recommendation for additional evaluation or imaging	27	(22.9)	17	(16.2)	10	(76.9)	<0.01

*n=26 unknown/missing
**n=26 unknown/missing
***n=26 unknown/missing

489 ^ n=55 missing
490

Supplementary Table 1: Imaging modalities

Type of Imaging	Index Scan (n = 530)		Initial Follow-up (n = 114)		Most recent (n = 46)	
CT abdomen (+/- pelvis) with contrast, n (%)	500	(94.3)	94	(82.5)	38	(82.6)
CT abdomen (+/- pelvis) without contrast, n (%)	10	(1.9)	6	(5.3)	0	(0)
CT chest with contrast, n (%)	12	(2.3)	9	(7.9)	4	(8.7)
CT chest without contrast, n (%)	3	(0.01)	0	(0)	0	(0)
CT spine, n (%)	5	(4.2)	N/A*		N/A	
Adrenal protocol CT, n (%)	0	(0)	2	(1.8)	0	(0)
MRI (chest or abdomen) with contrast, n (%)	N/A		3	(2.6)	3	(6.5)
MRI (chest or abdomen) without contrast, n (%)	N/A		0	(0)	1	(2.2)

*CT spine imaging was excluded on interval imaging as insufficient for adrenal assessment

Figures

Figure 1: Kaplan-Meier estimator curve of resolution probability. Timing of interval imaging showing complete resolution of adrenal hemorrhage or hematoma is plotted on the X axis, with the Y axis demonstrating the probability of resolution at the given time. Number at risk at corresponding time points are listed in table below. Figure has been truncated at 100 months, when number at risk is 10.

Figure2 A: Axial slice of abdominal computed tomography imaging demonstrating a 3.8cm right adrenal gland concerning for hematoma or hemorrhage. **B**. Axial slice of abdominal computed tomography performed 5 months after part A demonstrating normal-appearing right adrenal gland with complete resolution of hematoma.