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Review Article

Management strategies for giant renal artery aneurysms: a systematic review and case report

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Abstract: Background: Renal artery aneurysm (RAA) is a rare but potentially life-threatening condition. The definition of giant RAA is ≥ 50 mm. Although often asymptomatic, the risk of rupture increases significantly with size, posing a substantial threat. Giant RAAs have historically tended to be repaired using open surgery. At present, intravascular technology has become an alternative solution due to its advantage of less invasiveness. Objective: This study seeks to present a rare case of successful endovascular embolization for a giant renal aneurysm (RAA), while also systematically reviewing recent literature to compare the outcomes of surgical and endovascular treatments for giant RAA, and to describe management strategies for giant renal hemangiomas. Methods: We describe a case of a young man treated by endovascular coil embolization and had a large RAA. After the PRISMA guidelines were followed, a systematic literature review was carried out, initially identifying 347 studies. After screening and full-text review, 35 studies met the inclusion criteria for comparative analysis of patient demographics, treatment modalities, and outcomes. Results: A total of 35 studies, encompassing 35 patients with giant renal artery aneurysms, were included. The mean age was 53 years (15-88 years). Endovascular therapy was performed in 12 cases, while 20 patients underwent surgical management; 2 patients received combined treatment and 1 was treated conservatively. Overall, symptom improvement and complication profiles were reported descriptively across both surgical and endovascular treatments. Conclusion: Managing giant renal artery aneurysms necessitates a personalized, multifaceted approach. Intravascular therapy represents a feasible and minimally invasive option for selected patients with suitable anatomical structures and stable hemodynamics, while open surgery remains indispensable for complex anatomy or rupture. A multidisciplinary approach, guided by precise assessment of aneurysm morphology and renal function, is essential for optimal outcomes.

Keywords: Giant renal hemangioma, management strategies, systematic review, case report, rare case

Introduction

Renal artery aneurysm (RAA) is a rare, but potentially life-threatening renovascular disorder characterized by localized dilatation of the main renal artery or its branches. It is generally defined as an arterial dilation exceeding twice the normal diameter of the renal artery [1]. Although most RAAs are detected incidentally, they pose a substantial risk once complications such as rupture occur. Currently, there is no widely recognized definition for a giant RAA. Some investigators define it as an aneurysm measuring ≥ 30 mm, while others suggest a threshold of ≥ 50 mm [2]. In the present study, we adopted the ≥ 50 mm criterion to ensure a homogeneous definition of giant RAA and to minimize potential selection bias. Epidemiological studies have reported a prevalence of 0.3-1.0%. However, with the increasing use of advanced imaging techniques like computed tomography angiography (CTA) and digital subtraction angiography (DSA), the detection rate has risen significantly in recent years [3, 4].

The cause of gigantic RAA is multifactorial and is still not fully understood. Morphologically, RAAs can be classified into saccular, fusiform, dissecting, intrarenal, and pseudoaneurysmal types [5]. Most individuals are asymptomatic, and the aneurysm is typically found incidentally during imaging for unrelated illnesses. However, the risk of rupture increases markedly

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when the diameter exceeds 50 mm, and this risk is further amplified by pregnancy or concomitant infection [6]. Although the overall incidence is low, rupture of a giant RAA can result in catastrophic hemorrhage and high mortality, underscoring the importance of early identification and timely intervention.

Currently, no standardized clinical guidelines provide detailed recommendations for the management of giant RAAs. Historically, open surgical repair was regarded as the gold-standard treatment [7]. With rapid advances in endovascular and minimally invasive techniques, however, endovascular therapy has emerged as a promising and less invasive alternative. The most commonly employed endovascular modalities include coil embolization, covered stent placement, and selective arterial embolization [8, 9].

Despite these developments, the majority of published studies remain limited to case reports or small retrospective series, and no systematic review has comprehensively compared surgical and endovascular strategies for the treatment of giant RAAs. Consequently, clinical decision-making often relies heavily on physician experience rather than robust evidence-based data.

Against this background, the present study reports a rare case of a young male patient with a giant atypical RAA successfully treated by endovascular coil embolization. In addition, we conducted a comprehensive literature review of recently reported cases of giant RAAs to descriptive the outcomes of surgical and endovascular management. By synthesizing and analyzing the available evidence, this study aims to elucidate the indications, efficacy, and limitations of both treatment strategies, thereby providing a more reliable theoretical and clinical basis for the management of giant renal artery aneurysms.

Case presentation

A 21-year-old male hurried to Department of Urology with chief complaints of an accidentally touched mass and dull pain in the right upper abdomen. The physical examination confirmed a hard and round mass at the right hypochondriac region whose diameter was around 10 cm with clear boundary and without tenderness. The patient had been in good health conditions previously and had no history of hypertension or hematuria. He claimed no abdominal trauma, surgical history, smoking and alcohol abuse history or family history. It's worth noting that the patient is the YI Ethnic, which is one of ethnic minorities in China.

Abdominal CTA demonstrated an 11.5 cm* 10.5 cm*10.0 cm round and well-circumscribed mass located in the right kidney region, compressing surrounding organs. Meanwhile, the contrast-enhanced scan showed the right renal artery was cut off and the enhancement degree of the lesion was similar to that of the renal artery during the arterial phase but nonhomogeneous (**Figure 1**). Decreased right renal perfusion was also present. Radiologists had diagnosed the lesion as a tumor, so the patient was admitted into Department of Urology then. However, urologists remained skeptical of the nature of the lesion. After a discussion among radiologists, urologists, interventional radiologists and vascular surgeons, the diagnosis was corrected as a massive RAA. The patient was transferred to Department of Interventional Radiology to receive endovascular interventional therapy given his age, willingness and minimal trauma.

Pre-operative blood and urine tests exhibited completely normal results. Catheter selective angiography of the right renal artery under local anesthesia revealed a saccular RAA next to the first bifurcation, arising proximally from a large segmental branch and measuring around 12.0 cm*10.4 cm with a wide neck (**Figure 2**). Since the outflow tract was obscured, coil embolization through inflow occlusion was elected to be performed due to the specific morphology of the RAA. Two Interlock 8 mm* 20 cm coils (Boston Scientific, Marlborough, Massachusetts) were released to fill the inflow tract, but one of them floated into the sac at the first attempt. A micro-catheter was subsequently introduced into the right renal artery, and two Interlock 6 mm*20 cm micro-coils (Boston Scientific, Marlborough, Massachusetts, USA) and one MWCE-18-14-6-NESTER coil (Cook Medical, Bloomington, Indiana, USA) were sent to accomplish embolization. Post-procedure angiography confirmed a complete embolization of the RAA and satisfactory visualization of the main trunk of the right renal artery.

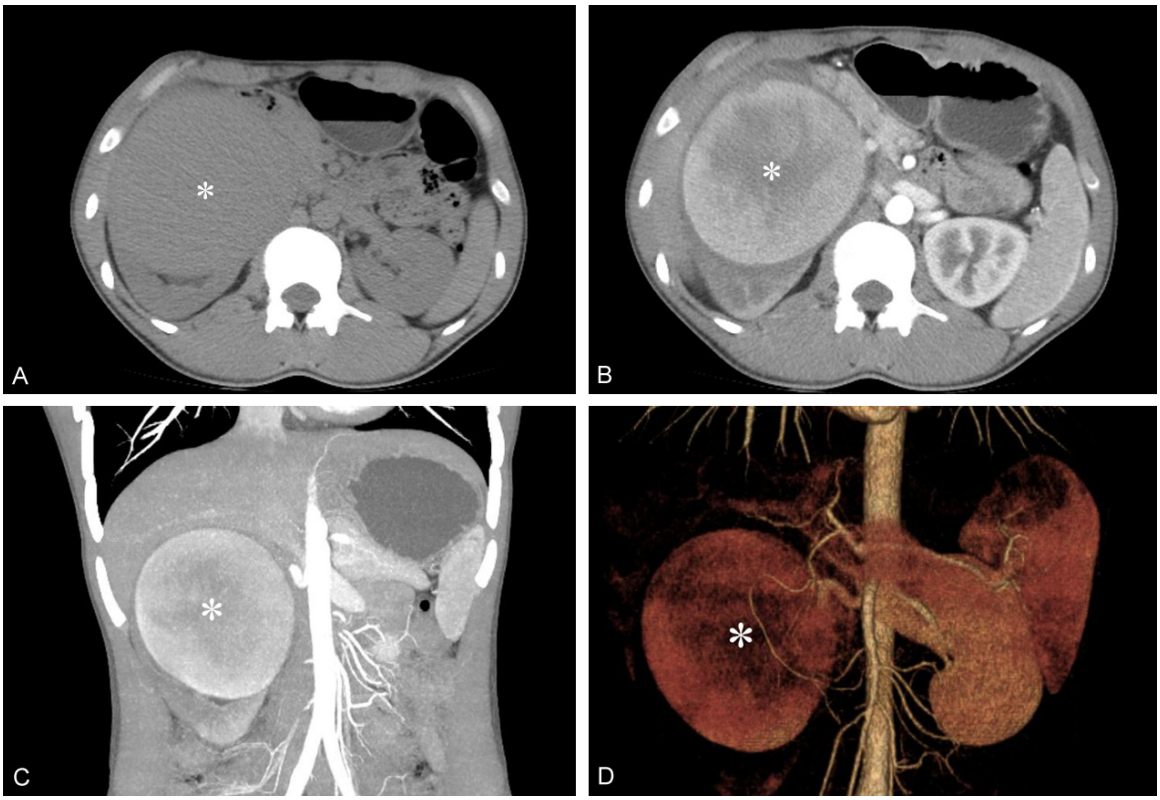

Figure 1. Pre-operative CTA imaging. A. Transverse imaging without contrast. B. Transverse imaging of the arterial phase. C. Sagittal imaging of the arterial phase. D. Volume rendering of the arterial phase. The RAA has been marked by "*".

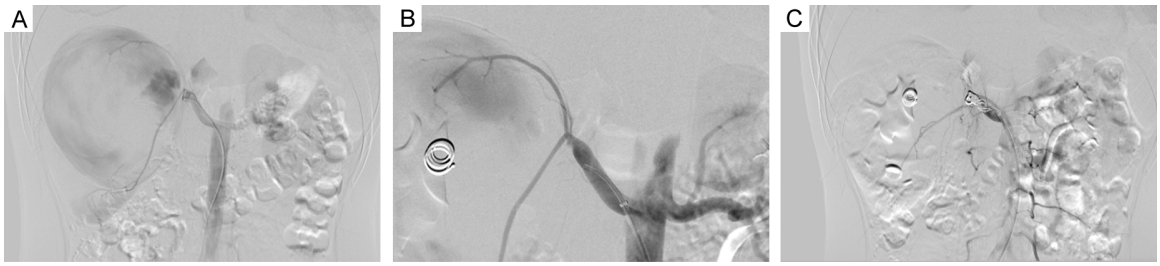

Figure 2. A. Pre-procedure angiography revealed a saccular RAA next to the first bifurcation, measuring around 12.0 cm*10.4 cm. B. A coil floated into the sac during the operating procedure. C. Post-procedure angiography confirmed a complete embolization of the RAA.

The patient suffered nausea and right flank pain on post-operative day 1 and fever with a peak of 38°C on day 2. Post-operative blood tests revealed a mild elevation in creatinine, alanine aminotransferase and aspartate aminotransferase. The highest white blood cell count was $21.00*10^9$/L with a proportion of neutrophils as 87.6% and C-reactive protein was 169.13 mg/L. The blood germiculture was negative. CTA conducted on post-operative day 2 demonstrated a more decreased right renal perfusion than pre-operative scan and no apparent abscess formation. Blood chemistry laboratory values declined back to normal limits spontaneously soon on post-operative day 3. All of these symptoms resolved through empiric antibacterial therapy within one week after embolization. The patient was discharged on post-operative day 7. At the two-month follow-up, an increased perfusion of the right kidney was surprisingly observed in CTA most likely owing to the formation of collateral circu-

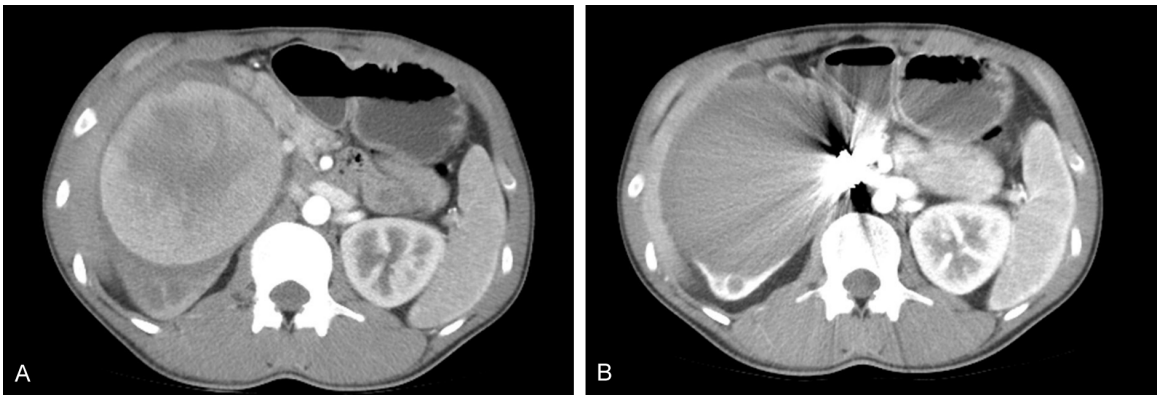

Figure 3. A and B. CTA performed on two months after operation exhibited an increased perfusion of the right kidney, while the RAA remained without significant enhancement.

Table 1. Quality assessment checklist

Checklist Items	Yes/no
Were patient demographic characteristics clearly described?	
Was the patient's history clearly described?	
Was the current clinical condition of the patient on presentation clearly described?	
Were diagnostic tests or assessment methods and the results clearly described?	
Was the intervention(s) or treatment procedure(s) clearly described?	
Was the post-intervention clinical condition clearly described?	
Were adverse events (harms) or unanticipated events identified and described?	
Does the case report provide takeaway lessons?	
Was informed consent or ethical approval obtained and clearly reported?	

lation, while the RAA remained without significant enhancement (**Figure 3**). The patient didn't complain of any discomfort and all the basic hematology and blood chemistry tests were normal. Unfortunately, the patient no longer carried on periodic follow-up in our center due to the move of his residence.

Methods

In August 2025, a systematic literature search was conducted using the PubMed, Web of Science, and ScienceDirect databases. The search terms included "giant renal artery aneurysm" and "management strategy". The inclusion criteria were as follows: (1) Study subjects: patients with a clearly diagnosed renal artery aneurysm (RAA) with an aneurysm diameter ≥ 50 mm; (2) Study type: case reports; (3) Language: English; (4) Publication period: from January 2000 to August 2025.

The exclusion criteria were: (1) cases initially suspected to be RAAs but later excluded from this diagnosis; (2) aneurysms not meeting the size criterion for a giant RAA (diameter < 50 mm) or cases without a clearly reported aneurysm size; (3) studies that included multiple RAA cases but did not provide detailed management information for cases meeting the size criterion; (4) non-English publications; (5) articles published before January 2000.

Quality assessment of the included studies was conducted using the Joanna Briggs Institute (JBI) critical appraisal checklist for case reports and case series. Each included study was independently evaluated by two reviewers. Disagreements were resolved through discussion or by consulting a third reviewer. The checklist consists of nine domains assessing the clarity and reliability of reporting, diagnostic accuracy, intervention description, and outcomes (**Table 1**). An overall judgment of risk of bias (Low/Moderate/High) should be made for each report.

All studies meeting the inclusion criteria were thoroughly reviewed, and relevant data were systematically extracted for further analysis.

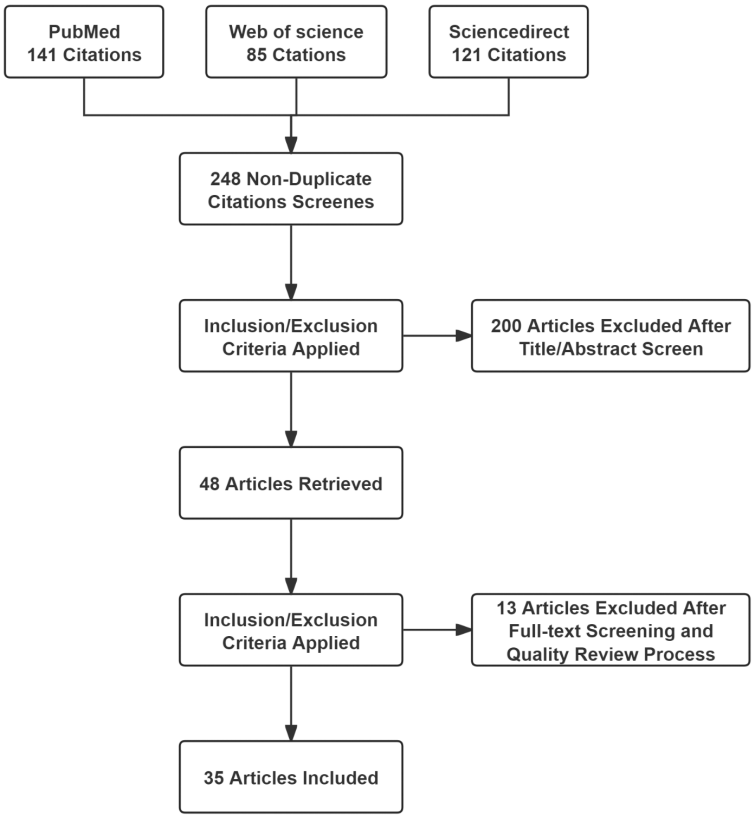

Figure 4. Flow diagram of the review study.

Results

Search results and patient characteristics

The systematic literature search initially identified 347 studies. After screening titles and abstracts and removing duplicates, 248 studies were retained for further evaluation. Following a detailed full-text review and examination, 35 studies met the inclusion criteria and got high quality assessment results (**Figure 4**; **Table 2**).

A total of 35 patients were included in this review, with a mean age of 53 years (range: 15-88 years). Female patients appeared to be more common among cases complicated by arteriovenous fistula. Among the included cases, 12 patients underwent endovascular therapy, and 20 patients received surgical treatment as the primary approach - including one patient who underwent successful surgery following failed endovascular intervention. In addition, 2 patients were treated with a combination of endovascular and surgical procedures, while 1 patient received conservative management primarily based on pharmacologic therapy (**Figure 5**).

Results of the endovascular treatment group

A variety of endovascular techniques were reported in the included studies. The choice of intervention was primarily determined by the aneurysm's anatomical characteristics, the presence or absence of an arteriovenous fistula, and the patient's baseline renal function. The main techniques employed included coil embolization, dedicated vascular occlusion devices, covered stent implantation, liquid embolic agents, and combined approaches.

Most cases adopted a combination strategy, such as "coil plus vascular plug" or "covered stent plus coil" techniques. Across all reported cases, technical success, defined as complete aneurysm exclusion or absence of contrast opacification, was reported in the majority of endovascularly treated cases. Nonetheless, a few cases required subsequent surgical intervention after failed endovascular treatment; these will be discussed in detail in the surgical treatment section.

Postoperatively, the aneurysmal blood flow was effectively eliminated in nearly all patients, and associated arteriovenous fistulas were successfully occluded. Clinical symptoms such as hypertension, abdominal pain, and hematuria showed significant improvement or complete resolution following treatment. During follow-up periods ranging from 3 months to 3 years, imaging studies including CTA and ultrasonography consistently demonstrated complete thrombosis and gradual shrinkage of the aneurysm sac, with no recurrence reported in any case.

It should be noted that outcome measures such as technical success, symptom improve-

Table 2. Introduced the characteristics of patients

	Gender	Age	Location	Size	Type	treatment method
Pappas 2022 [23]	M	42	Right renal artery	127 mm	Cystic	AVP + Coil Embolization
Jiang 2019 [24]	M	43	Distal trunk of right renal artery	63*21 mm	Spindle-shaped	PDAO
Ladlow 2022 [26]	M	72	Distal trunk of right renal artery	60*60*79 mm	Cystic	Stent-Graft Placement
Altit 2009 [21]	F	60	Lower pole of left kidney; Renal arteriovenous fistula	60 mm	Cystic	Coil Embolization
Huy 2022 [25]	F	45	Bilateral renal arteries	55*65 mm	Cystic	AVP + Coil Embolization
Hinojosa 2016 [29]	F	17	Proximal bifurcation of left renal artery	(R)67*46 mm; (L)43*17 mm	Cystic	Coil Embolization
Takebayashi 2008 [22]	M	28	Right renal artery	90 mm	Cystic	Coil Embolization (installment)
Neerhut 2022 [27]	F	64	Right renal artery	70 mm	Cystic	Stent-Graft Placement
Wang 2024 [30]	M	60	Right renal artery	110 mm	Cystic	Coil Embolization
Janicka 2022 [31]	M	45	Right renal artery	53*67*102 mm	Cystic	Coil Embolization
Janho 2019 [28]	M	35	Upper renal artery of right transplanted kidney	115*91 mm	Cystic	Coil Embolization
Gutta 2008 [32]	M	35	Left renal artery	100 mm	Cystic	Coil Embolization
Morosanu 2021 [33]	F	24	Left renal artery	60 mm	Cystic	Renal Autotransplantation
Kato 2006 [34]	F	78	Right renal artery	70 mm	Cystic	Nephrectomy
Tarmiz 2010 [35]	M	48	Right renal artery	180 mm	Cystic	Nephrectomy
Matsubara 2006 [36]	M	57	Left renal artery	70 mm	Spindle-shaped	Nephrectomy
Martin 2025 [37]	M	51	Bilateral renal arteries	50.2 mm	Cystic	Renal Autotransplantation
Okamoto 2014 [38]	F	75	Left renal artery	45*40 mm; 75*60 mm	Cystic	Nephrectomy
Dai 2025 [39]	M	35	Right renal artery	68.3*30 mm; 6*46.3 mm	Cystic	In Situ Renal Artery Reconstruction
Kotsis 2025 [40]	M	75	Left renal artery	82*80 mm	Spindle-shaped	In Situ Renal Artery Reconstruction
Gyedu 2008 [41]	M	48	Main trunk of left renal artery	120 mm	Cystic	In Situ Renal Artery Reconstruction
Li 2015 [42]	M	57	Bifurcation of right renal artery	51 mm	Cystic	Renal Autotransplantation
Yang 2005 [43]	F	33	Distal left renal artery	102*65*61 mm	Cystic	In Situ Renal Artery Reconstruction
Jawad 2023 [44]	M	35	Left renal artery	120*85*60 mm	Cystic	Nephrectomy
Ramdass 2013 [2]	F	81	Right renal artery	100 mm	Cystic	Nephrectomy
Cindolo 2015 [45]	F	59	Right renal artery	75*120 mm	Cystic	Nephrectomy
Paruzel 2011 [10]	F	87	Right renal artery	100 mm	Cystic	Nephrectomy
Chen 2019 [46]	F	29	Bilateral renal arteries	80 mm;70 mm	Cystic	In Situ Renal Artery Reconstruction
Frankel 2015 [47]	M	46	Right renal artery	95*100*130 mm; 42*45*50; 110*110*125 mm	Cystic	Nephrectomy
Sajja 2002 [48]	M	52	Left renal artery	160*130*100 mm	Cystic	Nephrectomy
Katsikatsos 2024 [49]	M	86	Left renal artery	54*42 mm	Cystic	Nephrectomy
Sabharwal 2006 [50]	M	63	Right renal artery	110*65 mm	Cystic	Nephrectomy
Turchino 2022 [11]	M	67	Right renal artery	76*66 mm	Cystic	Endovascular embolization combined with laparoscopic nephrectomy
Wang 2025 [12]	F	45	Upper and middle branches of right renal artery	64*43 mm	Cystic	Spring coil embolization combined with open resection for right RAA + plaque angioplasty
Ghenu 2022 [13]	F	88	Left renal artery	109*102*94 mm	Cystic	Conservative treatment with medication

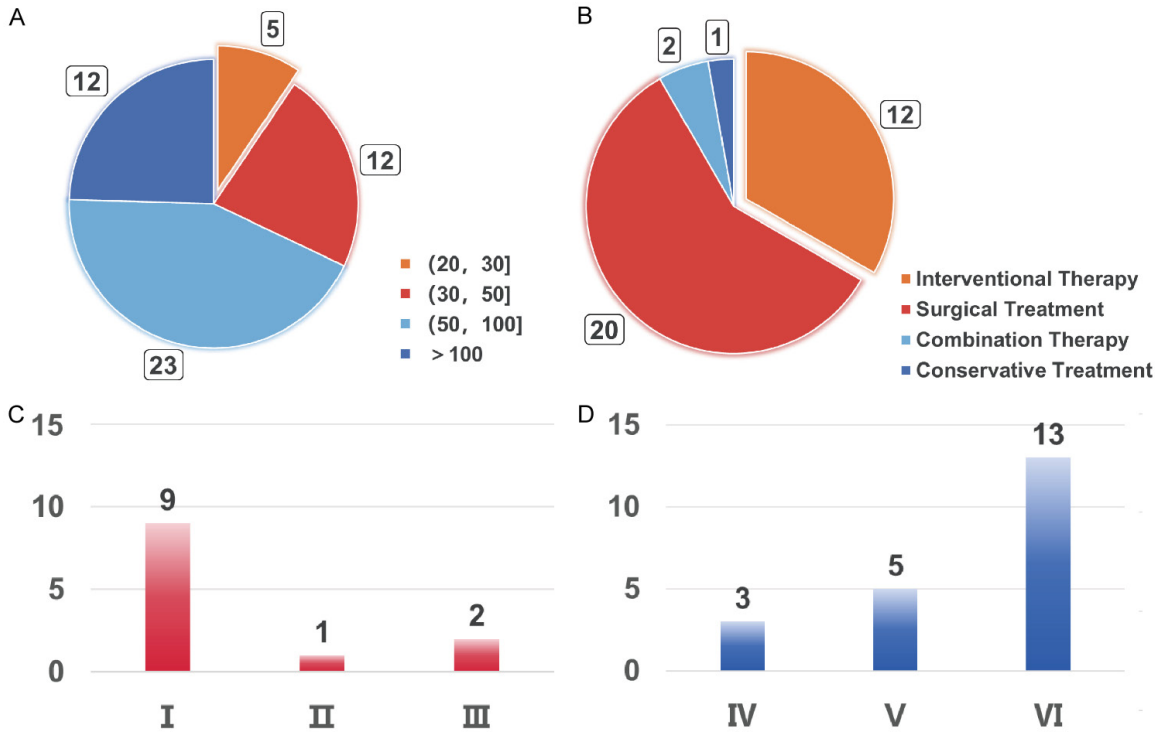

Figure 5. A. Displayed the number of cases with different sizes of vascular tumors. B. Displayed the number of cases treated with different treatment plans. C. Displayed the number of cases treated with three different intervention strategies. D. Displayed the number of cases treated with three different surgical treatment plans. (I: Spring coil embolization; II: PDAO; III: Placement of covered stent; IV: Ex vivo autologous kidney transplantation; V: In situ arterial reconstruction; VI: Nephrectomy).

ment, and renal function preservation were extracted descriptively from the original case reports. Definitions of these outcomes were not standardized across studies and varied in terms of imaging criteria, clinical judgment, and follow-up duration. Therefore, these results should be interpreted as qualitative summaries rather than standardized or comparable endpoints.

Results of the surgical treatment group

Based on the anatomical complexity of the aneurysm, renal function status, and overall health condition of the patients, the surgical interventions reported in the included studies could be broadly divided into two major categories: renal artery reconstruction with nephron-sparing surgery and nephrectomy.

For patients with preserved renal function, renal artery reconstruction and nephron-sparing procedures were commonly selected in patients with preserved renal function, although these approaches require advanced surgical expertise. The specific surgical techniques primarily included: 1. Ex vivo repair with autotransplantation: This technique was applied in complex cases of giant renal artery aneurysms (GRAAs) involving the renal hilum, arterial bifurcation, or multiple branches. 2. In situ renal artery reconstruction: Techniques in this category included aneurysmectomy with main-to-renal artery bypass, end-to-end anastomosis, or patch angioplasty. In cases without renal atrophy, nephron-sparing surgery was reported to achieve renal preservation in cases without pre-existing renal atrophy.

Nephrectomy continues to play an important role in the management of GRAA, with the main indications encompassing the following four clinical scenarios: (1) Loss of renal function: When prolonged compression from the aneurysm leads to severe renal parenchymal atrophy and irreversible loss of function (often < 10% of baseline on preoperative assessment), nephrectomy represents a reasonable option. (2) Large arteriovenous fistula: In cases where

the aneurysm erodes into the renal vein, forming a large, high-flow arteriovenous fistula and causing irreversible renal damage, radical nephrectomy serves as the definitive treatment. (3) Complex or emergency conditions: For massive, irregularly shaped, or ruptured aneurysms involving all major branches, when vascular reconstruction is not feasible, nephrectomy becomes a life-saving procedure. (4) Elderly or high-risk patients: In elderly patients with multiple comorbidities and normal contralateral renal function, nephrectomy may be selectively performed to avoid the high perioperative risk associated with complex vascular reconstruction.

In the reviewed literature, renal artery reconstruction procedures demonstrated high surgical success rates. The success of nephron-sparing surgery was closely correlated with preoperative renal function; in patients without renal atrophy, the renal preservation rate reached 100%. Following successful vascular reconstruction, renal function was effectively maintained or notably improved. In patients who underwent nephrectomy, serum creatinine levels remained stable as long as the contralateral kidney functioned normally.

From a symptomatic perspective, both reconstructive and extirpative surgical approaches effectively alleviated symptoms such as pain, hypertension, and heart failure. Regarding complications, the overall incidence among elective cases was low. However, one 87-year-old patient who underwent emergency nephrectomy for a ruptured GRAA ultimately died from respiratory and circulatory failure secondary to pneumonia, highlighting the substantial risks associated with emergency surgery and advanced age [10].

Results of combined and conservative treatment

Two cases in the reviewed literature employed combined therapeutic approaches. In one case, a 67-year-old patient with a giant aneurysm measuring 76 mm and concurrent anemia underwent preoperative embolization of the renal artery using an Amplatzer Vascular Plug (AVP) to reduce the risk of intraoperative bleeding, followed by successful laparoscopic nephrectomy [11]. In another case, a 45-year-old patient experienced recurrence after three sessions of coil embolization, and was ultimately cured through open surgical repair [12].

One 88-year-old patient presented with a GRAA that had caused severe atrophy of the affected kidney (parenchymal thickness of only 2 mm) and near-complete loss of renal function, with most of the aneurysm already thrombosed. Considering the patient's advanced age, high surgical risk, and personal preference, a conservative medical management strategy was adopted, primarily focusing on the control of hypertension and pain [13].

Discussion

Renal artery aneurysm (RAA) is an uncommon vascular entity; however, when the diameter exceeds 50 mm, it is classified as a giant renal artery aneurysm (GRAA), a condition that poses distinctive diagnostic and therapeutic challenges compared with ordinary RAA. GRAAs are often associated with chronic degenerative pathologies such as atherosclerosis, and the massive aneurysmal sac may exert significant compression on adjacent structures - including the renal collecting system and renal vein - leading to secondary pathologic changes such as severe hydronephrosis, renal parenchymal atrophy, or the formation of arteriovenous fistulae (AVFs) [5].

In this review, cases with aneurysm diameters of 76 mm and 109 mm presented with complex clinical manifestations such as refractory hypertension, abdominal pain, hematuria, and marked renal dysfunction [11, 13]. These cases highlight that a giant RAA should not be regarded merely as a vascular dilatation but rather as a space-occupying and hemodynamically active lesion, necessitating a comprehensive treatment strategy that balances vascular, renal, and systemic considerations.

The index case in this study was particularly rare and atypical for RAA, yet postoperatively developed a characteristic post-embolization syndrome, which was promptly recognized and managed through multidisciplinary collaboration.

Only about 25% of RAA patients are symptomatic, most commonly presenting with refractory hypertension, abdominal/flank/back pain, hematuria, or a palpable abdominal mass [5,

14, 15]. In contrast, our case was identified due to a remarkably large abdominal mass. The mean diameter of RAAs reported in the literature ranges from 12.9 to 16.0 mm, and aneurysms larger than 25 mm represent only about 3% of cases [5, 14, 15]. Most RAAs originate from the bifurcation of the main renal artery, and are typically solitary and unilateral [5, 16].

Epidemiologically, RAAs occur more frequently in women (54-73%), with a mean age at diagnosis of 61 ± 13 years, approximately 8.9 years later in men [17, 18]. Hypertension is present in 82% of patients [15]. The index case involved a 21-year-old male with no history of hypertension or smoking and a massive aneurysm measuring 11.5 cm, an extremely rare presentation underscoring the need to consider RAA even in atypical clinical scenarios (e.g., cases initially suspected as renal malignancy).

Long-term observational studies indicate that RAAs generally exhibit a very slow natural growth rate (0.06-0.23 mm/year) [16, 19]. We speculate that the present case likely originated during childhood, with accelerated growth during adolescence.

Endovascular coil embolization was performed, followed by transient fever and hepatic-renal dysfunction, consistent with post-embolization syndrome. Follow-up at two months demonstrated increased renal perfusion, possibly due to collateral circulation formation. Although endovascular therapy proved effective, the fragility of the aneurysmal wall warrants continued long-term surveillance due to residual rupture risk.

Building on this case, the present review systematically analyzed 35 patients with GRAA, summarizing treatment strategies and outcomes that reflect an individualized, anatomy-based management principle. The cornerstone of therapy lies in accurately balancing anatomical complexity, renal function, and surgical risk.

Endovascular therapy

In our review, endovascular treatment demonstrated a high technical success rate and generally favorable early outcomes in selected cases. These findings suggest that endovascular therapy represents a feasible and minimally invasive option for appropriately selected patients with giant renal artery aneurysms. Its principal benefit lies in minimal invasiveness - patients experience fewer perioperative complications and a faster recovery compared with open surgery. However, these advantages rely heavily on a detailed understanding of the patient's vascular anatomy and hemodynamic profile.

Coil embolization remains the most frequently employed technique. Two main strategies are used in practice. The first is intra-aneurysmal coil packing, in which coils are deployed directly into the aneurysmal sac to induce thrombosis while maintaining parent artery patency. This method works best for narrow-neck aneurysms and is particularly useful when preservation of renal function is a priority [20]. The second approach, parent artery occlusion, involves blocking the feeding artery and allowing infarction of the supplied renal parenchyma. This strategy is chosen when the aneurysm arises from distal branches or when the kidney is already nonfunctional. In some instances, a staged embolization protocol was adopted to promote gradual thrombosis and lower the risk of abrupt hemodynamic changes [21, 22].

We also noted the application of advanced occlusion devices such as the Amplatzer Vascular Plug (AVP) and patent ductus arteriosus (PDA) occluders. The AVP is mainly indicated for occlusion of the main renal artery or large fistulous tracts, while PDA occluders are advantageous in treating high-flow arteriovenous fistulae, as their design minimizes the chance of device migration [23-25]. Covered stents offer another alternative for cases with an adequate proximal and distal landing zone, enabling aneurysm exclusion while maintaining arterial continuity [26, 27]. In addition, liquid embolic materials like HIL 30% have occasionally been used as adjuncts to enhance packing density and reduce recanalization, especially in partially thrombosed or complex aneurysms [28].

From our analysis, endovascular therapy appears most suitable for patients with favorable anatomy - such as a defined neck and accessible landing zones - those with preserved renal function, or individuals whose comorbidities make open surgery undesirable. It is also a logical choice in hemodynamically complex situations like arteriovenous fistulae. Nevertheless, careful long-term imaging follow-up is essential

to detect potential recanalization or aneurysm reperfusion, as even technically successful embolization does not completely eliminate the risk of delayed rupture.

Surgical management

Despite the growing popularity of endovascular techniques, surgery continues to play a decisive role in the management of giant renal artery aneurysms, particularly for lesions with intricate anatomy or when endovascular exclusion is not feasible. In our review cohort, most surgically treated cases involved either complex hilar involvement, multiple arterial branches, or coexisting renal ischemia that precluded safe embolization.

Surgical approaches can be broadly divided into nephron-sparing reconstruction and nephrectomy. The overarching principle is to restore vascular integrity while preserving as much functional renal parenchyma as possible. Ex vivo repair with autotransplantation remains the benchmark technique for anatomically complex lesions. By allowing repair in a bloodless and cold-perfused environment, this method provides the best chance of both complete aneurysm removal and renal salvage. In situ reconstruction, including bypass grafting, end-to-end anastomosis, or patch angioplasty, is appropriate for accessible lesions and depends on the surgeon's expertise in microvascular techniques.

Nephron-sparing procedures are indicated when renal function remains recoverable. In our pooled analysis, kidneys without pre-existing atrophy achieved full preservation following reconstruction, and postoperative renal function improved significantly. These findings underscore the importance of comprehensive preoperative assessment using imaging and nuclear renal function studies to guide surgical decision-making.

Nephrectomy, although radical, still has a clear role under defined circumstances - such as a nonfunctional kidney (function < 10%), rupture, or when reconstruction is technically impossible. It also represents a pragmatic option for elderly or high-risk patients with a healthy contralateral kidney. Notably, one octogenarian in our review died from postoperative complications following emergency nephrectomy, reminding us that surgical risk increases sharply with age and urgent presentation [10].

In essence, surgery should be viewed not as a last resort but as an integral part of a multidisciplinary treatment algorithm. For young patients with long life expectancy and good renal function, anatomical repair offers the most durable solution. In contrast, nephrectomy remains a necessary, life-saving option when preservation is no longer viable. Optimal management thus depends on individualized assessment, balancing anatomical complexity, renal reserve, and overall patient condition.

Combined and conservative approaches

The reported combined treatment cases illustrate the synergistic potential of hybrid strategies. In patients with large, complex, or high-risk GRAAs, preoperative endovascular embolization effectively reduces hemodynamic stress and intraoperative bleeding, facilitating safe completion of subsequent definitive surgery, such as laparoscopic nephrectomy [11, 12]. Conversely, when repeated embolizations fail to achieve durable exclusion, timely transition to surgery ensures curative management.

Conservative therapy also holds value in select scenarios. In patients with severely atrophic, nonfunctional kidneys, largely thrombosed aneurysms, and low rupture risk, especially those of advanced age and high surgical risk, aggressive intervention offers limited benefit [13]. In such cases, the therapeutic objective should shift from curative resection to symptom control, risk management, and quality-of-life optimization, with medical therapy representing the most rational and patient-centered approach.

It should be noted that outcome measures such as "technical success", "symptom improvement" and "renal function preservation" were reported in a descriptive manner. Definitions of these outcomes were derived from the original case reports and were not standardized across studies. In most cases, technical success referred to angiographic exclusion of the aneurysm or absence of contrast opacification, whereas symptom improvement and renal function preservation were variably defined based on clinical judgment, symptom resolution, or changes in serum creatinine. Given

this heterogeneity, these outcomes should be interpreted as qualitative summaries rather than standardized or directly comparable clinical endpoints.

Several important limitations of this review should be acknowledged. First, this study exclusively included English-language case reports published over a 25-year period, with a total sample size of only 35 patients. This design is inherently susceptible to publication bias, as successful, technically feasible, or unusual cases are more likely to be reported, whereas unfavorable outcomes, complications, or treatment failures may be underrepresented. Second, selective reporting bias cannot be excluded, given the lack of standardized outcome definitions, heterogeneous follow-up durations, and inconsistent reporting of complications across case reports. As a result, this review is descriptive in nature and does not allow reliable comparison of effectiveness between endovascular and surgical treatment strategies.

Conclusion

Giant renal artery aneurysms (GRAAs) represent a distinct and clinically challenging subset of renovascular disease. Unlike ordinary renal artery aneurysms, GRAAs act as space-occupying and hemodynamically active lesions that may cause hydronephrosis, renal dysfunction, hypertension, hematuria, or arteriovenous fistula formation. Accordingly, management strategies should address not only aneurysm exclusion but also secondary effects on renal function and adjacent structures.

Based on the currently available case-based evidence, treatment of GRAAs should be individualized and guided primarily by aneurysm morphology, renal functional reserve, and overall patient condition. Both endovascular and surgical approaches appear to be feasible options in selected patients; however, definitive conclusions regarding their relative effectiveness cannot be drawn from case reports alone.

Endovascular therapy provides a minimally invasive alternative and has demonstrated favorable technical feasibility in appropriately selected cases, particularly when renal preservation is desirable or surgical risk is high. Surgical intervention, including renal artery reconstruction or nephrectomy, remains indispensable in situations involving complex hilar anatomy, multibranch involvement, rupture, or when endovascular exclusion is not technically feasible.

Hybrid strategies combining endovascular and surgical techniques may offer complementary advantages in high-risk or anatomically complex cases, while conservative management may be reasonable for selected patients with poor renal function, low rupture risk, and significant comorbidities. Ultimately, optimal management of GRAAs requires a multidisciplinary, patient-specific approach rather than reliance on comparative expectations of treatment superiority.

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Disclosure of conflict of interest

None.

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