



Case Report

When Bodybuilding Goes Wrong—Bilateral Renal Artery Thrombosis in a Long-Term Misuser of Anabolic Steroids Treated with AngioJet Rheolytic Thrombectomy

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Abstract: Bilateral renal infarction is an extremely rare condition with only few cases reported in the literature. We present a case of bilateral renal infarction affecting an otherwise healthy 34 year old bodybuilder chronically misusing testosterone and stanozolol. The patient presented with severe flank pain mimicking renal colic and biochemical features of acute kidney injury. Diagnostic workup revealed thrombosis affecting both renal arteries. Subsequently, the patient underwent a percutaneous rheolytic thrombectomy with AngioJet catheter, along with catheter-directed thrombolysis. Right-sided retroperitoneal hematoma developed as an early complication, mandating surgical exploration and nephrectomy due to kidney rupture and the unstable condition of the patient. Intensive care and continuous renal replacement therapy were instigated until a gradual improvement of the patient status and a return of kidney function was achieved. No abnormalities were found in the cardiological and hematological evaluation. We believe this is a first report of bilateral renal infarction associated with anabolic steroid misuse in an otherwise healthy individual, and a first report of AngioJet thrombectomy in bilateral thrombosis of renal arteries. It stresses the importance of a thorough diagnostic workup of colic patients and emphasizes the need for sports medicine to reach out to amateur athletes with education on the harms of doping.

Keywords: doping in sports; public health; testosterone; stanozolol; thrombosis; renal infarction; acute kidney injury; thrombolytic therapy; nephrectomy



Citation: Lemiński, A.; Kubis, M.; Kaczmarek, K.; Gołąb, A.; Kazimierczak, A.; Kotfis, K.; Słojewski, M. When Bodybuilding Goes Wrong—Bilateral Renal Artery Thrombosis in a Long-Term Misuser of Anabolic Steroids Treated with AngioJet Rheolytic Thrombectomy. *Int. J. Environ. Res. Public Health* **2022**, *19*, 2122. <https://doi.org/10.3390/ijerph19042122>

Academic Editors: Adrian Midgley and Paul B. Tchounwou

Received: 17 January 2022

Accepted: 11 February 2022

Published: 14 February 2022

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1. Introduction

Renal infarction (RI) is a rare condition that occurs when kidney vascularization becomes severely compromised, often leading to a loss of the renal unit. Causative factors for RI include atrial fibrillation, renal artery stenosis or dissection, inherited hypercoagulable states, amyloidosis and trauma [1–5]. There are scarce reports on bilateral RI caused by fibromuscular dysplasia, hereditary thrombophilia, cocaine abuse and severe COVID-19 [2,6–8]. However, to the best of our knowledge, no case of bilateral RI linked to bodybuilding and long-term misuse of anabolic androgenic steroids (AAS) has been published to date.

2. Case Presentation

We present a case of an otherwise healthy 34 year old male bodybuilder who presented to the emergency department due to severe right flank pain not responding to analgesics,

lasting for 2 h. The medical history revealed use of AAS (testosterone and stanozolol) for several months as a part of his bodybuilding program but was otherwise unremarkable with no familial history of thromboembolic events. The physical examination revealed right flank percussion tenderness, atrophic testicles, extensive muscle mass and reduced adipose tissue. The routine laboratory evaluation showed a white blood cells count of $12.23 \times 10^9/L$, thrombocytosis of $478 \times 10^9/L$, C-reactive protein of 19.3 mg/L, D-Dimer of 988.1 ng/mL, creatinine of 1.82 mg/dL, proteinuria of 1200 mg/L and up to 10 erythrocytes per high power field in the urinary sediment. The routine clotting parameters, i.e., an activated partial thromboplastin time (APTT) of 27.6 s, prothrombin time (PT) of 11.8 s and international normalized ratio (INR) of 1.07 were within normal ranges. The kidney ultrasound showed no signs of nephrolithiasis or hydronephrosis, but the Doppler examination revealed blood flow to be restricted to the proximal part of the right renal artery (RA). An abdominal angio-Computed Tomography (angio-CT) scan was performed, revealing bilateral thrombosis of RAs, with only a scant perfusion preserved in the upper pole of the left kidney (Figure 1A–D).

The AngioJet (Boston Scientific, Marlborough, MA, USA) rheolytic thrombectomy of both RAs and intra-arterial thrombolysis with 20 mg of alteplase were performed, restoring their patency, yet the parenchyma of the right kidney was only partly enhancing, and no venous return was seen. Additionally, an iatrogenic injury to the right lower pole segmental artery occurred. Despite attempts at endovascular management, a progressive decline in the hemoglobin level and deterioration of the patient's status were observed postoperatively. The emergency ultrasound confirmed the presence of right-sided retroperitoneal hematoma requiring urgent surgical revision. Intraoperatively, the rupture of kidney parenchyma and extensive macroscopic features of necrosis were found within the right kidney, which, given the unstable patient condition, mandated an immediate nephrectomy. The patient required admission to the intensive care unit and continuous renal replacement therapy due to clinical manifestations of acute kidney injury. He received a transfusion of five units of packed red blood cells. Subsequently, a progressive improvement of the clinical status and increase in the urine output were observed in the following days, along with a gradual lowering of serum creatinine (Table 1).

Table 1. Serum creatinine, estimated glomerular filtration rate and 24 h urine output during hospital stay.

Day of Stay	1	2	3	4	5	6	7
Creatinine [mg/dL]	1.82	2.66	3.82	4.34	4.98	4.43	3.89
eGFR [mL/min/1.73 m ²]	47	30	19	17	14	16	19
Urine output [mL]	n.d.	2100	450	780	4500	8400	2900

eGFR: estimated glomerular filtration rate.

The patient underwent a cardiological evaluation with resting echocardiography which revealed a left ventricle hypertrophy but no thrombotic material within heart cavities. The hematological evaluation has not revealed any inherited clotting disorders leading to hypercoagulability. The patient was discharged home prematurely, at his own request, with decreasing creatinine on low molecular weight heparin. After four years of follow-up, the patient is well, with no significant deterioration of the glomerular filtration rate (GFR) observed over time. He has not suffered any further thromboembolic events and is not medicated with anticoagulant. He undergoes a systematic control with his general practitioner and nephrologist. According to the information provided by the patient, a thrombophilia screen performed outside of our center tested negative and included antithrombin III, protein C, protein S, lupus anticoagulant, factor V Leiden, prothrombin gene mutation, anti- β -2-glycoprotein-1 antibodies and anti-cardiolipin antibodies.

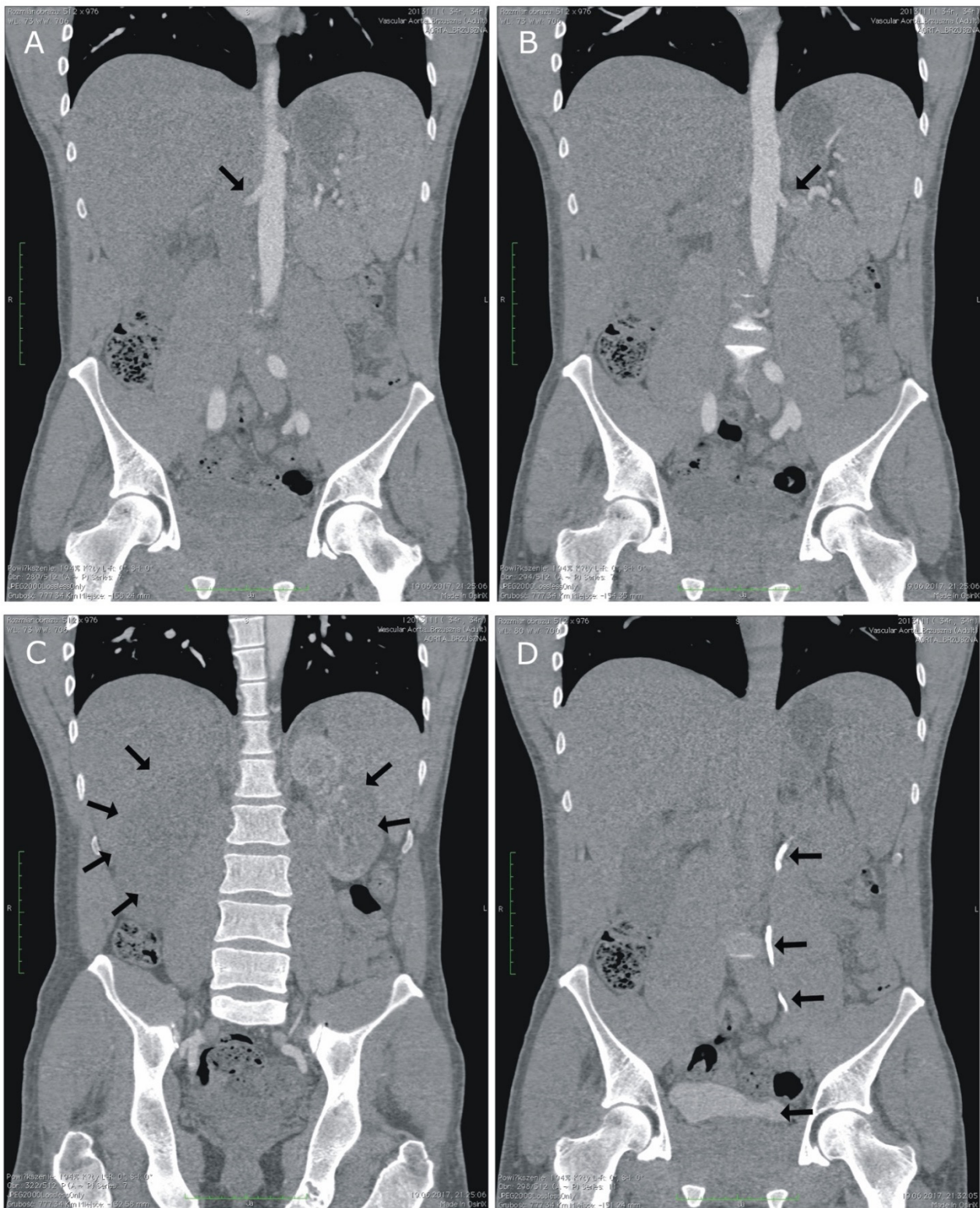


Figure 1. (A,B) Angio-computed tomography scans showing areas of thrombosis in the renal arteries. (C) Infarction (not enhancing) areas within the right and left kidneys. (D) Preserved excretion of contrast urine by intact portions of the left kidney parenchyma.

3. Discussion

Amateur sport offers unrestrained access to a plethora of dietary supplements and medications, including AAS. Their chronic abuse is widespread among young bodybuilders,

with consequences reaching far beyond muscle growth [9]. The spectrum of health sequelae of long-term AAS abuse predominantly affects men of a productive age and therefore constitutes an increasing public health concern [10]. These include but are not limited to cardiovascular toxicity, infertility, psychiatric disorders, withdrawal-associated hypogonadism and induced thrombophilia. Animal studies revealed that prolonged AAS administration intensifies platelet aggregation through increased production of thromboxane A2 and reduced biosynthesis of prostacyclin [11]. Furthermore, chronic AAS exposure induces polycythemia, retention of fluids and vasoconstriction, contributing to the development of hypertension. On top of that, AAS hasten the progress of atherosclerosis due to alterations in the lipid metabolism, which further contributes to an increased risk of thrombosis [12]. Given the detrimental effects of chronic AAS intake on the myocardium leading to left ventricle hypertrophy and diastolic impairment, the long-term misuse of these agents makes affected athletes and bodybuilders predisposed to cardiovascular complications [13]. Specifically, stanozolol combinations have been reported to increase the risk of cardiovascular and thrombotic events, being associated with cases of myocardial infarction, ischemic stroke, severe peripheral arterial thrombosis as well as sudden cardiac death in young bodybuilders [14–17].

Patients with RI may present with a nonspecific constellation of signs and symptoms, usually resembling renal colic [18]. Acute flank pain should trigger a thorough diagnostic workup with ultrasound, including a Doppler study as a main screening modality. Angio-CT and angio-MRI have largely replaced conventional angiography as noninvasive imaging options for a rapid assessment of the patency of RAs and perfusion of kidney parenchyma [19]. Unilateral RIs of limited extent without associated AKI are usually amenable to conservative management with anticoagulants [3,20]. Treatment of extensive or bilateral RI should include percutaneous transluminal angioplasty, AngioJet thrombectomy or catheter-directed thrombolysis, which allow for a successful reperfusion in the majority of cases. Rheolytic thrombectomy with AngioJet catheters has been successfully employed for a broad spectrum of thrombotic and embolic complications in both elective and emergency settings [21,22]. There have been several reports of successful applications of AngioJet in cases of renal infarction due to renal artery thrombosis or emboli; nonetheless, no case of kidney rupture after reperfusion has been described [23–25]. It remains undetermined whether the rupture of the right kidney after the restoration of the patency of RI occurred as a result of concomitant renal vein thrombosis, similarly to several reports of renal allograft ruptures, or due to intraoperative injury at the time of the thrombectomy [26,27]. Notwithstanding this, the remaining left kidney was reperfused successfully, and no significant deterioration of the creatinine level or GFR was observed in the subsequent four years of follow-up.

4. Limitations

This case report has some limitations that need to be acknowledged. The patient was discharged home prematurely at his own request. Consequently, the hematological evaluation for clotting disorders could not be accomplished during his hospital stay at our center with the panel usually including antithrombin III, protein C, protein S, lupus anticoagulant and factor V Leiden. Therefore, the thrombophilia screening was performed in his place of residence abroad. Given limited access to his medical files, we only managed to gather the information provided by a telephone follow-up from the patient (as per information from the GP), according to which no inherited clotting disorders leading to a hypercoagulable state were diagnosed and the performed thrombophilia screen included antithrombin III, protein C, protein S, lupus anticoagulant, factor V Leiden, prothrombin gene mutation, anti- β -2-glycoprotein-1 antibodies and anti-cardiolipin antibodies. The patient required no anticoagulant treatment. Moreover, the exact dosage and timespan of AAS administration remains unknown, as these were given non-professionally at the gym and no records were made. The patient reported the AAS use as being inconsistent and

variable, but nonetheless lasting several months. Notwithstanding this, it seems plausible that recreational AAS abuse was pathogenetically linked to this rare thrombotic episode.

5. Conclusions

Great care is needed in order not to overlook RI in a colic patient, particularly when no hydronephrosis is found and risk factors for thrombosis are present. Furthermore, widespread AAS abuse constitutes a growing public health problem and emphasizes an unmet need for education on the harms of doping among amateur athletes and bodybuilders. The rheolytic thrombectomy with an AngioJet catheter remains a viable treatment option for extensive or bilateral renal infarction.

Author Contributions: Conceptualization, A.L., M.K. and K.K. (Krystian Kaczmarek); methodology, A.L., M.K. and A.K.; validation, A.L. and A.K.; investigation, A.L. and M.K.; resources, M.S., A.L. and A.K.; writing—M.K. and A.L.; writing—review and editing, A.L. and K.K. (Katarzyna Kotfis); visualization, A.L. and M.K.; supervision, K.K. (Katarzyna Kotfis), A.K., A.G. and M.S.; project administration, M.S. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: The study was exempt from further review by the Institutional Review Board (Bioethical Committee) of the Pomeranian Medical University, Szczecin, Poland (protocol number KB-0012/106/09/2021/Z).

Informed Consent Statement: Written informed consent has been obtained from the patient to publish this paper.

Data Availability Statement: Data will be available from the corresponding author upon reasonable request.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Yang, J.; Lee, J.Y.; Na, Y.J.; Lim, S.Y.; Kim, M.G.; Jo, S.K.; Cho, W. Risk factors and outcomes of acute renal infarction. *Kidney Res. Clin. Pract.* **2016**, *35*, 90–95. [[CrossRef](#)] [[PubMed](#)]
2. Zhou, X.J.; Liu, L.J.; Chen, M.; Zhou, F.D. Asynchronous Bilateral Renal Infarction and Thrombophilia With Associated Gene Mutations in a 43-Year-Old Man: A Case Report. *Medicine* **2016**, *95*, e3258. [[CrossRef](#)] [[PubMed](#)]
3. Eren, N.; Gungor, O.; Kocyigit, I.; Guzel, F.B.; Erken, E.; Altunoren, O.; Tatar, E.; Eroglu, E.; Senel, E.; Kaya, B.; et al. Acute renal infarction in Turkey: A review of 121 cases. *Int. Urol. Nephrol.* **2018**, *50*, 2067–2072. [[CrossRef](#)] [[PubMed](#)]
4. Mihout, F.; Joseph, L.; Brocheriou, I.; Leblond, V.; Varnous, S.; Ronco, P.; Plaisier, E. Bilateral kidney infarction due to primary Al amyloidosis: A first case report. *Medicine* **2015**, *94*, e777. [[CrossRef](#)] [[PubMed](#)]
5. Yoon, K.; Song, S.Y.; Lee, C.H.; Ko, B.H.; Lee, S.; Kang, B.K.; Kim, M.M. Spontaneous Renal Artery Dissection as a Cause of Acute Renal Infarction: Clinical and MDCT Findings. *J. Korean Med. Sci.* **2017**, *32*, 605–612. [[CrossRef](#)]
6. Añazco, P.H.; Balta, F.M.; Córdova-Cueva, L. Bilateral renal infarction in a patient with severe COVID-19 infection. *J. Bras. Nefrol.* **2021**, *43*, 127–131. [[CrossRef](#)]
7. Ayach, T.; Kazory, A. Bilateral renal infarction: An uncommon presentation of fibromuscular dysplasia. *Clin. Kidney J.* **2013**, *6*, 646–649. [[CrossRef](#)]
8. Madhrira, M.M.; Mohan, S.; Markowitz, G.S.; Pogue, V.A.; Cheng, J.T. Acute bilateral renal infarction secondary to cocaine-induced vasospasm. *Kidney Int.* **2009**, *76*, 576–580. [[CrossRef](#)]
9. Leifman, H.; Rehnman, C.; Sjöblom, E.; Holgersson, S. Anabolic androgenic steroids-use and correlates among gym users—an assessment study using questionnaires and observations at gyms in the Stockholm region. *Int. J. Environ. Res. Public Health* **2011**, *8*, 2656–2674. [[CrossRef](#)]
10. Kanayama, G.; Kaufman, M.J.; Pope, H.G. Public health impact of androgens. *Curr. Opin. Endocrinol. Diabetes Obes.* **2018**, *25*, 218–223. [[CrossRef](#)]
11. Uzunova, A.D.; Ramey, E.R.; Ramwell, P.W. Arachidonate-Induced thrombosis in mice: Effects of gender or testosterone and estradiol administration. *Prostaglandins* **1977**, *13*, 995–1002. [[CrossRef](#)]
12. Chang, S.; Münster, A.M.B.; Gram, J.; Sidemann, J.J. Anabolic Androgenic Steroid Abuse: The Effects on Thrombosis Risk, Coagulation, and Fibrinolysis. *Semin. Thromb. Hemost.* **2018**, *44*, 734–746. [[CrossRef](#)] [[PubMed](#)]
13. Kouidi, E.J.; Kaltsatou, A.; Anifanti, M.A.; Deligiannis, A.P. Early Left Ventricular Diastolic Dysfunction, Reduced Baroreflex Sensitivity, and Cardiac Autonomic Imbalance in Anabolic–Androgenic Steroid Users. *Int. J. Environ. Res. Public Health* **2021**, *18*, 6974. [[CrossRef](#)] [[PubMed](#)]

14. Christou, G.A.; Christou, K.A.; Nikas, D.N.; Goudevenos, J.A. Acute myocardial infarction in a young bodybuilder taking anabolic androgenic steroids: A case report and critical review of the literature. *Eur. J. Prev. Cardiol.* **2016**, *23*, 1785–1796. [[CrossRef](#)] [[PubMed](#)]
15. Santamarina, R.D.; Besocke, A.G.; Romano, L.M.; Ioli, P.L.; Gonorazky, S.E. Ischemic stroke related to anabolic abuse. *Clin. Neuropharmacol.* **2008**, *31*, 80–85. [[CrossRef](#)] [[PubMed](#)]
16. Falkenberg, M.; Karlsson, J.; Ortenwall, P. Peripheral arterial thrombosis in two young men using anabolic steroids. *Eur. J. Vasc. Endovasc. Surg.* **1997**, *13*, 223–226. [[CrossRef](#)]
17. Torrisi, M.; Pennisi, G.; Russo, I.; Amico, F.; Esposito, M.; Liberto, A.; Cocimano, G.; Salerno, M.; Rosi, G.L.; Di Nunno, N.; et al. Sudden cardiac death in anabolic-androgenic steroid users: A literature review. *Medicina* **2020**, *56*, 587. [[CrossRef](#)]
18. Leong, F.T.; Freeman, L.J. Acute renal infarction. *J. R. Soc. Med.* **2005**, *98*, 121–122. [[CrossRef](#)]
19. Carman, T.L.; Olin, J.W.; Julianna, C. Noninvasive imaging of the renal arteries. *Urol. Clin. N. Am.* **2001**, *28*, 815–826. [[CrossRef](#)]
20. Oh, Y.K.; Yang, C.W.; Kim, Y.L.; Kang, S.W.; Park, C.W.; Kim, Y.S.; Lee, E.Y.; Han, B.G.; Lee, S.H.; Kim, S.H.; et al. Clinical Characteristics and Outcomes of Renal Infarction. *Am. J. Kidney Dis.* **2016**, *67*, 243–250. [[CrossRef](#)]
21. Ierardi, A.M.; Xhepa, G.; Piffaretti, G.; Bacuzzi, A.; Tozzi, M.; Carbone, M.; Barile, A.; Squillaci, E.; Fonio, P.; Brunese, L.; et al. Clinical experience with Angiojet: A comprehensive review. *Int. Angiol.* **2015**, *34*, 1–14. [[PubMed](#)]
22. Latacz, P.; Simka, M.; Brzegowy, P.; Srednicki, W.; Konduracka, E.; Mrowiecki, W.; Słowik, A.; Łasocha, B.; Mrowiecki, T.; Popiela, T. Treatment of high- and intermediate-risk pulmonary embolism using the AngioJet percutaneous mechanical thrombectomy system in patients with contraindications for thrombolytic treatment—A pilot study. *Wideochir. Inne Tech. Maloinwazyjne* **2018**, *13*, 233–242. [[CrossRef](#)] [[PubMed](#)]
23. Silverberg, D.; Menes, T.; Rimon, U.; Salomon, O.; Halak, M. Acute renal artery occlusion: Presentation, treatment, and outcome. *J. Vasc. Surg.* **2016**, *64*, 1026–1032. [[CrossRef](#)] [[PubMed](#)]
24. Siablis, D.; Liatsikos, E.N.; Goumenos, D.; Karnabatidis, D.; Voudoukis, T.; Barbalias, G.; Vlahogiannis, J. Percutaneous rheolytic thrombectomy for treatment of acute renal-artery thrombosis. *J. Endourol.* **2005**, *19*, 68–71. [[CrossRef](#)]
25. Greenberg, J.M.; Steiner, M.A.; Marshall, J.J. Acute renal artery thrombosis treated by percutaneous rheolytic thrombectomy. *Catheter. Cardiovasc. Interv.* **2002**, *56*, 66–68. [[CrossRef](#)]
26. Favi, E.; Iesari, S.; Cina, A.; Citterio, F. Spontaneous renal allograft rupture complicated by urinary leakage: Case report and review of the literature. *BMC Urol.* **2015**, *15*, 114. [[CrossRef](#)]
27. Shahrokh, H.; Rasouli, H.; Zargar, M.A.; Karimi, K.; Zargar, K. Spontaneous kidney allograft rupture. *Transplant. Proc.* **2005**, *37*, 3079–3080. [[CrossRef](#)]