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Title: Concomitant renal artery and aortic aneurysm: is endovascular surgery the correct approach?

Article Type: Case Report

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Abstract: Our case illustrates the concomitant presence of a giant aneurysm of the left renal artery at the ostium and an abdominal aortic aneurysm, in presence of a complex aortic anatomy. Type of approach and timing of the treatment is still not well established for the rare coexistence of these two pathologies. Endovascular therapy in case of surgical high risk patient is considered now the best choice to exclude arterial and aortic aneurysms even though the chance to do further interventions in the follow-up.

For this reason we simultaneously treated both the aneurysms through an embolization with plugs and coils of renal aneurysm and endovascular exclusion of aortic aneurysm; in the follow-up renal function of the patient worsened until haemodialysis and we saw the reperfusion of renal aneurysm and the onset of endoleak I type A from above the aortic and renal aneurysm and B from iliac legs of the previous endograft. We performed a parallel graft technique on visceral vessels in order to exclude the refilling of both aneurysms and preserve visceral vascularization. Follow-up at 12 months showed the complete exclusion of the aneurysms and the patency of stents in celiac trunk and superior mesenteric artery.

Suggested Reviewers:

Dear Editor,

it is an honour for me to send to your journal our case report titled "Concomitant renal artery and aortic aneurysm: is endovascular surgery the correct approach?".

Although endovascular therapy has changed and improved the result of some challenging cases, sometimes about rare pathologies, endovascular treatment can not be the correct or complete approach for a good outcome.

We think that our experience could be helpful in literature in case of the rare condition of concomitant presence of both the aneurysms showing how can be the management of the pathology.

Hoping in an your revision, best regards

Alberto Settembrini
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Dear Editor,

I would like to thank the reviewer for the comments.

About first comment, patient was considered unfit for open surgery because he needed a supra mesenteric cross clamping with with the risk of an important visceral involvement and the patient's general conditions were not such as to give good chances of success. Furthermore the patient was not particularly compliant so we decided to treat him under general anesthesia **(we modified the paper on line 85)**.

The second question is interesting: we decided not to do a fenestrated EVAR because although the patient was asymptomatic the aneurysmal dilation had increased in a short time and we did not think we could wait for the custom made graft; furthermore we considered chimney technique not safe in this case for the risk of mobilization of the stent in renal artery and it was necessary to do a three vessels chimney causing a significant increase of the time of the intervention, increasing the risks for the patient. Otherwise, in our opinion, embolization of the aneurysm could be a definitive solution in such a patient.

Alberto Settembrini
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1 **Concomitant renal artery and aortic aneurysm: is endovascular surgery the**
2 **correct approach?**

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17 **ABSTRACT**

18 Our case illustrates the concomitant presence of a giant aneurysm of the left
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21 well established for the rare coexistence of these two pathologies. Endovascular
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34 artery.

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36

37 **INTRODUCTION**

38 Isolated renal artery aneurysms (RAA) are rare with a reported prevalence of
39 0.01%-0.09% in autopsies series and from 0.3 to 9.7% in ~~the~~ general population
40 undergoing to angiographic or tomographic studies ^{1,2,7}—Risk factors for RRA
41 development are fibromuscular dysplasia, atherosclerosis and vasculitis. RRA
42 are usually asymptomatic, but their rupture can be life-threatening.^{8,3} It happens
43 most frequently when RRA diameters are > 2cm or in pregnant women. ^{veee}

44 Even much rare is the association of RAA with an abdominal aortic aneurysm
45 (AAA) and literature provides only few anecdotal examples.^{3,4,5,4,5,6,6}

46 Owing to ~~their-the~~ rare finding it is still debated which ~~could-beis~~ the best
47 approach to treat both the aneurysms, if at once or in multiple steps.

48 About ~~the~~ endovascular treatment of AAA, in case of complex aortic anatomies,
49 in the last years new approaches have emerged making it possible also for
50 thoraco-abdominal or pararenal aortic aneurysms. Parallel graft technique with
51 standard devices allows to treat AAA without an adequate infrarenal sealing
52 zone ~~thanks to the~~ releasing of covered stents into the renal and/or visceral
53 arteries to maintain their patency.

54 Our case illustrates the concomitant presence of a giant aneurysm of the left
55 renal artery involving the ostium and AAA, in presence of a complex aortic
56 anatomy.

57

58 **CASE PRESENTATION**

59 A 76-year-old caucasian man with a medical history included chronic renal
60 disease with a right atrophic kidney presented at our Hospital with a 4 cm left
61 RAA associated to a 4.8 cm saccular infrarenal AAA detected with abdomen
62 duplex ultrasound. Both aneurysms were known and the patient was in follow-
63 up since many years.

64 Patient's medical history included also chronic obstructive pulmonary disease,
65 hypertension and moderate aortic valve stenosis.

66 Computerized tomography angiogram (CTA) confirmed the presence of both left
67 RAA and AAA. The left saccular RAA had a proximal wide neck and involved the

68 ostium of the artery. The origins of superior mesenteric artery (SMA) and both
69 renal arteries were at the same level and meanwhile the infrarenal AAA's neck

70 length was only 10 mm (Fig.1). Moreover, ~~both aneurysm of both the~~ femoral
71 arteries ~~were aneurysmatic~~ with a diameter of 2.3 cm on the right and 1.8
72 cm on the left respectively . Considering the high surgical risk, due to the fragile

73 clinical conditions, and the need of a supra mesenteric cross clamping increasing
74 the risk of life threatening complications, we deemed the patient unfit for open

75 surgery_ and we planned for a combined endovascular aneurysm repair (EVAR)
76 of the AAA and embolization of the left RAA. Under general anesthesia, we

77 perform bilateral exposure of both ~~the~~ aneurysmatic femoral bifurcations
78 preparatory to EVAR procedure and to their open surgical correction. Through a

79 percutaneous left brachial access, we placed a 90 cm 7F introducer in the
80 superior mesenteric artery to create a reference point. Left RAA was selectively

81 catheterized with a J shaped 7F introducer and a 16 mm Amplatzer plug (Abbott,
82 Chicago, USA) was deployed. Then, we deployed from the right side a bifurcated

83 endograft Endurant 23-16-170 mm (Medtronic, Minneapolis, USA) and a left iliac
84 branch and two coils 20 x 20 mm (Cook, Bloomington, USA) into the aneurysm's

85 sac. And lastly, both the femoral aneurysms were corrected by means the
86 interposition of a PTFE 8 mm graft. At the completion angiography, we observed

87 just a slow flow persistence in the RAA with a leaking between the lower portion
88 of the plug and the lower rim of RAA neck. Considering the lengthy procedure,

89 the impairment of the renal function and the fragile clinical picture we decided

90 not to proceed further monitoring the AAA with close radiologic checks. Control
91 CTA at one month showed regular exclusion of both the aneurysms.

92 After 6 months, a new CTA showed a partial dislodgement of the plug with
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94 persistent perfusion of sac (Fig.2). We deployed, after selective catheterization of
95 the RAA, an adjunctive 14 mm Amplatzer plug and four coils obtaining the
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97 intervention, the patient went back to his hometown and was lost to follow-up
98 for 4 years. In the meantime patient's left renal function further worsened,
99 ~~necessitating-requiring~~ the beginning of hemodialysis treatment. Last follow up
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101 reported a reperfusion of RAA together with a significant increase in AAA
102 diameter up to 8.5 cm (Fig. 3). This was caused by the development of an aortic
103 type Ia endoleak originating from above the right renal artery and a type Ib
104 endoleak from the kinked left iliac limb. For all these reasons and considering
105 the end stage renal failure we scheduled a treatment through a two-chimney
106 technique on celiac trunk and SMA to exclude both aortic and renal aneurysms
107 preserving at the same time the function of visceral vascularization. Under local
108 anesthesia, via femoral and brachial access, we deployed a 7 x 37mm and 8 x 37
109 mm BeGraft stent graft (Bentley, Hechingen, Germany), respectively in the celiac
110 trunk and the superior mesenteric artery. To complete the procedure, a 32 x 70
111 Endurant aortic cuff was then placed in the suprarenal position. To correct the
112 iliac kinking of the limbs cause of aortic type IB endoleak, two further iliac
113 branches of 16 mm on the left and 20 mm on the right side and 4 spirals were
114 inserted. CTA after 1 month and duplex ultrasound after 6 and 12 months
115 showed the complete exclusion of the AAA and left RAA with growth stopping
116 (Fig.4).

117

118

119 DISCUSSION

120 RAAs are a rare occurrence, with an incidence of about 1%.² Diagnosis is often
121 made incidentally ~~when the abdomen is imaged for other reasons.~~ They Patients
122 are usually asymptomatic, but sometimes presentation symptoms can be high
123 blood pressure, haematuria, back pain or decreased kidney function. Notably,
124 their rupture can be a life-threatening emergency.

125 Due to their low incidence, the natural history and clinical relevance of RAA, are
126 not completely elucidated. The combination of AAA and RAA is even rarest. It has
127 been more frequently observed in the paediatric population³ while between
128 adults only anecdotal cases have been reported with a particular localization at
129 the origin of the renal artery. 4,5,6,12,7 (Tab.1)

130 Although controversial, recognised indication to their treatment are rupture,
131 presence of symptoms and diameter greater than 2 cm or enlarging nature,
132 pregnancy, renal embolization causing deteriorating renal function and portal
133 hypertension scheduled for liver transplant uncontrolled hypertension.^{1,2}

134 Treatment options for RAA include open surgery (renal artery bypass graft,
135 aneurismectomy. ex vivo repair, autotransplantation or nephrectomy),
136 laparoscopic repair or endovascular procedures by means of selective or non
137 selective embolization, with afferent and efferent vessel preservation or
138 aneurysm exclusion with covered stents.⁷

139 While the approach to RAA is not universally shared, because its treatment is
140 strictly dependent on location and anatomical features, being controversial and
141 technically challenging the endovascular repair of AAAs is widely described and
142 considered feasible even in complex anatomies thanks to the development of
143 advanced endovascular procedure such as parallel grafts.^{8,9}

144 In the case ~~here~~ presented, we have initially chosen a separate but simultaneous
145 endovascular treatment of the two aneurysms, by means of EVAR for the AAA
146 and multiple plug and coil embolizations to exclude the RAA. This strategy was
147 preferred because renal function was impaired but still stable. After ~~the~~ first
148 embolization the decision, ~~to~~ monitoring the RRA ~~and to~~ continue

149 | towards endovascular treatments has been justified for the high surgical risk of
150 | the patient who would hardly have endured a suprarenal or supraceliac aortic
151 | cross clamping. The late reperfusion of RAA and aortic endoleak IA, due to the
152 | progression of the aortic disease with dilatation of the aortic neck, entail a
153 | significant risk of aneurysms growth and rupture and made mandatory a new
154 | treatment. Also the development of the endoleak IB is to be considered an
155 | important topic in the evolution of the aortic disease because this complication is
156 | definitely due to the progression of the disease and the remodeling of the aorta.
157 | Considering the progressive but inexorable worsening of renal function,
158 | requiring hemodialysis, the unfavourable anatomical features, namely the close
159 | origin of all visceral vessels to renal arteries, and poor general conditions, we
160 | decided to continue endovascular treatment way through a two vessel chimney
161 | technique targeted on visceral vessels. It is important to underline that the end
162 | stage renal failure allowed us to exclude completely the RAA performing a two
163 | vessel chimney.
164 | For parallel stents technique to avoid gutters and to preserve visceral perfusion
165 | we have preferred balloon-expandable, PTFE-covered stents thanks to their high
166 | crushing resistance, high conformability, stability and predictable behaviour and
167 | foreshortening. ⁹⁹

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170 **CONCLUSION**

171 Treatment of concomitant AAA and RAA is still a challenge for the wide
172 variability of anatomy. Total endovascular repair of both pathologies could be
173 considered a real option also because all those treatments are repeatable, can
174 be performed under local anaesthesia also in case of critical conditions, but it is
175 mandatory a lifelong follow up to avoid unexpected and impressive growth of
176 both the aneurysms. In our experience, concomitant endovascular treatment of
177 AAA and RAA, through endovascular exclusion and coil embolizations, showed
178 satisfying middle-term results despite that it requires a close monitoring and
179 supplemental procedures.

180 Chimney technique has been successfully adopted for endovascular re-treatment
181 because we considered it a feasible way to have more chances to reach a stable
182 and long lasting system.

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226 **Legends**

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228 Figure 1: evidence of left renal artery and aortic aneurysm and close origin of
 229 superior mesenteric artery and renal arteries

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231 Figure 2: endoleak after coils and plug embolization of left renal artery

232

233 Figure 3: significant aortic I type A endoleak and concomitant new endoleak of
 234 left renal artery

235

236 Figure 4: CT angio shows regular patency of parallel graft and exclusion of aortic
 237 and renal aneurysm

238

239 Table 1: Published reports of concomitant renal and abdominal aortic aneurysms

<u>Author, year</u>	<u>Patient's characteristic</u>	<u>Aneurysms' features</u>	<u>Presentation</u>	<u>Treatment</u>	<u>Follow-up</u>
<u>Wetstein, 2016</u> ⁶	woman, 30years, Takayasu disease	saccular AAA (3.3 cm)+ proximal saccular right RAA (1.7 cm) and previous stented left renal artery	Takayasu disease symptoms Known history of AAA and subsequent occasional finding of RAA	OPEN supraceliac aorto-renal bypass ± aorto-bisiliac replacement	good at 1 year
<u>Jung, 2014</u> ⁷	man, 75 years, Concomitant gallbladder cancer	AAA 5.0 cm, left RAA 3.0 cm	abdominal mass	HYBRID EVAR ± open treatment of RAA (excision end-to-end anastomosis)	Discharge without any complications

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and gallbladder
cancer.

<u>Callicutt, 2005</u> ²	<u>man, 6 years</u>	<u>AAA 3.0 cm +</u> <u>Right RAA 3 cm</u> <u>with multiple</u> <u>areas of kidney</u> <u>infarction and</u> <u>fistula to right</u> <u>renal vein</u>	<u>worsening right</u> <u>flank pain, nausea</u> <u>and diarrhea with</u> <u>Low residual kidney</u> <u>function</u>	<u>OPEN</u> <u>nephrectomy</u> <u>±</u> <u>aorto-aortic</u> <u>replacement</u>	<u>good at</u> <u>1 year, with</u> <u>normal</u> <u>creatinine</u>
<u>Matsagas, 2004</u> ³	<u>N/A</u>	<u>Ruptured AAA</u>	<u>RAA occasional</u> <u>finding</u>	<u>OPEN</u> <u>concomitant</u> <u>aneurysms</u> <u>repair</u>	<u>N/A</u>

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118 **DISCUSSION**

119 RAAs are a rare occurrence, with an incidence of about 1%.² Diagnosis is often
120 made incidentally. Patients are usually asymptomatic, but sometimes
121 presentation symptoms can be high blood pressure, haematuria, back pain or
122 decreased kidney function. Notably, their rupture can be a life-threatening
123 emergency.

124 Due to their low incidence, the natural history and clinical relevance of RAA, are
125 not completely elucidated. The combination of AAA and RAA is even rarest. It has
126 been more frequently observed in the paediatric population³ while between
127 adults only anecdotal cases have been reported with a particular localization at
128 the origin of the renal artery.^{5,6,7} (Tab.1)

129 Although controversial, recognised indication to their treatment are rupture,
130 presence of symptoms and diameter greater than 2 cm or enlarging nature,
131 pregnancy, renal embolization causing deteriorating renal function and portal
132 hypertension scheduled for liver transplant uncontrolled hypertension.^{1,2}

133 Treatment options for RAA include open surgery (renal artery bypass graft,
134 aneurismectomy, ex vivo repair, autotransplantation or nephrectomy),
135 laparoscopic repair or endovascular procedures by means of selective or non
136 selective embolization, with afferent and efferent vessel preservation or
137 aneurysm exclusion with covered stents.

138 While the approach to RAA is not universally shared, because its treatment is
139 strictly dependent on location and anatomical features, being controversial and
140 technically challenging the endovascular repair of AAAs is widely described and
141 considered feasible even in complex anatomies thanks to the development of
142 advanced endovascular procedure such as parallel grafts.^{8,9}

143 In the case presented, we have initially chosen a separate but simultaneous
144 endovascular treatment of the two aneurysms, by means of EVAR for the AAA
145 and multiple plug and coil embolizations to exclude the RAA. This strategy was
146 preferred because renal function was impaired but still stable. After first
147 embolization the decision, monitoring the RRA or continuing towards

148 endovascular treatments has been justified for the high surgical risk of the
149 patient who would hardly have endured a suprarenal or supraceliac aortic cross
150 clamping. The late reperfusion of RAA and aortic endoleak IA, due to the
151 progression of the aortic disease with dilatation of the aortic neck, entail a
152 significant risk of aneurysms growth and rupture and made mandatory a new
153 treatment. Also the development of the endoleak IB is to be considered an
154 important topic in the evolution of the aortic disease because this complication is
155 definitely due to the progression of the disease and the remodeling of the aorta.

156 Considering the progressive but inexorable worsening of renal function,
157 requiring hemodialysis, the unfavourable anatomical features, namely the close
158 origin of all visceral vessels to renal arteries, and poor general conditions, we
159 decided to continue endovascular treatment way through a two vessel chimney
160 technique targeted on visceral vessels. It is important to underline that the end
161 stage renal failure allowed us to exclude completely the RAA performing a two
162 vessel chimney.

163 For parallel stents technique to avoid gutters and to preserve visceral perfusion
164 we have preferred balloon-expandable, PTFE-covered stents thanks to their high
165 crushing resistance, high conformability, stability and predictable behaviour and
166 foreshortening.⁹

167

168

169 **CONCLUSION**

170 Treatment of concomitant AAA and RAA is still a challenge for the wide
171 variability of anatomy. Total endovascular repair of both pathologies could be
172 considered a real option also because all those treatments are repeatable, can be
173 performed under local anaesthesia also in case of critical conditions, but it is
174 mandatory a lifelong follow up to avoid unexpected and impressive growth of
175 both the aneurysms. In our experience, concomitant endovascular treatment of
176 AAA and RAA, through endovascular exclusion and coil embolizations, showed
177 satisfying middle-term results despite that it requires a close monitoring and
178 supplemental procedures.

179 Chimney technique has been successfully adopted for endovascular re-treatment
180 because we considered it a feasible way to have more chances to reach a stable
181 and long lasting system.

182

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211

212 **Legends**

213

214 Figure 1: evidence of left renal artery and aortic aneurysm and close origin of
 215 superior mesenteric artery and renal arteries

216

217 Figure 2: endoleak after coils and plug embolization of left renal artery

218

219 Figure 3: significant aortic I type A endoleak and concomitant new endoleak of
 220 left renal artery

221

222 Figure 4: CT angio shows regular patency of parallel graft and exclusion of aortic
 223 and renal aneurysm

224

225 Table 1: Published reports of concomitant renal and abdominal aortic aneurysms

Author, year	Patient's characteristics	Aneurysms' features	Presentation	Treatment	Follow-up
Wetstein, 2016 ⁶	woman, 30years, Takayasu disease	saccular AAA (3.3 cm)+ proximal saccular right RAA (1.7 cm) and previous stented left renal artery	Takayasu disease symptoms Known history of AAA and subsequent occasional finding of RAA	OPEN supraceliac aorto-renal bypass + aorto-bisiliac replacement	good at 1 year
Jung, 2014 ⁷	man, 75 years. Concomitant gallbladder cancer	AAA 5.0 cm, left RAA 3.0 cm	abdominal mass	HYBRID EVAR + open treatment of RAA (excision end-to-end anastomosis)	Discharge without any complications

and gallbladder
cancer,

Callicutt, 2005 ²	man, 6 years	AAA 3.0 cm + Right RAA 3 cm with multiple areas of kidney infarction and fistula to right renal vein	worsening right flank pain, nausea and diarrhea with low residual kidney function	OPEN nephrectomy + aorto-aortic replacement	good at 1year, with normal creatinine
Matsagas, 2004 ³	N/A	Ruptured AAA	RAA occasional finding	OPEN concomitant aneurysms repair	N/A

FULL TEXT
NOT
AVAILABLE

Author, year	Patient's characteristics	Aneurysms' features	Presentation	Treatment	Follow-up
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Jung, 2014 ⁷	man, 75 years. Concomitant gallbladder cancer	AAA 5.0 cm, left RAA 3.0 cm	abdominal mass	HYBRID EVAR + open treatment of RAA (excision end-to-end anastomosis) and gallbladder cancer,	Discharge without any complications
Callicutt, 2005 ²	man, 6 years	AAA 3.0 cm + Right RAA 3 cm with multiple areas of kidney infarction and fistula to right renal vein	worsening right flank pain, nausea and diarrhea with low residual kidney function	OPEN nephrectomy + aorto-aortic replacement	good at 1year, with normal creatinine
Matsagas, 2004 ³ FULL TEXT NOT AVAILABLE	N/A	Ruptured AAA	RAA occasional finding	OPEN concomitant aneurysms repair	N/A

Figure 1



Figure 2

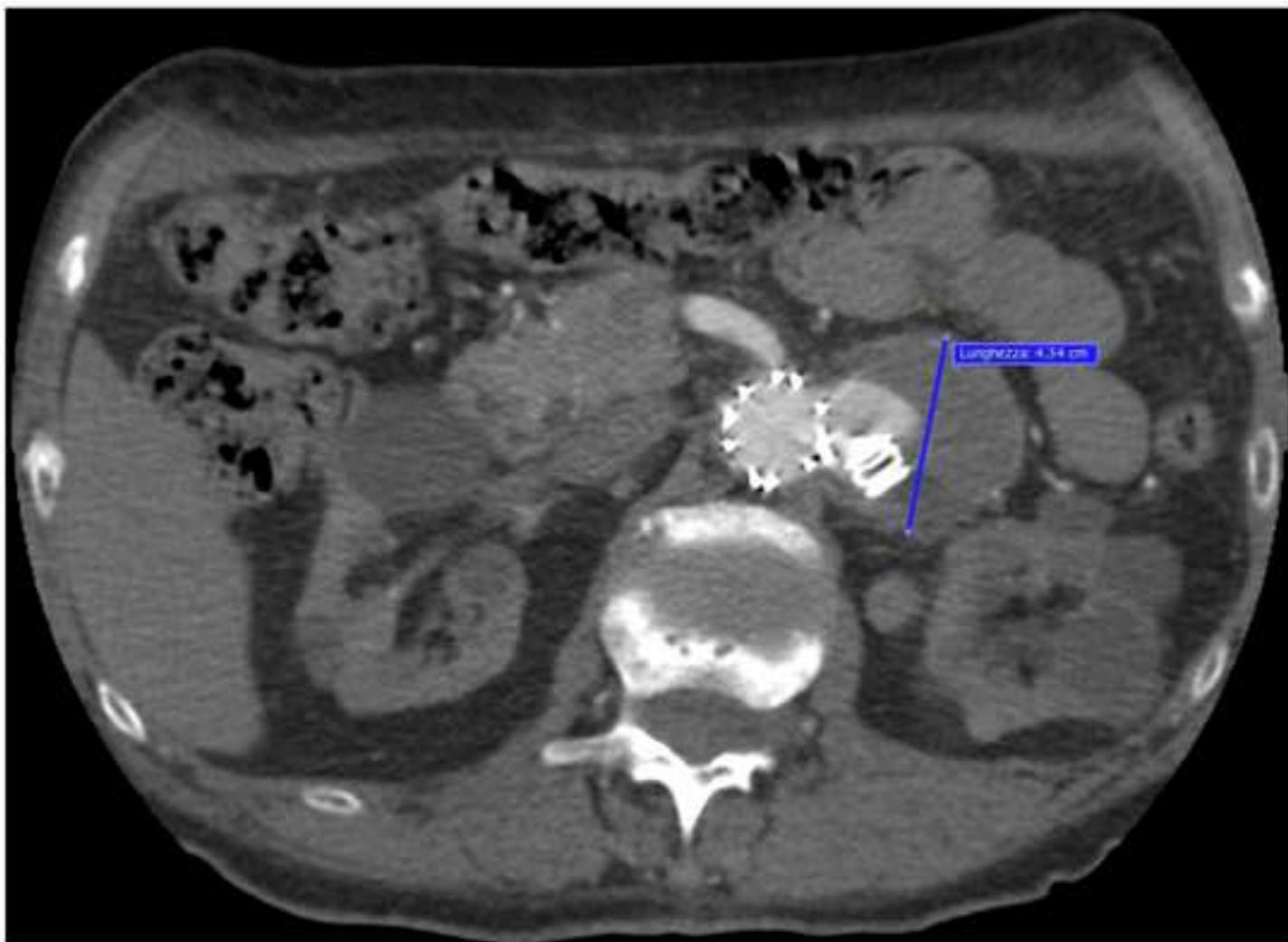


Figure 3



Figure 4



Data in Brief

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