

Archives of Urology and Nephrology

Research Article

Management of Ruptured Renal Angiomyolipom Single Center Experience: Prospective Study

Alaa Ali Mousa^{1*}, Hafez M Manaa Abdelhamid Khattab¹, Fayez Elaskary¹, Sameh A Nassar¹, Hany M Hendi¹, Mohamed Eldesouki¹, Ahmed Foad Abdullah¹

¹Damanhur National Medical Institute, Urology department, Al-Behera governorate, Damanhur - 22514, Egypt.

***Corresponding Author:** Alaa Ali Mousa, Damanhur National Medical Institute, Urology department, Al-Behera governorate, Damanhur - 22514, Egypt.

Received Date: 22 October 2025; **Accepted Date:** 12 November 2025; **Published Date:** 17 November 2025

Copyright: © 2025 Alaa Ali Mousa, this is an open-access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Abstract

Background: Benign kidney tumors known as renal angiomyolipomas (AMLs) have the potential to rupture, particularly in larger tumors, resulting in potentially fatal bleeding. To minimize consequences, prompt imaging, stabilization, and treatment such as surgery or embolization are essential. Rapid assessment and management are crucial since delays in treatment dramatically raise morbidity and mortality.

Objective: to share our experience in treating ruptured renal angiomyolipoma to help people in this extremely rare and dangerous disorder.

Methods: This study, which was conducted at the Urology Department of Damanhur National Medical Institute between November 2022 and November 2024, prospectively included 20 patients who presented with ruptured renal angiomyolipoma. Based on imaging results and clinical symptoms, ruptured AML was the verified diagnosis for each subject.

Results: Female patients made up 52.9% of the sample, and patients ranged in age from 33 to 55. In 82.3% of instances, spontaneous rupture was the most common cause, and most patients (88.23%) had unilateral lesions. Road traffic accidents came in second, followed by minor trauma (5.8%). The average measurements of the hematoma were 16.44 ± 4.45 cm in length, 10.55 ± 1.43 cm in depth, 11.41 ± 1.97 cm in width, and 619.53 ± 4.18 cm³ in volume. Pre-operative hemoglobin levels and the etiology of rupture did not significantly correlate. However, there was a notable difference between the operating time and the cause of rupture; in cases of rupture caused by RTA, the surgical time was much longer than in cases of spontaneous rupture and minor trauma.

Conclusion: Because ruptured renal angiomyolipoma (AML) is a potentially fatal condition, clinical results are greatly impacted by the time it takes to intervene. The presence of an intratumoral aneurysm and the size of the tumor are important risk factors for rupture. When bleeding occurs suddenly, it must be recognized and treated rapidly. This is frequently caused by the size of the tumor, vascular fragility, or underlying genetic abnormalities. Prolonged operative time, higher complexity of care, and an increased risk of hemodynamic instability are all consequences of delayed diagnosis and treatment, which also raises mortality.

Keywords: Renal angiomyolipoma, Ruptured, Tuberos sclerosi.

Introduction

The most prevalent benign kidney tumor, renal angiomyolipoma (AML), is derived from renal mesenchymal cells. It makes up around 3% of all solid renal masses and is composed of smooth muscle, fat, and vascular components [1]. An estimated 0.13% of the general population is thought to have renal AML [2]. The two forms of renal AMLs are tuberous sclerosis complex (TSC)-associated angiomyolipomas and sporadic angiomyolipomas. According to [3], 10% of cases are TSC-associated angiomyolipomas, which are autosomal dominant diseases. It is more common in young people and women, and the tumors develop quickly. There are instances when several systems are involved. An even higher percentage of renal hamartomas are sporadic, which make up about 80% of cases [4].

Retroperitoneal bleeding is the most potentially fatal consequence. Lenk's triad, acute stomach soreness, flank pain, and indications of internal bleeding can be a symptom of acutely bleeding AMLs [5]. Although rupture risk has traditionally been determined by tumor size, a 2018 literature analysis found that a variety of factors ultimately affect rupture risk [6]. Low-velocity force, exercise, pregnancy, female gender, intratumoral aneurysm formation, and genetic connection, namely with tuberous sclerosis complex (TSC), are among these factors [5].

Renal AMLs typically show up as discomfort or bleeding [7], but they are more likely to be found by accident, particularly as the number of abdominal scans rises. Due to their high lipid content, AMLs look characteristically hyperechoic on ultrasonography (US) examinations. In as many as one-third of cases, the US may misdiagnose these tumors, sometimes failing to detect renal cell carcinomas (RCC) [8]. Most renal AMLs can be identified by computed tomography (CT) scans; however, some fat-poor tumors that resemble RCC may require MRI scans and possibly a sample to confirm the diagnosis [9].

Hemorrhage, which can be fatal, is the main clinical issue for renal AMLs [10]. According to [11], nephrectomy has historically been the main treatment choice for individuals deemed to be at high risk of bleeding. Technology advancements have made management more focused. With active surveillance, small sized renal AMLs can be controlled [12,13]. Mammalian target of rapamycin (mTOR) inhibitors, selective arterial embolization (SAE), and nephron-sparing surgery (NSS) are less invasive methods of treating big and high-risk renal AMLs [14]. The goal of this study was to save the lives of individuals suffering from ruptured renal angiomyolipoma by sharing our experience in managing this extremely rare and dangerous entity.

Patients and Methods

Study Design and Population

In this prospective study, 20 patients with ruptured renal an-

giomyolipoma (AML) were enrolled. Clinical symptoms and imaging results revealed that each person had a ruptured AML and a retroperitoneal hematoma. The Urology Department of Damanhur National Medical Institute conducted this study between November 2022 and November 2024.

Ethics Approval and Consent to Participate

Following study approval by the local ethics and research committee and the General Authority for Hospitals and Educational Institutes' institutional research board, patient enrollment began. After patients or their family members were apprised of the potential risks associated with the procedure, a formal high-risk permission up to death was obtained, and each subject or his relative were given informed consent. With a special username and password for the investigators, the material was stored and protected in a computer-based system.

Patients' Criteria

Patients had to exhibit acute flank discomfort, hemodynamic instability symptoms, or imaging-confirmed AML bleeding to meet the inclusion criteria. Cases with bleeding from other sources, such as trauma or retroperitoneal causes were excluded.

Methodology in Detail

Quick history taking from family members or, if the patient's condition permits. Personal information, such as age, sex, occupation, habits, etc. If there is a history of trauma, description of its mechanism, kind, and duration was registered. Medical history, including diabetes, hypertension, bleeding disorders, and medications, particularly anticoagulants and antiplatelets. Family history is associated with the disease. surgical history, specifics of prior surgeries, prior abdominal incisions, anesthesia type, and the course of the post-operative period. Abdominal examination, both locally and generally. Laboratory evaluation, CBC, liver enzymes, coagulation profile, renal function tests, blood grouping, and cross-matching.

Imaging: To assist in treatment planning, determine the extent of the hemorrhage, and confirm the diagnosis, Abdominopelvic US, rapid contrast-enhanced computed tomography (CT) was used and sometimes nonenhanced rapid screening CT together with screening US if contrast contraindicated.

Interventions included supportive preoperative blood transfusion, urethral catheterization, large bore IV cannula insertion, supportive care, and patient preparation for an emergent surgical intervention. An urgent surgical exploration midline incision with Kocherization of the colon and incision of the posterior peritoneum, evacuation of hematoma and urgent lifesaving nephrectomy was done. The operative time from

the induction of anesthesia to wound closure was recorded. Using a Penrose drain, closure was completed in layers. Blood transfusions and supportive treatment measures are used as postoperative therapy to stabilize the patient's condition in the recovery room. After the patient's condition stabilized, they were moved to our inpatient ward after spending the first postoperative day in the recovery room or intensive care unit (ICU) with postoperative intense vital signs and fluid chart monitoring. Discharge from the hospital once the patient's health has stabilized and the drain and urethral cath-

eter removed.

Regretfully, we have lost three cases that arrived at the ER in a non-reversible shock stage and died despite intensive supportive care.

Outcomes of the Study

Mortality, length of hospital stays, blood transfusion requirements, and operating time were the main outcomes. Secondary outcomes evaluated the connection between clinical outcomes and time intervention.



Figure: 1



Figure: 2

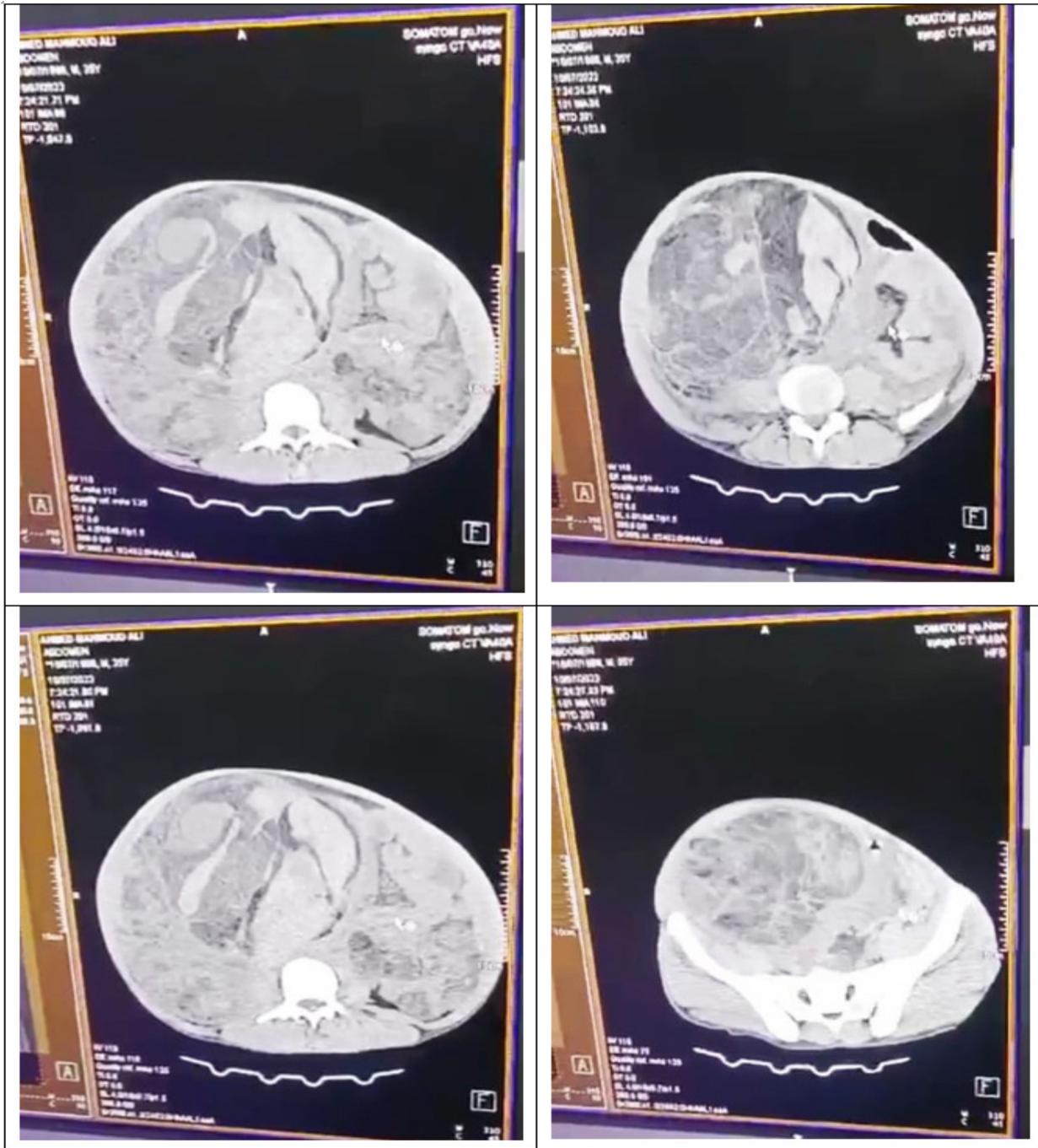


Figure: 3

Statistical Analysis

IBM SPSS Statistics 25 (IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY; IBM Corp.) was used to conduct statistical analysis. Descriptive statistics are used to present clinical results. The Wilcoxon test or paired t-tests were employed based on the distribution of continuous variables. The normal distribution was assessed using a Shapiro-Wilk test, a Q-Q plot, and a Histogram chart with a normal distribution curve. In a two-sided test, the results were deemed

significant if the p-value was less than 0.05. Unless otherwise noted, data are displayed as mean \pm standard deviation (SD).

Results

A flowchart of the 25 participants in the study who had surgery at Damanhur University's tract department because of renal angiomyolipoma. Of the 20 people who took part in

the trial, 5 were eliminated (2 patients refused to give their agreement, and 3 did not fit the inclusion requirements). Seventeen patients were saved in the current study; their ages ranged from 33 to 55 years old, with a mean age of 41.88 ± 6.14 years. Nine of the patients (52.9%) were female, while nine of the patients (47.1%) were male (Table 1).

Still alive (n=17)		
	Mean \pm SD	Median(range)
Age/year	41.88 ± 6.14	41(33-55)
	Male	Female
Gender	8 (47.1%)	9 (52.9%)

Table 1. Demographic data of the studied patients.

The current study found that most of our patients had unilateral (88.23%) lesions, the postoperative course was smooth in (76.4% of cases), and the volume of hematomas ranged from 220-1950 cm³ with a mean of 619.53 ± 4.18 cm³. 52.9% of patients had left-sided lesions, and 47.1% had right-sided lesions. The most common cause of rupture, accounting for 82.3% of cases, was traffic accidents, followed by spontaneous events (11.7%) and minor trauma (5.8%) (Table 2).

Still alive (n=17)		
	Mean \pm SD	Median (range)
Length of hematoma/cm	10.55 ± 1.43	11(7.5-13)
Wide of hematoma/cm	11.41 ± 1.97	11(8-15)
Depth of hematoma /cm	15.44 ± 4.45	15(11-30)
Volume of hematoma/cm ³	619.53 ± 4.18	605 (220-1950)
	No	%
Right site	8	(47.1%)
Left site	9	(52.9%)
Uni-lateral	15	(88.23%)
Bi-lateral	2	(11.7%)
Post-operative course		
Smooth	13	(76.4%)
Dialysis	2	(11.7%)
Died	1	(5.8%)
Around infection	1	(5.8%)
Cause of rupture		
Spontaneous	2	(11.7%)
RTA	14	(82.3%)
Minor trauma	1	(5.8%)

Road traffic Accident (RTA)

Table 2. Diagnostic features of hematoma.

The pre-operative hemoglobin levels in the current study ranged from 5.20 to 7.30, with an average of 6.46 ± 0.68 mg/dl, while the surgical duration ranged from 95 to 160 minutes, with an average of 124.52 ± 15.26 minutes. (Table 3).

Studied variables	Still alive (n=17)	
	Mean \pm SD	Median(range)
Pre-operative Hb (mg/l)	6.46 ± 0.68	6.5(5.20-7.30)
Operative time (min)	124.52 ± 15.26	127(95-160)

Table 3. Pre-operative Hb and Operative time among the studied patients.

The age of patients in this study did not significantly correlate with the rupture site, laterality, or cause ($p > 0.05$), (Table 4).

	Age/years	t-test	P value
Site			
Right	41.50 ± 4.30	-0.242	0.812
Left	42.22 ± 7.67		
Laterality			
Uni-lateral	42.80 ± 5.90	3.10	0.07
Bi-lateral	35 ± 2.82		
Cause of rupture			
Spontaneous	43.07 ± 5.92	F=0.87	0.437
RTA	38.75 ± 6.23		
Minor trauma	41.50 ± 0.70		

Road traffic accident (RTA), Independent t-test (t)

Table 4. Relation between the age of patients and the studied variables.

Gender did not significantly affect hematoma size, pre-operative hemoglobin levels, or operating time in this study ($p > 0.05$), (Table 5).

Variables	Gender		t-test	P value
	Mean \pm SD			
	Male	Female		
Length of hematoma	10.62 ± 1.06	10.50 ± 1.76	0.17	0.861
Wide of hematoma	11.87 ± 1.95	11.00 ± 2.00	0.91	0.377
Depth of hematoma	14.75 ± 2.54	16.05 ± 5.75	-0.61	0.55

Pre-operative Hb	6.50 ± 0.76	6.43 ± 0.64	0.193	0.85
Operative time (min)	128.3 ± 15.29	121.11 ± 15.27	0.97	0.344

Independent t-test (t)

Table 5. The relation between gender and the studied variables.

Pre-operative hemoglobin and operative time did not significantly correlate with laterality in our study ($p > 0.05$), (Table6).

	Laterality		t-test	P value
	Mean ±SD			
	Unilateral	Bilateral		
Pre-operative Hb	6.47 ± 0.72	6.40 ± 0.14	0.34	0.737
Operative time (min)	124.13 ± 16.02	127.50 ± 10.60	0.39	0.738

Independent t-test (t)

Table6. Relation between Laterality and the studied variables.

The cause of rupture and pre-operative hemoglobin levels did not significantly correlate in our study ($p = 0.146$), although the cause of rupture and surgical time did significantly differ ($p = 0.012$). In comparison to spontaneous rupture (127.64 ± 12.43) and rupture resulting from minor trauma (92.50 ± 3.53), patients with RTA rupture etiology had considerably longer operating times (133.25 ± 23.14), (Table 7).

Variables	Cause of rupture			F	P value
	Spontaneous	RTA	Minor trauma		
Pre-operative Hb	6.44 ± 0.74	5.55 ± 0.98	6.55 ± 0.49	2.16	0.146
Operative time (min)	127.64 ± 12.43	133.25 ± 23.14	92.50 ± 3.53	5.81	0.012*

Road traffic Accident (RTA), ANOVA F test (F), *significant

Table 7. Relation between the cause of rupture and the studied variables.

Discussion

Benign tumors called renal angiomyolipomas are usually seen in the kidneys and are made of smooth muscle, fat, and blood vessels. Even though they are usually asymptomatic, bigger AMLs (>4 cm) have the potential to rupture spontaneously and cause potentially fatal retroperitoneal bleeding, a disease known as Wunderlich syndrome [15]. The rupture is typically brought on by hormonal changes, especially during pregnancy, tumor size, or the existence of micro an-

eurysms [6].

Time is of the essence for treating ruptured AMLs because hemorrhage causes hemodynamic instability to develop quickly. Increased mortality, hypovolemic shock, and multi-organ failure can result from delayed intervention. According to [16], improving results requires quick imaging (such as contrast-enhanced CT), immediate resuscitation, and quick surgical or interventional radiological techniques (such as selective arterial embolization, or SAE). According to research, prompt care minimizes persistent bleeding and related problems, which drastically cuts down on operating time and mortality [17]. Therefore, the purpose of this study was to share our expertise in treating ruptured renal angiomyolipoma to help patients who suffer from this extremely rare and dangerous illness.

The study's patient population ranged in age from 33 to 55, and 52.9% of the cohort were female [18]. reported an age range of 12 to 64 years with a comparable female majority, which is consistent with these findings. Furthermore, similar age distributions and the noteworthy female predilection for renal angiomyolipoma (AMLs) were noted by [19-21]. which corroborated our findings. According to these studies, renal AMLs are more prevalent in women, which is consistent with what we found in our sample.

The study's surviving patients' hematoma diagnostic features showed that the average hematoma length, width, and depth were 10.55 ± 1.43 , 11.41 ± 1.97 , and 15.44 ± 4.45 , respectively. In 82.3% of instances, spontaneous rupture was the most common cause, and most patients (88.23%) had unilateral lesions. Other causes were mild trauma (5.8%) and road traffic accidents (11.7%). These results are consistent with earlier studies, including one by [22], which showed that tumor size is frequently linked to the clinical manifestations of renal angiomyolipomas (AMLs). While tumors bigger than 4 cm have a higher risk of spontaneous rupture, smaller lesions usually stay asymptomatic [22]. This is in line with the results of our investigation, which showed that the most frequent cause of hematoma was spontaneous rupture. The traditional trio of palpable mass, extensive hematuria, and flank pain in AML patients was also described by [23]. This trio aligns with the clinical characteristics we have seen in ruptured AML cases, which can also include serious side effects such hypovolemic shock from retroperitoneal hemorrhage. These results demonstrate that a considerable proportion of patients had spontaneous rupture, which supports the claim made by [23]. that such occurrences constitute a medical emergency requiring immediate attention.

Furthermore, the prevalence of unilateral presentation in our population is corroborated by [24], who found that sporadic AMLs typically arise unilaterally and are more common in women aged 50–60. This result is consistent with the demographic and clinical presentation of our research. In instances linked to tuberous sclerosis, [24]. also noted the elevated likelihood of bilateral presentation and quicker tumor progres-

sion. Although there was no specific reference to tuberous sclerosis in our study, the unilateral preponderance seen is consistent with previous research that shows that most AMLs unrelated to tuberous sclerosis tend to grow slowly and manifest unilaterally. However, our findings, which showed that greater tumor sizes were associated with hematoma formation, confirm the link between hypervascularity and the risk of rupture as mentioned by [25,26]. According to this research, the convoluted blood supply and absence of elastic membranes in AMLs raise the chance of rupture, especially when the tumor is larger than 4 cm. Furthermore, [24] highlighted the significance of aneurysm formation in rupture risk, and the results of the current investigation support their claim that an aneurysm size larger than 5 mm greatly increases rupture specificity. Our findings also align with the tumor-specific risk variables that [27] discovered, such as tumor size and aneurysm formation, underscoring the importance of these parameters in the therapeutic management of AMLs.

According to the current study, the hematoma's mean dimensions were 10.55 ± 1.43 cm in length, 11.41 ± 1.97 cm in width, 15.44 ± 4.45 cm in depth, and 619.53 ± 4.18 cm³ in volume. The position, laterality, and source of rupture were among the characteristics that did not significantly differ from the overall size of the hematoma. This underlines that other criteria may be more important in deciding outcomes or clinical therapy, even if hematoma size varies amongst patients and may not always correlate with parameters like the location or etiology of the rupture. This is in line with certain research findings that highlight the difficulty of managing AML, where tumor size has historically been a key factor in intervention decisions. According to [27], tumor size is a major factor in determining the course of treatment for AMLs; smaller, asymptomatic AMLs (less than 4 cm) are typically treated conservatively. Since larger tumors, especially those that are >4 cm or >6 cm or have intratumoral aneurysms >5 mm, are typically linked to more aggressive treatment options, this strategy is in line with the practice of surveillance for tumors under 4 cm [28].

The significance of tumor size in predicting rupture risk, however, is a topic of much discussion in the scientific community. Despite supporting the conventional 4 cm threshold for therapy [29], found no conclusive link between AML size and rupture in their systematic analysis, indicating that larger tumors are not necessarily more likely to rupture. According to [29], 9.4% of ruptured AMLs had a diameter of less than 4 cm, which calls into question the idea that rupture risk can be accurately predicted just by size. This idea is further reinforced by the [16] instance, in which a life-threatening bleeding was induced by a mere 2.5 cm AML. These results emphasize the difficulty of estimating rupture risk and the necessity of considering other variables in addition to tumor size, such as tumor vascularity, growth rate, and patient-specific characteristics. Additionally, there are studies in the literature that support the relationship between tumor size and rupture risk.

[30,31] discovered a direct correlation between tumor size and rupture risk, with several specialists establishing a 4 cm size threshold for intervention [32] provided more evidence for this idea, stating that only 3.9% of tumors less than 4 cm ruptured, compared to 27.6% of tumors larger than 4 cm. According to [33], 50–60% of AMLs that are 4 cm or longer run the risk of rupturing spontaneously. These findings support the notion that larger tumors have a higher propensity to burst, indicating that size is still a significant determinant of bleeding risk. However [12], suggested that, depending on the patient's clinical presentation, active surveillance can frequently monitor even massive AMLs larger than 4 cm.

There were no discernible variations in pre-operative hemoglobin (Hb) or surgical time between the nephrectomy groups in the current investigation. There was a notable difference between the operating time and the source of rupture, nevertheless, with RTA-related ruptures resulting in a much longer surgical time than spontaneous ruptures or moderate trauma. Based on these results, it is possible that the source of rupture may affect the surgical procedure's complexity because more severe ruptures (like those caused by RTAs) may require more extensive operative intervention. The study's findings align with the body of knowledge about the treatment of bleeding angiomyolipomas (AMLs). Treatments for bleeding AMLs include renal artery embolization, conservative therapy, and, if required, either immediate or postponed surgery following embolization [34]. In line with our research, surgical intervention was contemplated due to the potentially fatal hemodynamic instability. Furthermore, in high-risk AML cases, [35,36] recommended embolization because it prevents the need for surgery and anesthesia by cutting off the tumor's blood supply, which helps to stop bleeding. According to these studies, embolization can effectively control bleeding while maintaining renal function, which is consistent with the less intrusive strategy that many clinicians choose. Additionally, embolization has several benefits, including minimum invasiveness, low complication rates, and adequate renal function preservation, according to [23]. Although the focus of our investigation was on differences in operating times according to the reason of rupture, this perspective is in keeping with data that indicates embolization may be a successful first-line treatment and reflects a larger trend toward non-surgical therapies when suitable. However, there is also ample literature on embolization's drawbacks. Nephrectomy, whether partial or entire, should only be performed when embolization fails or is not accessible, as in our study, or when cancer is suspected. This is in accordance with [37]. In situations where embolization is unable to control the bleeding, this represents the decision-making process and may account for the longer operating times observed for trauma-related ruptures in our study.

Our results further confirm the efficacy of surgical management in offering long-lasting remedies, as reported by [38], who found no recurrence in patients who had surgery. Sur-

gical methods, such as radiofrequency ablation (RFA) and nephron sparing surgery, were also thought to be alternatives in certain AML cases. While arterial embolization is helpful in controlling bleeding, we concur with the literature that it has drawbacks. In contrast to surgery, embolization is linked to a greater recurrence rate, as noted by [24], who reported a secondary treatment rate of 31% following embolization as opposed to 1% following surgery. This result highlights the better long-term control that surgery provides, especially about preventing recurrence and lowering the need for follow-up procedures. Concerns about recurrence aside, the complications of embolization off target embolization, post-infarction syndrome, tumor necrosis, infection, and absences also point to the necessity of carefully balancing the procedure's advantages and disadvantages (Jou et al., 2009). Furthermore, [23] highlighted the limitations of embolization in specific circumstances, such as patients with large or multiple aneurysms, a significant proportion of fat tissue, or contrast media allergies. These diseases may reduce the procedure's effectiveness and require retreatment because of vascular rearrangement.

Both surgical and non-surgical methods may be useful in treating bleeding AMLs, according to the research. Surgery is frequently the better option since embolization has drawbacks, especially when it comes to complications and recurrence, even though it is useful for controlling bleeding and preserving the kidneys. The study's conclusions also emphasize how crucial it is to consider each patient's unique situation, including the tumor's characteristics and the reason for rupture, while choosing the best course of action.

Conclusion

The time to intervention has a significant impact on clinical outcomes for ruptured renal angiomyolipoma (AML), a potentially fatal disease. The abrupt beginning of bleeding, which is frequently caused by the size of the tumor, vascular fragility, or underlying genetic disorders, demands prompt diagnosis and treatment. The risk of hemodynamic instability is increased by delayed diagnosis and treatment, which also lengthens operating times and increases the complexity of care. Risk reduction and survival optimization depend on efficient time management and interdisciplinary collaboration. Tumor size, bilaterality, and the existence of internal aneurysms are important risk factors for rupture.

The study's mortality rate was 15% because we decided to perform an urgent nephrectomy and immediate surgical exploration due to the large size of the hematoma, rapidity of hemodynamic instability. The time between onset and presentation, and most importantly the hemodynamic instability in every case to the point where three of them presented with irreversible shock and died. When it comes to treating this deadly illness, speed is of the utmost importance.

References

1. Tang, Jian-Er, Rong-Jiang Wang, Zhi-Hai Fang, Ping-Ya Zhu, Jian-Xiang Yao, and Hua Yang. "Treatment of fat-poor renal angiomyolipoma with ectopic blood supply by fluorescent laparoscopy: A case report and review of literature." *World Journal of Clinical Oncology* 15, no. 11 (2024): 1435.
2. Flum, Andrew S., Nabeel Hamoui, Mohammed A. Said, Ximing J. Yang, David D. Casalino, Barry B. McGuire, Kent T. Perry, and Robert B. Nadler. "Update on the diagnosis and management of renal angiomyolipoma." *The Journal of urology* 195, no. 4 (2016): 834-846.
3. Murray, Timothy E., and Michael J. Lee. "Are we overtreating renal angiomyolipoma: a review of the literature and assessment of contemporary management and follow-up strategies." *CardioVascular and Interventional Radiology* 41, no. 4 (2018): 525-536.
4. Xu, Xiao-feng, Xian-hui Hu, Qi-ming Zuo, Jiao Zhang, Hao-yu Xu, and Yao Zhang. "A scoring system based on clinical features for the prediction of sporadic renal angiomyolipoma rupture and hemorrhage." *Medicine* 99, no. 20 (2020): e20167.
5. Vos, Nicolas, and Raymond Oyen. "Renal angiomyolipoma: the good, the bad, and the ugly." *Journal of the Belgian Society of Radiology* 102, no. 1 (2018): 41.
6. Wang, Chenyang, Xinyuan Li, Linglong Peng, Xin Gou, and Jing Fan. "An update on recent developments in rupture of renal angiomyolipoma." *Medicine* 97, no. 16 (2018): e0497.
7. Bhatt, Jaimin R., Patrick O. Richard, Nicole S. Kim, Antonio Finelli, Karthikeyan Manickavachagam, Laura Legere, Andrew Evans et al. "Natural history of renal angiomyolipoma (AML): most patients with large AMLs > 4 cm can be offered active surveillance as an initial management strategy." *European urology* 70, no. 1 (2016): 85-90.
8. de Silva, Suresh, Ross Copping, David Malouf, Anthony Hutton, Fiona Maclean, and Peter Aslan. "Frequency of angiomyolipomas among echogenic nonshadowing renal masses (> 4 mm) found at ultrasound and the utility of MRI for diagnosis." *American Journal of Roentgenology* 209, no. 5 (2017): 1074-1080.
9. Vaggers, Sophie, Patrick Rice, Bhaskar K. Somani, Rajan Veeratterapillay, and Bhavan P. Rai. "Evidence-based protocol-led management of renal angiomyolipoma: A review of literature." *Turkish Journal of Urology* 47, no. Suppl 1 (2020): S9.
10. Wang, Wenda, Dongxu Qiu, Yang Zhao, Zhan Wang, Xu Wang, Yanan Li, Yi Liu, Zhangcheng Liao, and Yushi Zhang. "New staging criteria predicting m-tor inhibitors treatment effect of renal angiomyolipoma in tuberous sclerosis complex patients." *World Journal of Urology* 42, no. 1 (2024): 532.
11. Oesterling, Joseph E., Elliot K. Fishman, Stanford M. Goldman, and Fray F. Marshall. "The management of renal angiomyolipoma." *The Journal of urology* 135, no. 6 (1986): 1121-1124.

12. Bhatt, Jaimin R., Patrick O. Richard, Nicole S. Kim, Antonio Finelli, Karthikeyan Manickavachagam, Laura Legere, Andrew Evans et al. "Natural history of renal angiomyolipoma (AML): most patients with large AMLs > 4 cm can be offered active surveillance as an initial management strategy." *European urology* 70, no. 1 (2016): 85-90.
13. Mues, Adam C., Jorge Moreno Palacios, George Haramis, Cristin Casazza, Ketan Badani, Mantu Gupta, James McKiernan, Mitchell C. Benson, and Jaime Landman. "Contemporary experience in the management of angiomyolipoma." *Journal of endourology* 24, no. 11 (2010): 1883-1886.
14. Flum, Andrew S., Nabeel Hamoui, Mohammed A. Said, Ximing J. Yang, David D. Casalino, Barry B. McGuire, Kent T. Perry, and Robert B. Nadler. "Update on the diagnosis and management of renal angiomyolipoma." *The Journal of urology* 195, no. 4 (2016): 834-846.
15. Pal, Atanu Kumar, Sidhartha Kalra, Sreerag Kodakkattil Sreenivasan, Lalgudi Narayanan Dorairajan, Ramanitharan Manikandan, and Shailendra Kumar Sah. "Management Outcomes of Large Renal Angiomyolipoma Presenting with Wunderlich Syndrome—Experience from a Tertiary Center." *Journal of Kidney Cancer and VHL* 10, no. 2 (2023): 21.
16. Tajiri, Masashi, Tomoyuki Gentsu, Masato Yamaguchi, Koji Sasaki, Eisuke Ueshima, Takuya Okada, Koji Sugimoto, and Takamichi Murakami. "A case of life-threatening rupture of small renal angiomyolipoma with an unidentified intratumoral aneurysm during follow-up." *Interventional Radiology* 9, no. 1 (2024): 20-25.
17. Restrepo, Juan Camilo Álvarez, David Andres Castañeda Millan, Carlos Andres Riveros Sabogal, Andres Felipe Puentes Bernal, and Wilfredo Donoso Donoso. "New trends and evidence for the management of renal angiomyolipoma: a comprehensive narrative review of the literature." *Journal of Kidney Cancer and VHL* 9, no. 1 (2022): 33.
18. Abouelkheir, Rasha Taha, Mostafa El-Ksas, Sherif Abdel Fattah, Talal Amer, and Tarek El-Diasty. "Efficacy and safety of selective renal arterial embolization in renal angiomyolipoma: a prospective single-center study." *Egyptian Journal of Radiology and Nuclear Medicine* 53, no. 1 (2022): 165.
19. Bardin, Florian, Olivier Chevallier, Aurélie Bertaut, Emmanuel Delorme, Morgan Moulin, Pierre Pottecher, Lucy Di Marco et al. "Selective arterial embolization of symptomatic and asymptomatic renal angiomyolipomas: a retrospective study of safety, outcomes and tumor size reduction." *Quantitative imaging in medicine and surgery* 7, no. 1 (2017): 8.
20. Duan, Xu-Hua, Meng-Fan Zhang, Jian-Zhuang Ren, Xin-Wei Han, Peng-Fei Chen, Kai Zhang, and Zi-Ling Jia. "Urgent transcatheter arterial embolization for the treatment of ruptured renal angiomyolipoma with spontaneous hemorrhage." *Acta Radiologica* 57, no. 11 (2016): 1360-1365.
21. Hocquelet, A., F. Cornelis, Y. Le Bras, M. Meyer, E. Tricaud, A. S. Lasserre, J. M. Ferrière, G. Robert, and N. Grenier. "Long-term results of preventive embolization of renal angiomyolipomas: evaluation of predictive factors of volume decrease." *European radiology* 24, no. 8 (2014): 1785-1793.
22. Kothary, Nishita, Michael C. Soulen, Timothy WI Clark, A. J. Wein, Richard D. Shlansky-Goldberg, S. William Stavropoulos, and Peter B. Crino. "Renal angiomyolipoma: long-term results after arterial embolization." *Journal of Vascular and Interventional Radiology* 16, no. 1 (2005): 45-50.
23. He, Wei, Xiaoxu Chen, Haiyong Ji, Jianwei Wang, and Zhihong Niu. "Emergency retroperitoneal laparoscopic partial nephrectomy for ruptured renal angiomyolipomas: a retrospective single-center series of 15 cases." *BMC surgery* 20, no. 1 (2020): 59.
24. Fernández-Pello, Sergio, Milan Hora, Teele Kuusk, Rana Tahbaz, Saeed Dabestani, Yasmin Abu-Ghanem, Laurence Albiges et al. "Management of sporadic renal angiomyolipomas: a systematic review of available evidence to guide recommendations from the European Association of Urology Renal Cell Carcinoma Guidelines Panel." *European urology oncology* 3, no. 1 (2020): 57-72.
25. Halpenny, D., A. Snow, G. McNeill, and W. C. Torreggiani. "The radiological diagnosis and treatment of renal angiomyolipoma—current status." *Clinical radiology* 65, no. 2 (2010): 99-108.
26. Salik, Aysun Erbahçeci. "Transarterial embolization of symptomatic renal angiomyolipomas." *Medical Journal of Bakirkoy* (2019).
27. Sapadin, Abby Jo, Daniel Girzadas, Darshika Chhabra, and Tasneem Ahmed. "Ruptured angiomyolipoma, a novel entity for emergency physicians in the differential diagnosis of haemorrhagic shock in a female patient of reproductive age." *BMJ Case Reports CP* 15, no. 8 (2022): e248626.
28. Restrepo, Juan Camilo Álvarez, David Andres Castañeda Millan, Carlos Andres Riveros Sabogal, Andres Felipe Puentes Bernal, and Wilfredo Donoso Donoso. "New trends and evidence for the management of renal angiomyolipoma: a comprehensive narrative review of the literature." *Journal of Kidney Cancer and VHL* 9, no. 1 (2022): 33.
29. Kuusk, Teele, Fausto Biancari, Brian Lane, Conrad Tobert, Steven Campbell, Uri Rimon, Vito D'Andrea, Aare Mehik, and Markku H. Vaarala. "Treatment of renal angiomyolipoma: pooled analysis of individual patient data." *BMC urology* 15, no. 1 (2015): 123.
30. Steiner, Mitchell S., Stanford M. Goldman, Elliot K. Fishman, and Fray F. Marshall. "The natural history of renal angiomyolipoma." *The Journal of urology* 150, no. 6 (1993): 1782-1786.

31. Seyam, Raouf M., Nabil K. Bissada, Said A. Kattan, Alaa A. Mokhtar, Muhammad Aslam, Wahib E. Fahmy, Walid A. Mourad, Ali A. Binmahfouz, Hassan M. Alzahrani, and Kamal A. Hanash. "Changing trends in presentation, diagnosis and management of renal angiomyolipoma: comparison of sporadic and tuberous sclerosis complex-associated forms." *Urology* 72, no. 5 (2008): 1077-1082.
32. Xu, Xiao-feng, Xian-hui Hu, Qi-ming Zuo, Jiao Zhang, Hao-yu Xu, and Yao Zhang. "A scoring system based on clinical features for the prediction of sporadic renal angiomyolipoma rupture and hemorrhage." *Medicine* 99, no. 20 (2020): e20167.
33. Takebayashi, Shigeo, Ayumi Horikawa, Mito Arai, Shinichiroh Iso, and Kazumi Noguchi. "Transarterial ethanol ablation for sporadic and non-hemorrhaging angiomyolipoma in the kidney." *European journal of radiology* 72, no. 1 (2009): 139-145.
34. Jou, Yeong-Chin, Wen-Pin Chen, and Chun-Lin Huang. "Urgent angioembolization with early elective nephron-sparing surgery for spontaneously ruptured renal angiomyolipoma." *Journal of the Chinese Medical Association* 72, no. 8 (2009): 450-452.
35. Nelson, Caleb P., and Martin G. Sanda. "Contemporary diagnosis and management of renal angiomyolipoma." *The Journal of urology* 168, no. 4 Part 1 (2002): 1315-1325.
36. Halpenny, D., A. Snow, G. McNeill, and W. C. Torreggiani. "The radiological diagnosis and treatment of renal angiomyolipoma—current status." *Clinical radiology* 65, no. 2 (2010): 99-108.
37. Thapa, Narayan, Suman Maharjan, Anil Hona, Jayaram Pandey, and Sabin Karki. "Spontaneous rupture of renal angiomyolipoma and its management: a case report." *Annals of Medicine and Surgery* 79 (2022).
38. Mues, Adam C., Jorge Moreno Palacios, George Haramis, Cristin Casazza, Ketan Badani, Mantu Gupta, James McKiernan, Mitchell C. Benson, and Jaime Landman. "Contemporary experience in the management of angiomyolipoma." *Journal of endourology* 24, no. 11 (2010): 1883-1886.